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Emergency medicine is a specialty which closely reflects societal challenges and consequences of public policy decisions. The emergency department specifically deals with social injustice, health and economic disparities, violence, substance abuse, and disaster preparedness and response. This journal focuses on how emergency care affects the health of the community and population, and conversely, how these societal challenges affect the composition of the patient population who seek care in the emergency department. The development of better systems to provide emergency care, including technology solutions, is critical to enhancing population health.

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# The Effect of Dictation on Emergency Medicine Resident Time to Note Completion

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**Introduction**: Timely documentation of a patient encounter is a necessary component for delivering high-quality healthcare as it has direct impacts on continuity of care. The use of voice recognition software has been integrated into the electronic health record (EHR) to increase efficiency of documentation. We aimed to investigate the impact of dictation use on emergency medicine (EM) residents' time to note completion.

**Methods**: We conducted this study in a three-year EM residency program at an academic emergency department. Notes written in the EHR by EM residents were included for analysis. We split notes into two cohorts based on academic year: 2018-19 academic year (AY18-19); and 2021-22 academic year (AY21-22). We analyzed approximately 37,000 notes per cohort. Dictation was available to all residents in each cohort. The length of the note (measured by character count) and time to note completion (less than or greater than 24 hours) was analyzed.

**Results**: For both the AY18-19 and AY21-22, the rate of note completion within 24 hours was higher when using dictation compared to typing (odds ratio [OR] 1.3 and OR 2.9, respectively). Aggregated data of both cohorts showed 77.9% of dictated notes were completed within 24 hours compared to 70.9% of typed notes ($P < .001$). In both cohorts, the average number of characters per note was larger if the note was dictated. For AY18-19, the average was 6,628 characters for dictated notes vs 6,136 for typed notes ($P < .05$). Similarly, for AY21-22, the average was 6,531 vs 6,347 ($P < .05$).

**Conclusion**: The use of dictation by EM residents for note completion resulted in a higher likelihood of the note being completed within 24 hours. [West J Emerg Med. 2025;26(6)1499–1503.]

## INTRODUCTION

Timely documentation of a patient encounter is a necessary component for delivering high-quality healthcare as it has a direct impact on continuity of care.[1,2] However, many physicians report being unable to complete tasks related to the electronic health record (EHR) during their clinical hours, often requiring remote access to the EHR outside scheduled work time.[3] Inefficient documentation processes may contribute to physicians' spending significant time outside their clinical shifts to finalize patient notes.

Initiatives aimed at improving physician well-being have targeted the reduction of EHR- and documentation-related burdens.[4] The Stanford Model of Occupational Well-Being is a widely recognized framework that identifies workplace efficiency as a component influencing physician wellness.[5] Within this model, streamlined documentation is highlighted as a critical factor in enhancing workplace efficiency. Therefore, optimizing workplace efficiency by improving interactions with the EHR may support physician wellness. Additionally, the Council of Residency Directors in Emergency Medicine has recommended optimization of the EHR as a best practice for promoting resident wellness.[6]

Various interventions have been tried to decrease the burden of charting on clinicians. To help increase the efficiency of documentation and decrease the amount of time spent on documenting, some EHR vendors have introduced shortcuts, often called "dot phrases," which are short texts beginning with "." that are typed into a note and are then replaced by different, often more lengthy, text (for example, replacing ".wdl" with "within defined limits"). However, a recent study has shown that dot phrases do not affect the time to note completion.[7] The use of a medical scribe, a person who accompanies the physician during the patient encounter and documents portions of the chart, has been shown to increase clinician efficiency.[8] One study demonstrated that faculty use of scribes can enhance resident educational experiences.[9] However, there is a lack of research examining the effects of scribes documenting on behalf of residents, specifically regarding the impact on a resident's ability to independently and effectively document in the EHR. Another strategy to alleviate the burden of documentation is the integration of voice recognition software. The use of dictation strongly correlated with increased emergency medicine (EM) resident productivity as measured by relative value units per hour.[10]

However, to our knowledge, there has not been a study investigating the effect of dictation on timely EM resident note completion as an indicator of efficiency. Our primary goal in this study was to determine whether dictated notes were linked to improved documentation efficiency by assessing whether notes are more likely to be completed within 24 hours when dictation is used.

*Population Health Research Capsule*

What do we already know about this issue?
*Timely documentation is crucial to high-quality patient care as it facilitates continuity among team members.*

What was the research question?
*We examined whether the use of dictation improves the timeliness of documentation completion.*

What was the major inding of the study?
*Within two cohorts analyzed, dictation improved timely note completion, with ORs of 1.47 and 2.93, respectively.*

How does this improve population health?
*Using dictation results in faster time to note completion, enhancing continuity of patient care and supporting clinician wellness by reducing the amount of after-hours work.*

## METHODS

### Study Setting and Population

The study was conducted in a three-year EM residency program at an academic emergency department (ED). The ED is in a midwestern, small-city urban location with 54 beds and approximately 60,000 patient visits annually. The EM residents were eligible for inclusion if they had worked in the ED uninterrupted between 2017–2022. There were 12 EM residents per year until 2020, after which there were 13 per year. The institution uses M*Modal Fluency Direct (3M Company, Maplewood, MN) for dictation, and a microphone and dictation software integrated with the EHR was available at each workstation and in multiple shared work areas (eg, resident lounge). All residents receive dictation training during residency orientation.

Most residents will start a patient note while on shift, but it is not mandatory that they stay at the hospital after their shift to complete their notes. All residents receive personal microphones, can dictate using their personal phone, and can access dictation software remotely; thus, they are able to complete notes at their convenience. Additionally, there is no strict consequence for not completing a note within 24 hours. However, weekly reports are generated, and residents who are frequently delinquent may be placed on an individualized improvement plan or probation based on tardy chart completion.

### Study Protocol

We included notes written by EM residents between 2017–2022. This included notes from an adult ED at an academic medical facility, a pediatric ED, and an affiliated community ED. Although a randomized control study design was considered, we conducted a retrospective study to better reflect real-world use of dictation in actual clinical practice. Data obtained included the note length (total number of characters in the note), whether the note was signed by a resident within 24 hours of the resident assigning him/herself to the patient, and whether dictation was used to complete any portion of the note. We collected data on note length to assess whether it acted as a confounder, specifically examining whether shorter notes are associated with faster chart completion. For this study, we defined efficiency as documentation timeliness, measured by the completion of notes within 24 hours. This timeframe was selected as it aligns with institutional documentation standards and logically supports continuity of care among the healthcare team. We did not assess quality of the note, although this is also important.

Each resident was assigned a study identification number, and the identification key was accessible only by the data scientist on the study team (DH) who did not perform the statistical analysis. Patient information was de-identified for the author performing the data analysis (LW). Data was imported to Microsoft Excel (Microsoft Corp, Redmond, WA) for analysis.

**Data Analysis**

Analysis was run on notes completed by two cohorts of residents: the 2018-19 academic year (AY18-19) and the 2021-22 academic year (AY21-22). We excluded AY19-20 and AY20-21 due to the effects of the COVID-19 pandemic on clinical volumes and related interruptions to clinical practice. Notes that included any portion completed using dictation were identified by an internal flag within the EHR. We stratified notes by disposition to account for the fact that some notes may be completed sooner if they have a higher priority disposition. For example, the note for a patient being transferred to an outside facility needs to be completed before transfer. Each patient note was coded into one of two categories based on their disposition: high priority ("Admit," "Transfer to another facility," "Against medical advice"); or regular priority (all other disposition codes that were not a high priority). Notes for patients handed off during shift change, or "sign out" patients, were not categorized as high priority.

We used a logistic regression model to adjust for covariates potentially affecting time to note completion. Predictor variables included dictation use, note length, resident's postgraduate year (PGY), and note priority. Additionally, one resident was excluded from the analysis due to an off-schedule progression through the program and graduation. This study was deemed exempt as quality improvement by the institutional review board.

## RESULTS

We included 37,778 notes in the analysis of the AY18-19 cohort and 37,716 notes of the AY21-22 cohort. Of the 37,778 notes in the AY18-19 cohort, 35,162 (93.08%) were non-priority dispositions and 2,616 (6.92%) were high-priority dispositions. Of 37,716 notes in the AY21-22 cohort, 36,692 (97.28%) were non-priority and 1,024 (2.72%) were high priority.

In the AY18-19 cohort, the unadjusted rate of note completion within 24 hours was higher when using dictation compared to typing (odds ratio [OR] 1.3). Similarly, in the AY21-22 the unadjusted rate of note completion within 24 hours was higher when using dictation compared to typing (OR 2.9). Aggerated data from the two cohorts showed that 77.9% of dictated notes were completed within 24 hours vs 70.9% of typed notes ($P < .001$). The Figure depicts the overall aggregated time to note completion for both academic years with and without dictation. In both the AY18-19 and AY21-22 cohorts, the logistic regression model was statistically significant, and all the predictors were significant as well. Additionally, the AY18-19 model correctly predicted timely note completion approximately 60% of the time, and the AY21-22 model correctly predicted completion of notes in 24 hours in the analysis sample approximately 68% of the time. The $R^2$ for AY18-19 was .0453, and the $R^2$ for AY21-22 was .1151.

In the AY18-19 cohort, dictation use and disposition priority status were both strong positive predictors of timely note completion while an increase in note length, whether dictated or typed, was associated with a decrease in the likelihood of timely note completion. The predicted probability of an average length, regular-priority note being completed on time by a PGY-3 resident when dictation was not used was 0.63, and 0.71 when dictation was used (OR 1.47). Timely note completion was about one and a half times more likely with dictation than without after controlling for other explanatory variables.

In AY21-22, most of the same effects were observed, with dictation use predicting an even greater increase in the likelihood of timely note completion. After adjusting for other predictors, the OR for note completion within 24 hours with

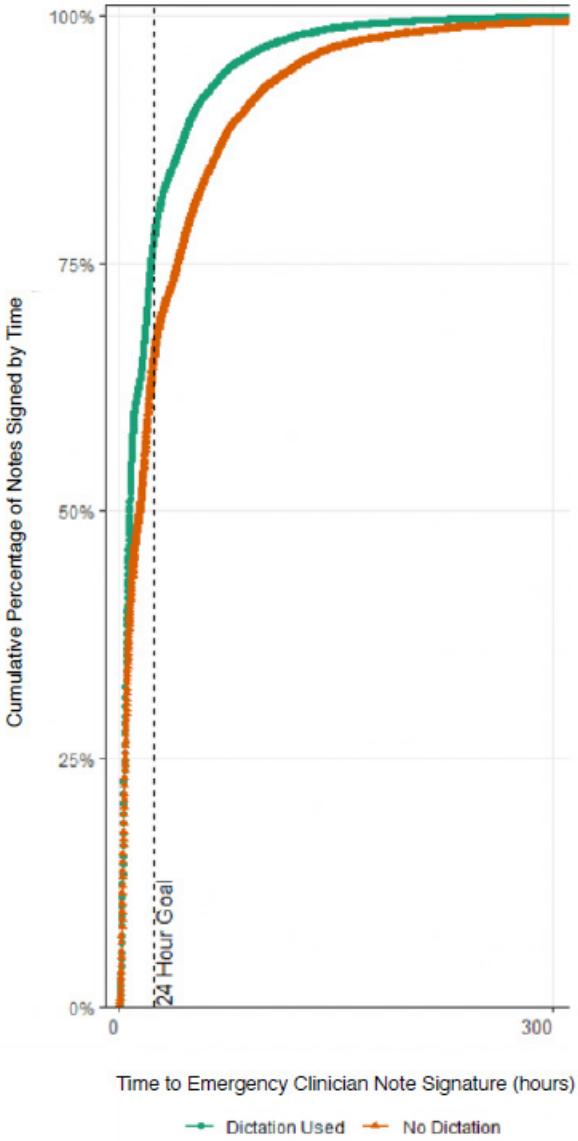


**Figure 1**. Overall aggregated time to note completion by emergency medicine residents for academic years 2018-2019 and 2021-2022 with and without dictation.

dictation use was 2.93, aligning with the simple contingency analysis. In the AY18-19, the average number of characters per typed note was 6,136 compared to dictated notes, which was significantly larger at 6,628 ($P < .05$). In the AY21-22, the average number of characters per typed note was 6,347; the average number of characters per dictated note was significantly larger at 6,531 ($P < .05$).

## DISCUSSION

Dictation is widely used among EM residents—at least in this residency program. In both cohorts analyzed, the rate of note completion within 24 hours was more likely with dictation than without after controlling for other explanatory variables. The use of dictation improving documentation efficiency is a crucial finding as other interventions, such as dot phrases, have not been proven to increase efficiency.[6] (Interestingly, the integration of artificial intelligence may enhance efficiency of documentation; however, this is in still in the preliminary stages of evaluation.[11]) The relatively low $R^2$ suggests that even though dictation and the other predictors have statistically significant relationships with timely note completion, many external factors played an important role in note completion, which our study was not able to capture. Additionally, there is a noteworthy difference in the ORs between the two cohorts with respect to time to note completion and note length. The reason for these differences is unclear and warrants further investigation, potentially through focus groups or qualitative methods, to explore differences in workflows, training, or other contextual factors between the resident cohorts.

While dictation use was associated with a higher rate of note completion within 24 hours, it did result in longer note length by several hundred characters. It is important to acknowledge that while the note length was longer in dictated notes, we did not assess the quality of included information. It is possible that the additional included information was beneficial and that dictation facilitates easier inclusion of helpful medical information and decision-making. However, it is also possible that dictation results in a greater volume of low-quality information being included in the note. Significant inter-physician variation has been previously noted in EHR data and has been cited as a possible barrier to safe and efficient care.[12] Assessment of the quality of dictated vs typed notes represents an avenue for further study. Additionally, dictation is also known to cause errors in transcription, some of which can be clinically significant.[13] Exploring the impact of these errors on resident documentation efficiency and clinical care could also be investigated further.

Finally, the association between dictation and increased note completion within 24 hours suggests potential downstream effects on resident wellness, as it may contribute to greater workplace efficiency and reduce the need to complete notes outside clinical shifts. This relationship warrants further investigation.

## LIMITATIONS

There are several limitations to this study. First, because we conducted this study at a single institution generalizability may be limited; other implementations of dictation could provide different results. Additionally, notes were included for analysis if any portion of the note was completed with dictation, but there was no data on how much of the note was completed with dictation. Further, not all notes written by residents were included for analysis. Notes written at the Veterans' Administration hospital and the unaffiliated community site were not included as these sites represented a small minority of the residents' training experience and used a different EHR. Finally, factors that may influence time to note completion, such as priority of disposition, were accounted for; however, there are additional factors that may impact time to note completion that were not accounted for, such as patient volume or overall shift workload. Future areas of investigation may include conducting focus groups or interviews to further investigate the perception of residents on what factors influence time to note completion and how dictation influences efficiency.

## CONCLUSION

The use of dictation by residents for note completion results in a higher likelihood of the note being completed within 24 hours.

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# Program Director Perspectives on the Impact of the Proposed 48-Month Emergency Medicine Residency Requirement: A National Survey

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**Introduction:** In early 2025, the Accreditation Council for Graduate Medical Education (ACGME) announced proposed revisions to emergency medicine (EM) residency training to include substantial changes to the length of training programs, required rotations, and structured experiences. To date, no published national survey has sought to determine how these changes would impact individual programs.

**Methods:** Over a three-week period in April 2025, we anonymously surveyed program directors or their designees online through the Council of Residency Directors in Emergency Medicine listserv. Survey respondents were asked about the impact the changes would have on their programs and their overall opinions of the proposed 48-month minimum requirement.

**Results:** A total of 86 program directors responded to the survey (response rate of 29.9%) with representative samples from current three-year (83.7%, 72/86) and four-year (16.3%, 14/86) programs. Most program directors reported that they would have to make significant revisions in either structured experiences, required rotations, or both. Most survey respondents from three-year programs (52/72) do not support the proposed changes, whereas all respondents from four-year programs (14/14) do support the changes (P<.001).

**Conclusion:** Proposed program requirements may require modifications in both three- and four-year programs; 33 of the 86 program directors surveyed reported that would need more than one year to meet the requirements, if adopted. This raises the concern that programs may not be prepared to implement the revisions within the proposed timeline, potentially impacting resident education and the future EM workforce. The ACGME should consider a staged rollout of requirements to allow them to be thoughtfully implemented in a meaningful way. [West J Emerg Med. 2025;26(6)1504–1509.]

## INTRODUCTION

On February 12, 2025, the Accreditation Council for Graduate Medical Education (ACGME) proposed significant revisions to the program requirements for emergency medicine (EM) residency training in the United States, with the most notable change being the standardization of training length to 48 months for all programs, effective July 1, 2027.[1] This proposed change has generated considerable discussion and debate within the EM community, with concerns raised about its potential impact on resident education, program finances, and the EM workforce. Currently, most programs are three years in length, with four-year programs comprising less than 25% of EM residency programs in the US.[2]

Approximately 60% of EM program directors (PD) (173/289) from the ACGME database completed a survey created by the Program Requirements Writing Group 3, which

found that summed averages for necessary experiences were 41.6 months for three-year programs and 50.7 months for four-year programs. This survey has subsequently been used as justification for the proposed new program requirements, including the 48-month minimum program length. However, the survey did not specifically ask about support for a change from three to four years of training, and it was not designed to examine the impact of any potential changes. The ACGME's rationale for this change includes concerns about declining board pass rates, potentially attributed to shorter EM shifts and fewer patient encounters during training.[4] Yet the available published data show that graduates of three- and four-year programs perform similarly in clinical practice and on board pass rates. [5,6]

To further explore the perceived challenges and opportunities associated with this change, we surveyed EM PDs on the changes that would be required within their programs and anticipated challenges with the new requirements, and we gauged their support for the proposed requirement of 48 months of training for all EM programs.

*Population Health Research Capsule*

What do we already know about this issue?
*The ACGME has proposed major changes to emergency medicine (EM) training.*

What was the research question?
*How do program directors view the proposed ACGME changes and what resources are needed to comply?*

What was the major finding of the study?
*33.6% of 3-year and 100% of 4-year programs support the change to 48 months minimum residency training in emergency medicine (P < .001).*

How does this improve population health?
*The study identifies changes that EM programs would need to implement meet new standards, to ensure the future workforce is well-prepared to deliver quality care.*

## METHODS

We conducted a national cross-sectional survey of EM PDs, or their selected designees (defined as a faculty member delegated by the PD or other residency leadership), from ACGME-accredited EM residency programs in the US over a three-week period in April 2025. After we developed the survey instrument it was piloted for content validity, clarity, and relevance by four members of our educational leadership teams who have experience in program leadership and survey-based research. All feedback was incorporated into the survey, which was approved by our institutional review board as an exempt study. The survey was designed on SurveyMonkey (Momentive Inc., San Mateo, CA) and disseminated to EM PDs through the Council of Residency Directors (CORD) in Emergency Medicine Program Director list-serv. Reminders were sent at one-week intervals for a total of three times. At the time of the study there were 288 PDs in ACGME-accredited EM programs.

The survey (Appendix A) consisted of 11 questions and was divided into three sections: demographic information; curricular changes; and reflection. In the section on proposed curricular changes, participants were asked to assume that the program requirements had been adopted and to answer questions on anticipated changes to their program's required rotations (62 weeks at primary emergency department [ED], low-resource ED, high-resource ED, low-acuity area, critical care, pediatric intensive care unit, pediatric ED, administration/quality assurance, toxicology/addiction medicine, and emergency medical services). They were then asked about anticipated changes that would be necessary to meet the required structured experiences (non-laboratory diagnostics such as ultrasound, telemedicine, primary assessment and decision-making, airway management, ophthalmologic procedures, acute psychiatric emergencies, sensitive exams, transitions of care, and observation medicine). The final section of the survey included questions on the time needed to adopt the 48-month format, additional resources required (additional funding aside from salary, additional training sites, additional core faculty, additional clinical faculty, more protected time, additional simulation or procedure lab time), and agreement on the proposed changes.

We summarized categorical survey responses with frequencies and percentages. Chi-square tests were used to evaluate associations. *P*-values < .05 were considered statistically significant. We performed analysis using SAS v9.4 (SAS Institute Inc, Cary, NC).

## RESULTS

A total of 92 respondents completed the survey. However, six were excluded because they did not identify as either a PD or their designee, and their data was not included in the analysis. In total, 86 EM programs were included in the analysis of the survey data for a final response rate of 29.9%. Of the 86 PDs who completed the survey, 72 (83.7%) were from three-year programs and 14 (16.3%) from four-year programs, which is similar to the breakdown of three- and four-year programs currently listed on the Emergency Medicine Residents' Association Match website.[7] Most programs were university-based (33, 38.4%), followed

by community-based university-affiliated (31, 36%), and community-based (22, 25.6%). Participant programs were geographically representative (Table) of the EM academic community based on Fellowship and Residency Electronic Interactive Database Access geographic regions.[7]

**Curriculum Changes**

Of the 86 PDs who responded to the survey, 50 (58%) anticipated needing to make three or more changes to their curricula to meet the required nine structured experiences (Table). This was not significantly different between three- and four-year programs. Of the 86 respondents, 14 (16%) reported already having all the required rotations in the proposed requirements, and 34 (40%) reported that they would need to add three or more rotations. Forty-four respondents (51.2%) indicated that they would be likely to increase their complement of residents, whereas 12 (14%) indicated that they would likely decrease the number of residents. Twenty-five respondents (29.1%) indicated that they were unlikely to change their complement, and five respondents (5.8%) did not answer the question. Most of the programs that would look to expand their complement were currently three-year programs (42/44, 95.5%).

**Time Needed**

Forty-nine (57%) PDs indicated readiness for all the changes within a one-year period, while 33 (38.4%) reported they would require more than one year to prepare, 20 (23%)

**Table.** Survey results comparing three- and four-year programs by demographic region, program type, time required to implement changes, additional resources required to implement changes, agreement on 48 months of training, total changes needed in experiences, and total changes needed in rotations.

| | Frequency (N = 86) | Percentage | 3 years (n = 72) | | 4 years (n = 14) | | P-value |
|---|---|---|---|---|---|---|---|
| What geographic region is your program in (as listed in FRIEDA)? | | | | | | | |
| East North Central (IL, IN, MI, OH, WI) | 15 | 17.4% | 13 | 18.1% | 2 | 14.3% | |
| East South Central (AL, KY, MS, TN) | 2 | 2.3% | 2 | 2.8% | 0 | 0.0% | |
| Mid Atlantic (NJ, NY, PA) | 22 | 25.6% | 18 | 25.0% | 4 | 28.6% | |
| Mountain (AZ, CO, ID, MT, NM, NV, UT, WY) | 3 | 3.5% | 2 | 2.8% | 1 | 7.1% | |
| New England (CT, MA, ME, NH, RI, VT) | 4 | 4.7% | 2 | 2.8% | 2 | 14.3% | |
| Pacific (AK, CA, HI, OR, WA) | 5 | 5.8% | 3 | 4.2% | 2 | 14.3% | |
| South Atlantic (DC, DE, FL, GA, MD, NC, SC, VA, WV) | 16 | 18.6% | 16 | 22.2% | 0 | 0.0% | |
| Territory (PR) | 1 | 1.2% | 1 | 1.4% | 0 | 0.0% | |
| West North Central (IA, KS, MN, MO, ND, NE, SD) | 6 | 7.0% | 5 | 6.9% | 1 | 7.1% | |
| West South Central (AR, LA, OK, TX) | 12 | 14.0% | 10 | 13.9% | 2 | 14.3% | |
| What best describes your program? | | | | | | | |
| Community-based | 22 | 25.6% | 19 | 26.4% | 3 | 21.4% | |
| Community-based, university affiliated | 31 | 36.0% | 28 | 38.9% | 3 | 21.4% | .27 |
| University based | 33 | 38.4% | 25 | 34.7% | 8 | 57.1% | |
| Given your current resources, how much time do you feel you would need to create the new rotations and experiences required in the new rules? | | | | | | | |
| Ready now | 6 | 7.0% | 4 | 5.6% | 2 | 14.3% | |
| < 1 year | 21 | 24.4% | 16 | 22.2% | 5 | 35.7% | |
| 1 year | 22 | 25.6% | 20 | 27.8% | 2 | 14.3% | |
| 2 years | 20 | 23.3% | 15 | 20.8% | 5 | 35.7% | |
| 3 years | 10 | 11.6% | 10 | 13.9% | 0 | 0.0% | |
| ≥ 4 years | 3 | 3.5% | 3 | 4.2% | 0 | 0.0% | |
| Missing | 4 | 4.7% | 4 | 5.6% | 0 | 0.0% | |

*FRIEDA,* Fellowship and Residency Electronic Interactive Database Access.

**Table.** Continued.

| | Frequency (N = 86) | Percentage | 3 years (n = 72) | | 4 years (n = 14) | | P-value |
|---|---|---|---|---|---|---|---|
| What additional resources would you require to meet the new requirements?* | | | | | | | |
| Additional funding aside from salary | 48 | 55.8% | 45 | 62.5% | 3 | 21.4% | |
| Additional training sites | 41 | 47.7% | 33 | 45.8% | 8 | 57.1% | |
| Additional core faculty | 36 | 41.9% | 34 | 47.2% | 2 | 14.3% | |
| Additional clinical faculty | 20 | 23.3% | 19 | 26.4% | 1 | 7.1% | |
| More protected time | 41 | 47.7% | 38 | 52.8% | 3 | 21.4% | |
| Additional simulation or procedure lab time | 36 | 41.9% | 33 | 45.8% | 3 | 21.4% | |
| Do you agree with the change to require 48 months of training for all EM programs? | | | | | | | |
| No | 52 | 60.5% | 52 | 72.2% | 0 | 0.0% | |
| Yes | 29 | 33.7% | 15 | 20.8% | 14 | 100.0% | <.001 |
| Missing | 5 | 5.8% | 5 | 6.9% | 0 | 0.0% | |
| Total changes needed in structured experiences | | | | | | | |
| 0 | 1 | 1% | 1 | 1% | 0 | 0.0% | |
| 1 to 2 | 31 | 36% | 28 | 39% | 3 | 21.4% | |
| 3 to 4 | 28 | 33% | 21 | 29% | 7 | 50.0% | .40 |
| ≥ 5 | 22 | 26% | 18 | 25% | 4 | 28.6% | |
| Missing | 4 | 5% | 4 | 6% | 0 | 0.0% | |
| Total changes needed in required rotations | | | | | | | |
| 0 | 14 | 16% | 11 | 15% | 3 | 21.4% | |
| 1 to 2 | 34 | 40% | 30 | 42% | 4 | 28.6% | |
| 3 to 4 | 24 | 28% | 19 | 26% | 5 | 35.7% | .72 |
| ≥ 5 | 10 | 12% | 8 | 11% | 2 | 14.3% | |
| Missing | 4 | 5% | 4 | 6% | 0 | 0.0% | |
| Anticipated changes in resident complement | | | | | | | |
| Decrease | 12 | 14% | 10 | 13.9% | 2 | 14.3% | |
| No Change | 25 | 29.1% | 15 | 20.8% | 10 | 71.4% | <.001 |
| Increase | 44 | 51.2% | 42 | 58.3% | 2 | 14.3% | |
| Missing | 5 | 5.8% | 5 | 6.9% | 0 | 0.0% | |

*Not mutually exclusive.
*EM*, emergency medicine; *FRIEDA*, Fellowship and Residency Electronic Interactive Database Access.

would require two years, and 13 (15%) would require more than three years to prepare.

### Overall Support

Of the PDs of four-year programs, 100% (14/14) supported the change to a minimum 48 months of residency training. However, only 21% (15/72) of three-year PDs supported the change ($P$<.001).

## DISCUSSION

### Structured Experiences

Our survey results indicate that the new program requirements would require a substantial need for curricular revision, which impacts programs differently. For the new "experiences" requirement, only one PD surveyed reported already having all components in place. By contrast, 36% of PDs (31/86) reported that they would probably require one to two changes, and 26% (22/86) would have to make ≥ 5 curricular changes to meet the "experiences" requirements. Curricular revision, including time to pilot, revise, and assess the curricula, is a time-intensive process that can take over a year.

### Required Rotations

The required rotations also pose challenges for programs.

While 16% (14/86) reported already having all required rotations, 40% (34/86) of the PDs surveyed reported that they would require ≥ 3 revisions to their rotations. When these new rotations require a new training site, such as adding a low-resource ED, it takes a considerable amount of time to research sites and reach agreements. These external sites can also impact the funding of programs through the Centers for Medicare and Medicaid Services.[8] Additionally, new rotations may require the addition of new faculty, more faculty development, and institutional agreements that cost money and take time.

### Time Needed

While 57% of the PDs surveyed (49/86) reported readiness for changes in one year, 38% (33/86) reported they would need more than one year to prepare for the new requirements. This affected both three-year (28/72, 39%) and four-year (5/14, 36%) programs. More concerning is that 15% (13/86) of the PDs surveyed anticipated needing more than three years to prepare for the new program requirements. If those programs were truly unable to prepare in the time frame proposed by the Residency Review Committee (RRC) and decided to close their programs, this could have a major impact on the number of trainees in EM. Additionally, should the RRC-EM grant exceptions or extensions to some programs transitioning to a 48-month format, it could create a competitive advantage to those programs in resident recruitment.

### Overall Support

While overall support for the change to 48 months of training was universal for the PDs of four-year programs, there was considerable disagreement among the PDs of three-year programs, with only 15 (22%) supporting the change and 52 (78%) opposing. Our findings of support for a 48-month training requirement mirror a previous study that showed a strong correlation between the current length of a program and its PD's support for that format.[9]

There has been robust discussion regarding the proposed changes since they were presented. Emergency medicine is not alone in considering lengthening residency training time. Family medicine has also discussed a transition to a 48-month training program, which would entail more study and a gradual transition rather than a sudden turnaround.[10] The majority of EM program directors surveyed indicated that they would be likely to increase their complements of residents, which could significantly impact the future workforce in EM. Further study is needed to determine how these complement changes may affect the total number of residency spots available in EM each year. More study is needed to fully understand the impacts these changes would have on EM training programs, as well as their impact on the costs involved, especially when considering the lack of evidence to support the extension of training.

## LIMITATIONS

The results of this survey do not include all EM residency programs in the United States, as not all programs are part of CORD, and not all members participate in the list-serv we used to disseminate the survey. Additionally, only 29.9% of programs responded to the survey, creating a significant risk of non-responder bias; however, an appropriate representation of programs both geographically and in terms of length of training was included, which provides support that the data are appropriately representative of the general EM academic community. The narrow three-week window to respond also may have impacted the total number of responses. Finally, we did not collect data on whether the respondent was a program director or their designee, only that they attested to being either the PD or a designee.

## CONCLUSION

Most of the program directors who responded to a survey on the proposed new minimum of 48 months training in emergency medicine were opposed to the change, and a significant minority reported being unprepared to implement the new requirements within one year as proposed by the RRC-EM. If the ACGME does adopt the proposed program requirements in total, multiple years may be required for programs to create new and effective curricula and rotations. More study is needed on the impact of the proposed changes that focuses on the outcomes of graduates. Previous studies have already shown us that graduates of three- and four-year programs perform similarly on the American Board of Emergency Medicine certifying exam and in clinical practice.[5,6] The ACGME should consider a phased roll-out of new requirements to ensure programs have time to thoughtfully and meaningfully adhere to the new requirements in a way that is beneficial to their trainees.

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# A Qualitative Study of Senior Residents' Strategies to Prepare for Unsupervised Practice

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**Introduction:** As emergency medicine (EM) residents prepare for the transition into unsupervised practice, their focus shifts from demonstrating competencies within familiar training environments to anticipating their new roles and responsibilities as attending physicians, often in unfamiliar settings. Using the self-regulated learning framework, we explored how senior EM residents proactively identify goals and enact learning strategies leading up to the transition from residency into unsupervised practice.

**Methods:** In this study we used a constructivist grounded theory approach, interviewing EM residents in their final year of training at two residency programs. Using the self-regulated learning framework as a sensitizing concept for analysis, we conducted inductive, line-by-line coding of interview transcripts and grouped codes into categories. Theoretical sufficiency was reached after 12 interviews, with four subsequent interviews producing no divergent or disconfirming examples.

**Results:** We interviewed16 senior residents about their self-regulated learning approaches to preparing for unsupervised practice. Participants identified two types of gaps that they sought to address prior to entering practice: knowledge/skill gaps, and autonomy gaps. We employed specific workplace learning strategies to address each type of gap, which we have termed cherry-picking, case-based hypotheticals, parachuting, and making the call, and reflection on both internal and external sources of feedback to assess the effectiveness of these learning strategies. This study presents participants' identification of gaps in their residency training, their learning strategies, and reflections as cyclical processes of self-regulated learning.

**Conclusion:** In their final months of training EM residents strategically leverage learning strategies to bridge gaps between their self-assessed capabilities and those they anticipate needing to succeed in unsupervised practice. These findings show that trainees have agency in how they use goal setting, strategic actions, and ongoing reflection to prepare themselves for unsupervised practice. Our findings also suggest tailored approaches whereby programs can support learning experiences that foster senior residents' agency when preparing for the challenges of future practice. [West J Emerg Med. 2025;26(6)1510–1518.]

## INTRODUCTION

Competency-based medical education frameworks provide scaffolding and accountability to ensure that emergency medicine (EM) trainees develop the necessary knowledge and skills for unsupervised practice.[1,2] While competency-based medical education frameworks provide a roadmap for residents to deliberately practice the core elements of EM, graduates of EM training programs often

lament the inevitability of encountering new challenges when entering practice.[3,4] This suggests that the training experiences that advance residents' competencies (what a resident does to demonstrate their abilities) must be done in conjunction with efforts to advance residents' capabilities (the things they can think or do in future practice.)[5] While competencies are often embedded in the tools that training programs use to assess residents,[1,6,7] capability development requires trainees to engage in dynamic self-assessment[8] to consider what they can work on now to prepare themselves for future transitions. A capability approach looks beyond training residents who are simply competent, aiming instead to develop trainees who can self-diagnose their future learning needs and enact learning strategies to achieve their goals.[9–11]

Self-regulated learning (SRL) provides a framework to study how senior residents approach workplace learning to prepare for their transitions into unsupervised practice.[12] The SRL theory proposes that individuals are "metacognitively, motivationally, and behaviorally active participants in their own learning process."[13] This provides a structure to consider how residents might assess their abilities and modulate their activities during training.[14] These SRL behaviors are often depicted as a cycle whereby individuals set goals, employ learning strategies to attain these goals, and reflect on their progress.[14] This cycle is context-dependent, shaped by learner characteristics (eg, knowledge, prior experiences, emotions, and confidence) as well as by the learning environment (structure, supports, and cultural expectations).[15] Learner-related factors such as autonomy, efficacy, and accumulated experience have been shown to support engagement with SRL,[16] suggesting that residents in the final months of training have nuanced and mature self-regulated learning habits.

The end of residency training is a compelling period to examine SRL as it relates to capability development. As residents prepare for the transition into unsupervised practice, their focus shifts from demonstrating advanced competencies within familiar training environments[7] to anticipating their performance with new roles and responsibilities as attending physicians, often in unfamiliar practice environments.[17–21] In recent work exploring how senior EM residents conceptualized their preparedness for unsupervised practice, we found that trainees were cognizant of the inevitable mismatch between what they learned in training and what they would be expected to do in unsupervised practice.[3]

We were struck by trainees' sense of agency in their reflections,[22] particularly by how they set goals and leveraged their learning environments to create learning strategies that addressed their anticipated future practice needs. Recognizing that these findings have not been described previously in the literature, we returned to our data using the lens of SRL to explore how senior residents proactively identified goals and enacted learning strategies specific to their transitions from residency into unsupervised practice. By elaborating these strategies, we hope to provide insights that educators can use to tailor their support for senior trainees during these important transition periods.

*Population Health Research Capsule*

What do we already know about this issue?
*Emergency medicine (EM) residency graduates are often anxious about the unfamiliar clinical problems that they will encounter in unsupervised practice.*

What was the research question?
*What workplace learning strategies do EM senior residents use to prepare themselves for unsupervised practice?*

What was the major finding of the study?
*We describe self-regulated learning strategies: cherry picking, case-based hypotheticals, parachuting, and making the call.*

How does this improve population health?
*These learning strategies can improve new physicians' preparedness to treat patients without supervision in a variety of clinical settings.*

## METHODS

We chose a constructivist grounded theory approach for this qualitative study, a methodology appropriate to study a complex social process about which relatively little is already known.[23] We assembled a research team with a range of expertise and experiences, recognizing the importance of subjectivity in our processes of building theory through analyses of our participants' narratives.[24] The author group consisted of emergency clinician educators from both participating institutions, all of whom regularly supervise senior residents. We approached this study with an understanding of the challenges and affordances of the emergency department (ED) learning environment. At the time of data collection, three of the authors (MG, AG, MD) were each one year removed from residency, which allowed them to reflect on their recent training experiences as well as the challenges of working as new attending physicians.

### Conceptual framework

This study is part of a larger program of research about how senior residents prepare themselves for unsupervised practice. In prior work,[3] we described how senior residents adopted a future-oriented, capability approach to workplace

learning,[5] using past training experiences as starting points to engage with unforeseen problems in practice. Our participants recognized that uncertainty and unfamiliar problems were inevitabilities of future practice, and defined preparedness in terms of the skills and approaches that would enable them to capably adapt to unforeseen challenges. This understanding led us to consider how senior residents might proactively use their final months of training to further these goals of adaptability[25,26] and capability development.[5] For this study, we used the SRL framework as a sensitizing concept for additional analysis, focusing on how participants described their dynamic processes of setting goals, strategizing for workplace learning, and monitoring their progress.[13,14,27,28]

**Setting, Population and Sampling Strategy**

We recruited EM residents in their final year of training at two four-year residency programs, each housed within large, academic healthcare centers with Level I trauma designation and rotations between multiple clinical sites. Fourth-year trainees in each program work a combination of "pre-attending" shifts, in which they supervise junior trainees with an attending physician also present, and primary shifts, during which they manage patients directly with attending supervision. We chose this cohort because of their proximity to their transition into unsupervised practice as well as their familiarity with their residency learning environments accumulated over three prior years of training. We sampled from geographically distinct areas (Midwest and Western United States) to account for local practice patterns and workplace cultures.

Interviews occurred between April–June 2023, when participants were still immersed in training but had solidified their immediate post-residency career plans. Email invitations were sent to all 28 eligible residents, with assurances that data would be deidentified before analysis and that participation would have no bearing on their standing within their programs. Interviews were scheduled in the order that residents responded. Participants were reimbursed with a $100 gift card. This study was reviewed and deemed exempt by institutional review boards at both sites.

**Procedures**

The principal investigator (MG) used videoconferencing software (Zoom Video Communications, Inc., San Jose, CA) to conduct individual virtual interviews. We piloted the interview guide (Supplemental material) with two senior trainees not participating in this study, and modified questions for clarity. We then conducted semi-structured interviews, asking participants about their career plans after residency, what it means to be "prepared" for unsupervised practice, and what challenges they anticipated as they entered work in new contexts. We probed about how residents developed learning goals and enacted specific workplace learning strategies to prepare themselves for the experiences they anticipated in unsupervised practice. We used a professional transcription service (Rev.com. Inc., Austin, TX) to transcribe recordings, which MG then deidentified and checked for accuracy prior to analysis by the group.

**Analysis**

The entire research team coded four initial interview transcripts line-by-line to inductively develop a preliminary codebook, after which we agreed on a focused set of codes for the remaining data. Two investigators (MG and AG) then coded all transcripts with Dedoose (Social Cultural Research Consultants, LLC, Los Angeles, CA), using memos to keep track of conflicting examples or ideas requiring more exploration, and meeting frequently to discuss coding discrepancies. The entire group met periodically to resolve differing interpretations of the data, discuss relationships between codes, and group codes into categories. Drawing from these categories, we constructed theory as defined by Charmaz: to "present arguments about the world and the relationships within it." [28,29(p128)] Our coding framework sufficiently captured our construct of interest after 12 interviews. Finding no divergent or disconfirming examples in four subsequent interviews, we deemed our dataset sufficient for the study's aims.[30]

**RESULTS**

We interviewed 16 EM senior residents (ten and six from each respective residency program; nine women and seven men). These residents had accepted positions to work clinically at a variety of community, academic, county, and community-academic hybrid sites, often splitting time between multiple clinical practice settings. Three participants were entering EM fellowships but with clinical roles as attending physicians. One participant was slated to start work as a critical care fellow, albeit with opportunities to work unsupervised shifts in the hospital's ED. Across these interviews, participants shared a view that the resources, practice patterns, and pathologies characteristic of their training sites did not reflect clinical practice in most other settings. This perception shaped their learning goals for the final months of training, motivating them to develop learning strategies that bridged gaps between the capabilities they had developed in their existing training contexts and the skills they anticipated needing in unsupervised practice.

We identified learning strategies in our initial coding of participants' stories. We then applied SRL as a theoretical lens, which allowed us to arrange those strategies into cycles involving an initial planning phase, in which participants self-identified gaps, an action phase where they deployed learning strategies to address these gaps, and a phase of reflection on their progress. Finally, we divided these cycles as we recognized that they addressed two types of gaps—knowledge/skill gaps and autonomy gaps—to represent how our participants engaged in SRL cycles as a response to their impending clinical transitions.

**Gaps in Participants' Knowledge and Skills**

In reflecting on their readiness to enter unsupervised practice, participants identified crucial gaps in their abilities to understand and manage unfamiliar clinical problems. These perceived gaps stemmed from limitations to the pathologies and patient complaints that they were exposed to during training, due to the time-limited nature of training as well as the affordances and limitations of working at an academic healthcare center. Many participants anticipated managing conditions with less input from specialists than they did at their current academic healthcare centers and worried they might be insufficiently prepared to manage these problems on their own. As Participant 11 reflected, "we just have so many consultants …we take a backseat on a lot of things." Participants also worried that structures within their training environments—such as the tendency for nurse practitioners or physician assistants to care for patients with low-acuity complaints— buffered them from the realities of community practice:

> I feel like we often are protected from the urgent care complaints… just because we have great mid-levels, and also it just doesn't feel like that type of community medicine comes in that much. (Participant 6)

*Learning Strategies: Cherry-picking and Case-based Hypotheticals*

Participants adopted two strategies to address perceived knowledge and skill gaps in their training. For each, they strategically leveraged the resources of their training environments to build confidence that they could handle the anticipated challenges of their future practice. First, participants described acts of cherry- picking, selectively engaging with clinical tasks that addressed gaps in their knowledge and skills. They seemed to view their last months of training as an opportunity to seek out pathologies and procedures in areas where they felt inadequately prepared, at times prioritizing these over tasks that they viewed as less educationally enriching. For example, after self-identifying a need for more experience with orthopedic injuries, Participant 15 described an instance in which they intentionally sought out orthopedic experiences on shift.

> "I knew there was a bunch of ortho stuff going into the department, and so I just said to [my attending] … 'you won't see me for a while. I'm going to spend the next few hours doing ortho stuff.' And, so, I just went along and properly learned some better techniques."

Yet residents often discussed the difficult balance between cherry-picking and expectations of patient throughput. Several participants noted that they had not felt empowered to focus on gaps in their learning until the final years of their training. They attributed this greater sense of agency to their familiarity with the clinical workflow, their comfort with their clinical supervisors, and the sense of urgency imparted by the upcoming transition to unsupervised practice. As Participant 6 explained:

> I was able to recognize that, after I don't know how many years … if the patient needs to be seen because they're super sick, then happily I'll see them and I'll see them fast. But you know, the eighth abdominal pain can sit for 20 minutes while I focus on the critical care or the pathology that I don't really understand or recognize yet, because that's more important.

A second strategy that participants used to address their gaps in knowledge and skills was case-based hypotheticals, moments when they deliberately slowed down and stretched a clinical experience to consider alternative approaches or dimensions they might face. Participant 7 used the expression "mental war-gaming" to describe their process of thinking through a range of case-specific "if this happens, what would I do?" hypotheticals with the help of their supervisor. Another participant elaborated on how considering hypotheticals with trusted supervisors helped them to feel more confident tackling novel problems in unsupervised practice:

> Just trying to go through every line of how this [case] could turn out, so that when it does turn out that way [next year], I have a good frame of reference of what the attending would do … I think that just doubles your number. You're essentially creating a new patient in your mind, right? … It's not the unknown anymore." (Participant 6)

*Reflection: Programmatic Feedback*

Participants often struggled with the poor alignment of external formative feedback sources—such as procedure logs, competency metrics, standardized tests, and evaluations from attendings—with their self-assessed knowledge and skills gaps. Despite this, they relied on programmatic assessment for feedback on these gaps and used it to calibrate their self-assessments. Participant 8 described the trust they placed in their program's assessment processes:

> I think you just have to really rely on the system that's in place, and you have to trust the program leadership and the attendings to call you out when they think you are not ready in something.

Although these were recognized to be imperfect sources of feedback, many felt that nationally recognized milestone assessments and standardized tests were the best available substrate to reflect on their abilities to apply knowledge and skills in unsupervised practice.

> I think to be a practicing emergency physician...you have to be able to pass the boards… Do you have enough information in your head that you're not going to miss something glaringly obvious because you don't know it? (Participant 14)

**Gaps in Participants' Autonomy**

As part of their transition to the attending physician role, participants anticipated a major leap in autonomy, with expectations of practicing independently and bearing the ultimate responsibility for decisions. Working without supervisory guidance was an anticipated source of stress and anxiety, as Participant 13 reflected:

> I am going to be the adult in the room making all of these decisions. I don't necessarily have the attending to say, 'I'm not sure, let me go ask them.' …Every call ... I'll be the final one making it.

Confidence was frequently mentioned as an attribute needed for unsupervised practice, on par with any knowledge or skill set. Thus, participants strategized ways that they could use their workplace learning to build confidence in the decision-making they would need when working without supervision.

*Learning Strategies: Parachuting and Making the Call*

Participants adopted two learning strategies to engender confidence that they could engage in new tasks without the input of supervisors. They pushed themselves to expand their comfort zones in two ways: by trying new management approaches with supervisory support; or by deliberately seeking experiences where supervisory support felt absent. First, participants described acts of parachuting, deliberately seeking to safely try new things while still having the backstop provided by their clinical supervisors. They sought opportunities to trial unfamiliar approaches to patient care, for example treating with a medication they had little experience with or attempting a procedural method that they had not tried before, viewing these instances as moments when they could "widen [their] experience before getting too set in one way" (Participant 7). Participants were able to test their limits or attempt new things with reassurances that supervisors were available to help. Participant 5 described this support structure in the following way:

> [T]his parachute that you know is there…no matter how much flexibility and how much autonomy our attendings give us, it's very clear that there's somebody to catch you if you fall.

Second, participants described deliberate efforts to adopt a mindset of working without supervisory support, pushing themselves to engage with high-stakes decisions before their supervisors provided input. Participant 13 described stroke evaluations as moments when they found opportunities to "make the call" with no supervisory guidance:

> I try to jump on [stroke evaluations], whether or not the attending is there yet, and kind of make a call before that support comes in.

Making the call in this manner fostered self-reliance, and participants expected that experiences like this would lessen the stress of similar decisions in future unsupervised practice:

> Whenever I come up with a patient and I'm like, 'Oh, I need to ask about what to do.' Then I just pause. I'm like, 'No, I'm not going to ask. I'm going to figure out what I'm going to do and then present it that way.' (Participant 2)

In addition to finding opportunities to practice their independent thinking during supervised shifts, several participants sought out authentic experiences of autonomy through moonlighting (working physician shifts for pay outside of their regular training, often unsupervised) to build confidence at the end of training.

*Reflection: Internal Emotions and External Standards*

Gauging whether they were ready for increased autonomy was difficult for participants, and they struggled to link their readiness to existing performance metrics within their residency training structures. Participants instead reflected on their emotional reactions in the workplace, as well as implicit feedback from their clinical supervisors as more holistic measures of whether they could be confidently autonomous. During high-stakes scenarios, participants took stock of their own internal emotional states, using these reactions as a measuring stick for whether they could handle the pressures of unsupervised practice. Participant 3 reflected on their comfort level while leading a pediatric code as evidence that they were ready to handle the increased autonomy:

> Yeah, you know I felt uncomfortable in regard to it being a 3-year-old and it being stressful, but I didn't feel out of my depth by any means. I felt like if that showed up at [a community hospital], even without a ton of surgeons, I felt like I would have been able to handle it.

Residents also cited their supervisors as external reference points that helped them reflect on their abilities to work autonomously. They described a practice of comparing their management plans to those of their supervisors, using instances of alignment or misalignment as ongoing sources of feedback. Working alongside attending physicians provided opportunities to identify a range of acceptable practice and evaluate decision-making against a trusted standard, either reaffirming or calling into question their sense of practice readiness.

> "I am just quizzing myself against the attendings… you're ready for more independent practice when all of your care decisions seem to fall within the range of people that you work with." (Participant 9)

## DISCUSSION

Senior residents in this study described a range of strategies that they used to prepare themselves for unsupervised practice. Using SRL as a framework to interrogate these strategies, we showed how residents identified specific knowledge and skill gaps and the need to build confidence in their ability to work autonomously. They then strategically leveraged their familiarity with their training environments toward. tailored approaches that addressed these self-identified areas of development. To reflect on whether their learning strategies were effective, they looked to programmatic feedback, their own emotions, or their performance relative to their supervisors, using these sources of feedback to prepare themselves for new cycles of learning. Taken together, these acts of gap identification, strategic action, and reflection provided unique cycles of SRL specific to their upcoming transitions into practice (Figure).

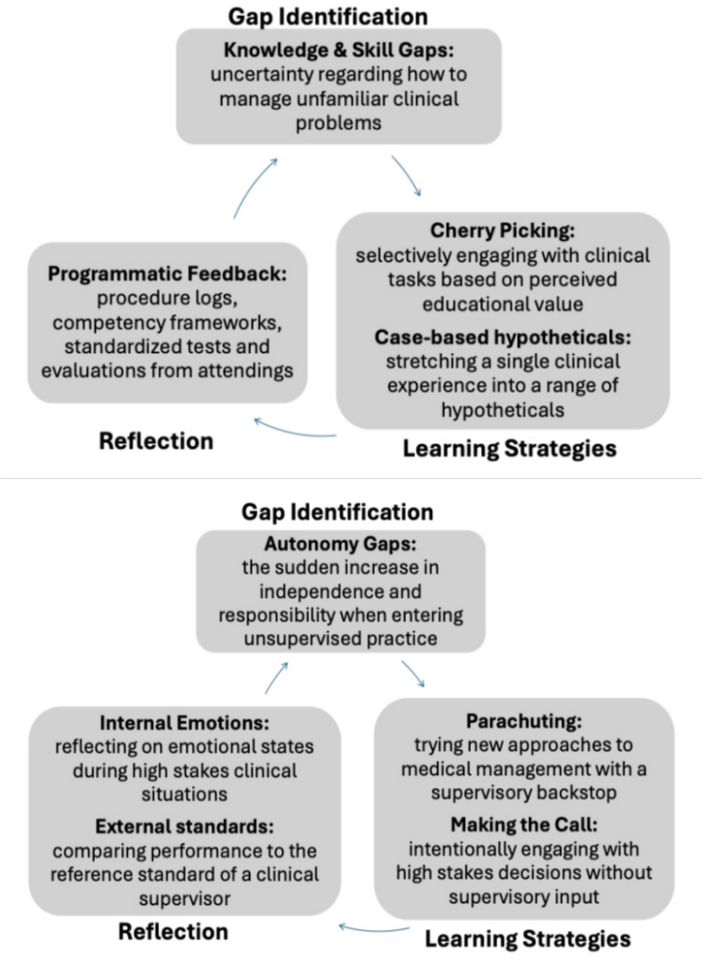


**Figure.** Gap identification, learning strategies, and means of reflection described by participants in a study of how senior residents in emergency medicine programs prepare for independent practice.

This study adds to previous research on transitions into practice, which has historically focused on perspectives of attending physicians who have already entered their new professional roles.[18,31-35] Teunissen and Westerman have argued that "a transition is not a moment, but rather a dynamic process,"[36(p45)] encompassing the periods both leading up to and succeeding an advance in training. Other authors have questioned the very notion of "preparedness" for medical trainees, for whom performance depends heavily on the shifting contexts of their work environment.[37] Our study provides a different perspective, namely that trainees can exert agency in how they use goal setting, strategic actions, and ongoing reflection to prepare themselves for the needs they anticipate in unsupervised practice, even if the specifics of their future practice remain unpredictable.

Our participants' learning strategies align with recent work that has described SRL as context dependent.[12,15] Senior trainees are more likely to employ nuanced learning strategies because they have developed competence with routine aspects of care over time within the contexts of their training environments.[5] Furthermore, because they were familiar with their learning environments and supervisors, and perhaps because they felt a sense of urgency from the upcoming transition to practice, our participants seemed empowered to prioritize learning over service to the department. While many participants did reference a tension between "moving the meat" and taking time to grapple with new learning,[38] senior residents in this study seemed more comfortable deferring non-emergent patient care to focus on high-yield learning opportunities. Our results also resonate with other models of self-regulated learning that have been studied in medical training, such as the master adaptive learner framework.[39,40]

Regan et al noted that master adaptive learners identify knowledge and skill gaps based on a combination of performance- and community-related cues; they triage learning opportunities based on complex considerations of needs, desires, and obligations; and they self-assess the effectiveness of their learning efforts.[41] These authors also note the influence of context on SRL, with transitions in training

prompting trainees to re-evaluate and adapt their learning strategies, and the specifics of each learning environment helping to shape the goals that trainees set for themselves.[42] Our study's participants showed similar processes of gap identification, learning, and self-assessment, all heavily influenced by the context of preparing for unsupervised practice during the final months of residency training. It would be informative to study how trainees develop specific learning goals regarding other significant transitions or milestones in training.

While these senior residents' learning strategies were geared toward proactively seeking educational opportunities and fostering autonomy, supervisors clearly played a fundamental role in these experiences. Participants drew from supervisors' support in both explicit and tacit ways—borrowing from supervisors' experience to stretch their learning through hypotheticals that they might see in practice or engaging in new tasks equipped with their metaphorical parachutes. This framing expands the traditional framing of learner-centric SRL cycles toward paradigms such as "co-regulated learning" that emphasize the critical aspects of supervisory support at each step.[43] Supervising physicians can guide senior residents' goals for their workplace learning by highlighting differences between their training environments and their future practice settings, or spotlighting the skills that will maximize their confidence and future success. Supervisors can also guide senior residents to authentic experiences of autonomy and productive struggle,[44] allowing them to grapple with clinical uncertainty while still being available for support.[45]

These findings present several important considerations for residency training programs. First, programs can more meaningfully consider residents' individualized post-training needs, probing for perceived gaps and letting residents select (or even design) experiences that are likely to set them up for success in their unique practice contexts. Second, they can provide level-appropriate supervisory opportunities for senior residents while still in training, whether junior-attending shifts in the ED[46] or moonlighting opportunities that allow them to assume the duties of an attending physician.[47] Experiences when trainees are pushed to "make the call" clearly build confidence for future autonomy.

Finally, while residents in this study identified individualized learning goals, their means for reflection often involved less specific tools such as exam scores and procedure logs. This suggests opportunities for programs to better support each resident's self-regulated learning efforts by helping them identify sources of feedback that meaningfully address their unique and contextualized learning goals. Our results suggest that residents gauge their own performance through multiple sources of feedback that are both explicit (eg, post-shift discussions with attendings, workplace-based assessments, and semi-annual reviews), and implicit (eg, social cues generated from their interactions with attendings, staff, and patients).[48]

## LIMITATIONS

Our results and analyses reflect several methodological decisions. We interviewed residents from two residency programs to allow for more diverse perspectives; however, both programs featured large Level I trauma centers and academic hospitals, and most of these residents were preparing for transitions to community practice. Thus, these participants' actual and perceived knowledge gaps and learning goals may not reflect those of trainees from other programs. We focused only on residents' strategies in anticipation of unsupervised practice; thus, our study was not designed to follow-up with participants after graduation to see whether these strategies were actually helpful in fostering preparedness.

It is important to note that this was a preplanned return to a dataset that was initially collected as part of a broader study about residents' preparedness for practice.[3] Returning to these data with a SRL lens enabled us to focus on specific dimensions of participants' stories that were germane to cycles of learning, although this choice may have necessarily excluded other important aspects of their experiences.[49] Finally, MG had professional relationships with the participants that he interviewed, either as a supervisor or former co-resident, and this may have shaped their responses as well as his interpretation of the data.

## CONCLUSION

Emergency medicine residents strategically leverage learning strategies in their final months of training to bridge perceived gaps between their self-assessed capabilities and those they anticipate needing to succeed in unsupervised practice. We present these strategies—cherry-picking, case-based hypotheticals, parachuting, and making the call—within cyclical processes of self-regulated learning, although they are notably codependent on supervisory support. These findings suggest tailored approaches whereby programs can support learning experiences that foster senior residents' agency when preparing for the challenges of future practice.

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# Language Differences by Race in the Narrative Section of the Emergency Medicine Standardized Letter of Evaluation

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**Introduction:** Discrimination and bias based on race/ethnicity permeate the medical education system. Racial disparities in assessment measures can ultimately impact applicants' Match results. Few studies to date have examined the narrative portion of the emergency medicine (EM) Standardized Letter of Evaluation (SLOE) for language differences by race. In this study we aimed to determine whether there were language differences by race in the narrative portion of the EM SLOE.

**Methods:** This study is an analysis of word category frequencies in the narrative portion of the SLOE for applicants applying to EM residency. The sample was drawn from the students who applied to the study institution in 2022. The narrative portion of the SLOE and other applicant factors were collected from the Electronic Residency Application Service (ERAS) applications and de-identified. We compared the number of SLOEs containing predefined keywords by race using chi2 analysis. Keywords were identified in six thematic word categories: agency; standout traits; ability; grindstone habits; achievement; and compassion. We performed logistic regression to determine whether any differences remained after controlling for other factors in the application.

**Results:** Of 1,104 applicants to the institution, 2,288 SLOEs with self-identified race/ethnicity were available for analysis. Black and Hispanic applicants had higher proportions of SLOEs that contained a compassion word than White applicants (24.9% and 22.4% vs 16.9%, respectively). This finding persisted after controlling for other factors in the application for Black applicants (odds ratio 1.61, 95% CI 1.1- 2.36]). There was no evidence of difference in word use by race across other thematic categories.

**Conclusion:** We found differences in the proportion of SLOEs containing compassion words in the narrative portion of the EM SLOE between Black and White applicants, with Black applicants being described with compassion language more frequently. However, we found no difference in any other word category, indicating less overall disparity than other narrative assessment studies. [West J Emerg Med. 2025;26(6)1519–1525.]

## INTRODUCTION

Discrimination and bias based on race permeate the medical education system. In particular, these factors have been shown to influence subjective and objective assessment measures used for the residency Match.[1-4] Disparities in assessment measures can ultimately impact applicants' Match results.[5,6] A recent study on the emergency medicine (EM) Standardized Letter of Evaluation (SLOE) demonstrated differences in the rankings on the letter by race, after controlling for other markers of performance.[7] The EM SLOE has become the component of a residency application that program directors value most when selecting students to

interview and rank; therefore, bias within this tool will affect Match outcomes for applicants to EM residency.[8-10] Further, better understanding the strengths and limitations of the EM SLOE will help leaders in other specialties create equitable standardized letters as more specialties adopt them.[11]

In addition to the numerical rankings, the EM SLOE contains a narrative section, in which writers are instructed to provide "detail on strengths, explaining growth opportunities or lower ratings from above, and highlighting anything else you feel like we should know about this student."[12] Previous studies on narrative assessment have shown bias in terms of the language used for different groups such as sex or race.[3,13,14] One study showed that significant differences exist in the language used to describe White vs Black applicants on the Medical Student Performance Evaluation (MSPE).[3] Evidence suggests that residency program directors rely on descriptors within narrative summaries to influence their impression of applicants, both negatively and positively.[15] Studies have also shown that there is bias toward under-represented in medicine (UIM) students in the use of positive attribute language in letters of recommendation for residency.[14] Consequently, negatively biased narratives could decrease applicants' Match potential.

Only one single-center study to date has examined the narrative section of the EM SLOE for language differences by race. The authors found that Black and UIM students were more likely to be described with communal language as compared to White and non-UIM students.[16] On the other hand, two studies examining word differences by sex on the EM SLOE demonstrated that the narrative section was "relatively free of gender bias."[17,18] Our specific aim in this study was to determine whether there were language differences by race in the narrative section of the EM SLOE.

*Population Health Research Capsule*

What do we already know about this issue?
*Narrative bias in medical evaluations can disadvantage under-represented applicants and affect residency Match outcomes.*

What was the research question?
*Are there racial differences in word use within emergency medicine Standardized Letters of Evaluation narratives?*

What was the major finding of the study?
*Black applicants had more compassion language (OR 1.61, 95% CI 1.10-2.36, P<.05) vs White applicants; no other differences were found.*

How does this improve population health?
*Identifying narrative bias in residency evaluations supports equitable selection, improving diversity and long-term health equity.*

## METHODS

### Study Design

This study is a cross-sectional, descriptive linguistic analysis of word category frequencies in the narrative section of the SLOE for applicants applying to EM residency.

### Setting and Participants

The study population includes medical students who applied to EM residency during the 2022-2023 application season. The study sample was drawn from the students who applied to the study EM residency program in 2022. Applicant data were downloaded from the Electronic Residency Application Service (ERAS) system for each student included in our study. This study was approved by the institution's institutional review board (IRB23-0426).

### Study Protocol

The narrative section of the SLOE (with identifiers removed), student race, degree to be earned (MD/DO/IMG), Alpha Omega Alpha Honor Medical Society (AOA) status, and sex were collected from ERAS applications and de-identified. Data collection and de-identification was performed by a member of the research team (PK). Students self-identified their race/ethnicity during ERAS submission, with the following options: "American Indian or Alaska Native," "Asian," "Black or African American," "Hispanic, Latino, or of Spanish origin," "Native Hawaiian or other Pacific Islander," "White," "Other," or "Unknown." Students were able to select as many as needed or leave this section blank.

We assessed word category frequencies using the Linguistic Inquiry and Word Count (LIWC) application (Pennebaker Conglomerates, Inc, Austin, TX). This linguistic analysis program measures the use of words within text documents based on predefined or individually designed word category dictionaries. This tool has been validated and used in similar prior studies.[17,18] Based on prior research and extensive literature review—including a landmark study on the MSPE using these categories—we examined six thematic categories: standout traits; ability; agency; grindstone habits (ie, work ethic); achievement; and compassion.[3,19,20]

### Outcomes

We compared word category frequency in the narrative section of the SLOE by race. Our primary outcome was the use of a word from a thematic category at least one time in the narrative section of the SLOE, similar to previous work on the MSPE.[3] We compared Black, Asian, and Hispanic

students to White students, and UIM students, comprising Black, Hispanic, American Indian/Alaska Native, and Native Hawaiian/Pacific Islander students. to non-UIM students.[21] We built a LIWC word category dictionary using the six non-overlapping word categories. Each category was populated with word options using prior literature and "add dictionary words" function within LIWC (Table 1).[3]

**Table 1.** Words in each thematic category used to analyze the narrative section of the Standardized Letter of Evaluation.

| Thematic Category | Individual terms |
|---|---|
| Agency | ambitious, confident, active, motivated, responsible |
| Standout Traits | exceptional, best, outstanding, superb, excellent, phenomenal, stellar |
| Ability | intelligent, bright, talent, brilliant, competent, smart, gifted |
| Grindstone Habits | organized, hardworking, conscientious, diligent |
| Achievement | perform, earn, skill, success, progress |
| Compassion | caring, kind, empathy, compassionate |

**Analysis**

We assessed for differences in frequency of a word in each thematic category appearing at least once in the narrative portion by comparing SLOEs from applicants of each individual race to White applicants' SLOEs, using chi-squared analysis. (Not included were American Indian/Alaska Native, and Native Hawaiian/Pacific Islander students due to insufficient sample size for statistical analysis.) Chi-squared tests were also used to evaluate whether there was an association between UIM status and proportion of SLOEs with a word category used at least once. We performed a multivariable logistic regression for each word category to demonstrate the effect of race on at least one word appearing in each category after controlling for sex, AOA status, USMLE (US Medical Licensing Examination) Step 1 score, and medical school type (MD, DO, international medical graduate [IMG]). Word category analyses were conducted using Stata v17 2021 (StataCorp LLC, College Station, TX).

## RESULTS

In 2022, 1,186 applicants applied to the institution's EM program. Of those applicants, 1,117 had at least one SLOE and 1,104 of those applicants had a self-identified race/ethnicity. In total, 2,288 SLOES with applicant self-identified race/ethnicity were available for analysis. The applicants represented in our sample were similar to the national applicant pool with respect to race and UIM status (Table 2). In our study sample, applicants were more likely to identify as female, be applying from US allopathic medical schools, and inducted into the AOA. Applicants were less likely to be applying from US osteopathic medical schools) or IMG programs. Study applicants were 54.5% White, 19.1% Asian, 9.2% Black, 11.1% Hispanic, 1.3% American Indian or Alaska Native, and 0.27% Native Hawaiian or other Pacific Islander.

Compared to SLOEs for White applicants, the narrative section of SLOEs submitted for Black and Hispanic applicants were significantly more likely to contain a compassion word (24.9% and 22.4% vs 16.9%, respectively) (Table 3).

Compared to SLOEs for non-UIM applicants, SLOEs submitted by UIM applicants were significantly more likely to contain a compassion word (23.4% vs 17.4%). There were no other differences in SLOEs containing a word from the study categories by race. After controlling for USMLE Step 1 score, medical school type, AOA membership, and sex via multivariable logistic regression, SLOEs submitted by Black applicants were shown to have a significantly higher use of a word from the "compassion" category, OR 1.61 (95 CI 1.10-2.36). There were no differences by race for any other word category after controlling for the above variables.

Regression models did show that objective measures such as medical school type and Step 1 score were significantly associated with the primary outcome of one word used in each category (Table 4). Specifically, standout traits, ability, grindstone characteristics, compassion, and achievement were significantly associated with one or more objective measures. Additionally, female sex was associated with a higher proportion of SLOEs with standout and ability words.

## DISCUSSION

This study revealed minor differences in word category use by race in the narrative section of the EM SLOE. Hispanic applicants and Black applicants had a higher proportion of SLOEs containing a compassion word than White applicants and, similarly, UIM applicants had a higher proportion of SLOEs containing a "compassion" word than non-UIM applicants. These differences in word use only persisted for Black applicants, as compared to White applicants, after controlling for other applicant factors. Word differences were found in multiple categories by Step 1 score and medical school type. Further, we found differences in word use by sex that mirror those found in previous studies on the narrative section of the EM SLOE.[17,18] These differences demonstrate that while this is a convenience sampling, the study was powered to detect differences.

The difference in use of compassion words that we found is similar to previous work in narrative assessment, which has shown UIM learners and female (as compared to male) learners to be more likely to be described with compassion

**Table 2.** Applicant demographics in a study of differences in word use in the narrative section of the Standardized Letter of Evaluation in emergency medicine.

| Demographic | No. of Applicants in Sample (N = 1,104) | Percentage of Applicants in Sample | Percentage of Applicants in National Applicant Pool[20] |
|---|---|---|---|
| Sex | | | |
| Male | 565 | 51.2 | 59.5 |
| Female | 532 | 48.2 | 40.4 |
| Another gender identity | 7 | 0.6 | |
| UIM status | | | |
| Non-UIM | 813 | 73.6 | 73.8 |
| UIM | 228 | 20.7 | 19.6 |
| Race/ethnicity | | | |
| Non-Hispanic White | 602 | 54.5 | 55.2 |
| Asian | 211 | 19.1 | 18.7 |
| Black | 102 | 9.2 | 7.8 |
| Hispanic, Latino, or of Spanish origin | 123 | 11.1 | 10.7 |
| American Indian or Alaska Native | 14 | 1.3 | 0.98 |
| Native Hawaiian or other Pacific Islander | 3 | 0.27 | 0.21 |
| Other | 63 | 5.7 | 5.03 |
| Type of school | | | |
| US MD | 824 | 74.6 | 47.1 |
| US DO | 173 | 15.7 | 25.4 |
| IMG | 107 | 9.7 | 27.4 |
| AOA status | | | |
| AOA | 105 | 9.5 | 3.4 |
| Not AOA | 999 | 90.5 | 96.6 |

*AOA,* Alpha Omega Alpha Honor Medical Society; *DO*, doctor of osteopathic medicine; *IMG,* international medical graduate; *MD*, doctor of medicine; *UIM*, under-represented in medicine.

**Table 3.** Standard Letters of Evaluation with at least one word in a thematic category in the narrative, by race.

| | White | Black | Asian | Hispanic | Non-UIM[a] | UIM[a] |
|---|---|---|---|---|---|---|
| Total SLOEs | 1,305 | 214 | 484 | 286 | 1,783 | 522 |
| Agency | 361 (27.7%) | 62 (28.3%) | 130 (27.2%) | 73 (25.5%) | 489 (27.4%) | 140 (26.8%) |
| Standout Traits | 850 (65.1%) | 142 (66.7%) | 319 (65.9%) | 174 (60.8%) | 1,164 (65.3%) | 332 (63.6%) |
| Ability | 203 (15.6%) | 30 (14.1%) | 72 (14.9%) | 38 (13.3%) | 275 (15.4%) | 69 (13.2%) |
| Grindstone Characteristics | 242 (18.5%) | 36 (16.9%) | 95 (19.6%) | 56 (19.6%) | 337 (18.9%) | 95 (18.2%) |
| Compassion | 221 (16.9%) | **53 (24.9%)*** | 89 (18.4%) | **64 (22.4%)**** | 310 (17.4%) | **122 (23.4%)***** |
| Achievement | 198 (15.2%) | 30 (14.1%) | 71 (14.7%) | 32 (11.2%) | 267 (15.0%) | 68 (13.0%) |

*Denotes significant difference from White by chi-squared test, P < .01.
**Denotes significant difference from white by chi-squared test, P = .03.
***Denotes significant difference from non-UIM by chi-squared test, P < .01.
[a]UIM indicates Black, Hispanic, American Indian or Alaska Native, and Native Hawaiian or other Pacific Islander applicant SLOE, non-UIM indicates non-Hispanic White and Asian applicant SLOEs.
*EM*, emergency medicine; *SLOE*, Standardized Letter of Evaluation; *UIM,* under-represented in medicine.

**Table 4.** Odds ratio for a word in a thematic category appearing at least once, by race,

| | Agency | Standout | Ability | Grindstone | Compassion | Achievement |
|---|---|---|---|---|---|---|
| White | Reference | Reference | Reference | Reference | Reference | Reference |
| Black | 1.07 (0.75, 1.53) | 1.24 (0.87, 1.74) | 0.99 (0.63, 1.58) | 0.93 (0.61, 1.41) | **1.61 (1.10, 2.36)** | 0.93 (0.59, 1.47) |
| Asian | 0.98 (0.76, 1.26) | 1.01 (0.79, 1.29) | 0.93 (0.68, 1.29) | 1.06 (0.79, 1.41) | 0.99 (0.73, 1.35) | 1.02 (0.74, 1.39) |
| Hispanic | 1.01 (0.74, 1.38) | 0.91 (0.68, 1.22) | 0.89 (0.59, 1.34) | 1.01 (0.71, 1.44) | 1.34 (0.95, 1.90) | 0.75 (0.49, 1.14) |
| USMLE Step 1 score | 1.00 (0.99, 1.01) | **1.02 (1.01, 1.03)** | **1.01 (1.00, 1.02)** | 1.00 (0.99, 1.01) | 1.00 (0.99, 1.01) | 0.99 (.99, 1.01) |
| Sex | 1.17 (0.96, 1.43) | **1.43 (1.18, 1.74)** | **1.31 (1.02, 1.69)** | 0.94 (0.75, 1.19) | 1.18 (0.93, 1.49) | 0.83 (0.64, 1.01) |
| AOA | 1.08 (0.75, 1.53) | 1.35 (0.95, 1.92) | 1.29 (0.88, 1.90) | 1.00 (0.69, 1.46) | 0.98 (0.67, 1.44) | 0.65 (0.41, 1.05) |
| Medical school type* | 1.08 (0.97, 1.21) | **0.77 (0.69, 0.85)** | 0.99 (0.86, 1.15) | **0.78 (0.68, 0.89)** | **0.80 (0.69, 0.92)** | **0.81 (0.70, 0.94)** |

*Medical school types: US private MD; US public MD; DO; international.
Statistically significant findings are in bold (P < .05).
*AOA*, Alpha Omega Alpha Honor Medical Society; *DO*, doctor of osteopathic medicine; *EM*, emergency medicine; *MD*, doctor of medicine.

language.[14,23] Additionally, these findings are similar to a recent study on language differences in the EM SLOE by race, which demonstrated that Black and UIM applicants were more likely to be described with communal language.[15] While different, communal language and compassion language are similar and represent categories that do not describe achievement or traditional competency. Further, the previous study reported a trend toward a difference between Black and UIM students, as compared to White and non-UIM peers, regarding empathetic language, which our study confirms by demonstrating the difference between Black and White applicants regarding compassion language.

This highlights an important contrast; while compassion is a desirable trait, it risks reinforcing the portrayal of UIM applicants as inherently more empathetic or caring, potentially overshadowing their professional competencies and achievements. Previous work has shown that communal language was inversely related to academic hiring and promotion.[19] Further, a qualitative study of internal medicine fellowship letters of recommendation demonstrated the potential for compassion language to overshadow or replace competency language.[11] Therefore, while it is encouraging that we did not find differences in any other word category, the difference in compassion language reveals that the narrative section in the EM SLOE is not fully free of bias and highlights the need for further contextual analysis.

In contrast with prior work on narrative evaluation, we did not find any other differences by race. These results suggest that the EM SLOE narrative, while not free from racial bias, may demonstrate less bias than other assessments, such as the MSPE letter and traditional narrative letters of recommendations.[3,14] While prior studies have evidenced bias across personal attribute- and competency-based word categories, our study did not demonstrate significant bias across competency-based terms. These results are encouraging for other specialties looking to follow the Coalition for Physician Accountability recommendations that all specialties adopt a standardized letter of evaluation for the residency application process and provides further evidence for the universal move from traditional letters of recommendation to SLOEs.[24] Further, given there may be less negative bias in the narrative section as compared to the numerical rankings, it is possible that program directors can ensure a more equitable decision-making process by incorporating the narrative section into decision-making. This also emphasizes the need to be vigilant for bias of omission vs commission, as highlighting compassion language may be at the expense of other descriptors. As programs and program directors have increased awareness of bias in evaluation, the residency selection process must evolve to appropriately weigh evaluations based on potential for bias.

These results open multiple future directions for further understanding how to mitigate racial bias in narrative assessment. It is possible that the word limit on the SLOE (350 words) lends itself to a more concise narrative that leaves less room for biased language. Another possibility is that the SLOE instructions "to explain the rankings and competency-based assessments above" cause the writers to focus more on competency-based behavior and less on personal attributes (eg, friendly, personable, energetic, quiet) that are more prone to bias.[14] Further study is needed to elucidate the reasons for the decreased bias as compared to other narrative studies, including perspectives from SLOE authors.

## LIMITATIONS

There are multiple limitations to this study. First, this was not a full textual analysis of the narratives on the SLOE, meaning that although there were few word differences, it is

possible that the overall message conveyed in the narrative may still reflect bias. Further, more in-depth study, such as narrative performative analysis, will be needed to ensure that language use in the SLOE's narrative assessment is equitable. Second, although like previous work on narrative assessment, our study is limited by the finite number of words included in each category. Categories with a more exhaustive number of words included may yield differing results. Third, our study population was drawn from the applicant pool of a single institution, which may limit the generalizability of findings. A multi-institutional study would be beneficial to corroborate these results. Finally, while included in the UIM analysis, American Indian or Alaska Native, Native Hawaiian, and other Pacific Islander applicants were not represented well enough in our sample to be included in the analysis by specific race/ethnicity.

## CONCLUSION

There were differences in the proportion of Standardized Letters of Evaluation containing compassion words in the narrative section of the EM SLOE between Black and White applicants, with Black applicants being described with compassion language more frequently. However, no difference existed in any other word category, indicating less overall disparity than other narrative assessments.

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# A Taste of Our Own Medicine: Fostering Empathy in Medical Learners Through Patient Simulation

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**Introduction:** Residents and medical students spend thousands of hours of medical education learning the physician's perspective but rarely find themselves on the other side of the stethoscope. In this study we evaluated whether a brief, novel curriculum of simulating the patient experience could improve medical learners' reported empathy for patients and ability to explain medical interventions.

**Curricular Design:** Fifty-eight medical learners (medical students and resident physicians) participated in a 50-minute didactic session where learners simulated patient experiences such as wearing a patient gown and cervical collar, walking with crutches, and tasting potassium chloride and thickened water. Learners evaluated their perceptions of the curriculum with a survey.

**Impact/Effectiveness:** Participants reported limited experience as patients, with 66.7% never having been hospitalized and 50% not taking any daily medications. Learners rated the curriculum highly on a seven-point Likert scale with 98% expressing it helped them to empathize with patients (90% either agreed or strongly agreed) and 95% expressing that it would help them explain interventions (81% either agreed or strongly agreed). There was no difference between medical students and residents regarding reported effect on empathy (M 6.24 vs 6.44; $P = .30$) or effect on ability to explain the intervention (M 6.06 vs 6.24; $P = .43$). This brief curriculum simulating the patient experience was well-received by medical student and resident learners, who overwhelmingly felt it improved their empathy for patients and explanations of common interventions. This approach to fostering empathy could help both medical student and resident learners, many of whom may have limited experience as a patient. [West J Emerg Med. 2025;26(6)1526–1529.]

## BACKGROUND

Resident physicians and medical students receive extensive medical education focused on thinking like a physician. While trainees have significant clinical knowledge, many lack significant personal experience as a patient, with < 5% of those aged 18-24 years of age being hospitalized per year.[1] Curricular activities where learners simulate the patient perspective can potentially overcome trainees' gaps in patient experience. However, such studies have been limited. Some prior studies have maintained a very narrow focus, such as tasting various oral antibiotics or participating in a diabetic shopping experience.[2,3] While such activities can lead to increased empathy, the effects may not easily translate to other domains.

Other studies have involved longer interventions such as an overnight hospital stay or three-hour visit to the emergency department (ED).[4,5] While these broaden the spectrum of experiences encountered, they are very resource intensive for learners and may tax hospitals with limited bed capacity and education funding. A recent simulation-based study of residents role-playing as patients was rated favorably but without measurable improvements in empathy.[6] Empathy has been associated with increased patient satisfaction, patient adherence to plans, and improved

clinical outcomes.[7] We hypothesized that having learners undergo simulated patient interventions would improve reported learner empathy.

## CURRICULAR DESIGN

In this study we piloted a brief patient simulation curriculum employing common but uncomfortable activities that exemplify a spectrum of medical experiences faced by patients. The curriculum was designed using Kern's six-step approach to curriculum development, with needs assessment from a group of five medical educators and 12 learners.[8] This needs assessment noted a lack of direct experience with the interventions that trainees were learning. Experiences were chosen to cover a broad variety of common medical interventions while also retaining a brevity that allowed for easy integration into existing didactics. We considered but did not pursue other interventions, such as tasting oral antibiotics (risk of side effects) or trying bilevel positive airway pressure (resource intensive).

We hypothesized that this curriculum would increase medical learners' reported empathy for their patients (primary outcome) and their perceived ability to explain these medical interventions (secondary outcome). This study consisted of a 50-minute didactic session where medical learners simulated patient experiences. Emergency medicine (EM) residents, internal medicine residents, and medical students were recruited to the study. A total of 58 learners participated: 33 medical students and 25 EM or internal medicine residents over the course of two separate days. This study was approved by the University of Chicago Institutional Review Board [IRB21-1203].

During the didactic session, learners were separated into two groups of 12-15 learners, each with an instructor. They followed an activity flow starting with donning patient gowns and taping intravenous tubing to their arms to simulate hospital garb (five minutes). Learners subsequently underwent a "trauma" station where they were fitted with cervical collars and then placed on a hard, trauma backboard with a simplified trauma roll performed by other learners (seven minutes). After the trauma roll, they were instructed to ambulate using crutches (five minutes). Finally, learners experienced a "per os station" where they were given 20 mL of thickened water and 20 mL of a typical potassium chloride oral solution to simulate dysphagia diet and potassium repletion, respectively (five minutes). As trainees transitioned between activities, instructors elicited learner experience and had a 2-3 minute debrief of each activity.

After completing all activities, learners filled out an anonymous survey regarding their perceptions of the curriculum and prior patient experience. Learners used a Likert scale to rate how they felt the study changed their empathy for and explanations to patients. Finally, the survey collected qualitative data focusing on learners' feelings during their time as "patients" and how the activity might impact their medical practice. After completing the survey, the trainees had a large-group debrief for approximately 10 minutes where they shared their experience and personal learning points. Learners were compensated with a $10 gift card for their participation.

We analyzed survey findings in Stata (StataCorp LLC, College Station, TX) and Microsoft Excel (Microsoft Corporation, Redmond, WA) using two-sample *t*-tests with Bonferroni correction. Qualitative data were coded using an inductive approach to generate themes with two coders. Discrepancies were discussed until coders agreed. A priori power analysis indicated that a sample of 32 participants would provide 80% power to detect a change of 20% in perceived empathy (Cohen $d = 0.8$, $\alpha = 0.05$), which was chosen as a de novo threshold. This study exceeded that sample size.

## IMPACT / EFFECTIVENESS

A total of 58 learners participated in two separate sessions; 33 medical students and 25 residents, with equal male/female ratio, and all participants completed the survey. Participants reported limited experience as patients, with the majority never having been hospitalized and half taking no daily medications (Table 1).

Learners rated the curriculum highly on a seven-point Likert scale: 99% of participants expressed that the curriculum helped them to empathize with patients, with 90% either agreeing or strongly agreeing (Table 2); and 95% of learners reported that the session would help them better explain interventions to patients, with 81% either agreeing or strongly agreeing. There was no difference between medical students and residents regarding reported effect on empathy (M 6.24 vs

**Table 1.** Baseline demographic information of medical student/resident learners who participated in a didactic session that simulated patient experience.

| Learner demographics | Count (percentage) |
|---|---|
| Training level | |
| Medical student | 33 (57%) |
| Resident | 25 (43%) |
| Sex | |
| Female | 29 (50%) |
| Male | 29 (50%) |
| Prior hospitalizations | |
| Never | 38 (66%) |
| Once | 15 (26%) |
| Twice | 2 (3%) |
| ≥ Three times | 3 (5%) |
| Daily medication use | |
| Yes | 29 (50%) |
| No | 29 (50%) |

**Table 2.** Survey findings of medical student/resident learners who participated in a didactic session that simulated patient experience.

| This activity: | Strongly disagree | Disagree | Slightly disagree | Neutral | Slightly agree | Agree | Strongly agree |
|---|---|---|---|---|---|---|---|
| Helps me empathize with patients | 0 | 0 | 0 | 1 (2%) | 5 (9%) | 26 (45%) | 26 (45%) |
| Helps me explain interventions to patients | 0 | 0 | 0 | 3 (5%) | 8 (14%) | 25 (43%) | 22 (38%) |

6.44; $P = .30$) or ability to explain interventions (M 6.06 vs 6.24; $P = .43$). However, learners who had never been hospitalized prior to the study had a significantly higher reported increase in empathy compared to learners who had been previously hospitalized (M 6.47 vs 6.05; $P = .03$). There was no difference in reported improvement in explanations to patients between learners who had been hospitalized and those who had not (M 5.85 vs 6.29; $P = .06$). Of those who participated in the session, 97% reported they would change how they would describe interventions to patients based on their experience in the study.

Qualitatively, the two most common themes identified were 1) discomfort leading to reconsideration of interventions; and 2) empathy toward what the patients were experiencing (Table 3). A representative quote of these two changes was as follows: "[The study] will help me prepare patients for uncomfortable parts of their hospitalization and be conscious about when I can back off on uncomfortable interventions."

## LESSONS LEARNED

We devised a learner handout with the station flow and instructions, which helped learners track their progress. Speech/swallow staff generously provided liquid thickening mix, and hospital pharmacists provided potassium chloride. Learners had the option to change into gowns in the bathroom or don gowns over their clothes. None chose to fully change, which facilitated a discussion about patient vulnerability. When learners had emotional responses to the stimuli, it helped to empathize and then remind them of the shift in magnitude as a patient: "Now imagine you have to drink thickened water every single day from now on." The one-hour duration was feasible to implement during weekly didactics, and the various stations could support small-group rotations with floating instructors.

This was a single-center study focused on perceived changes in empathy. This study only used a post-survey, which could have led to response shift or recall bias. Future iterations could evaluate higher levels on the Kirkpatrick model to establish improved communication or change in practice. The questions of the validated Jefferson Scale of Empathy had a focus beyond the scope of this intervention but could be considered as a future measure.

**Table 3.** Qualitative themes in survey of participants in a didactic session that simulated patient experience.

| Themes identified | Example | Percentage of learners noting theme |
|---|---|---|
| Discomfort with interventions | "The C-collar is really uncomfortable." | 57% |
| Empathy toward patients | "Opened my eyes to the challenges of being a patient" | 24% |
| Vulnerability | "It made me feel vulnerable and uncomfortable." | 10% |
| Gratitude | "I feel appreciative of my health." | 5% |

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# The State of Simulation in Emergency Medicine Residency Programs in the United States

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**Introduction:** Using simulation-based medical education has proven to be an effective instructional strategy both procedurally and clinically. Emergency medicine (EM) residency programs use simulation in a variety of ways and settings. Given the ongoing development of the field and the recent expansion of EM training programs, our objective was to assess the current state of simulation use in Accreditation Council for Graduate Medical Education (ACGME)-approved EM residency programs in the United States.

**Methods:** We performed this cross-sectional national survey from July–September 2022. The survey was sent to the residency program directors of all 277 ACGME-accredited EM residency programs in the US. The survey focused on simulation use, technology, types of simulation (procedural vs case-based), barriers to growth, and overall sentiments regarding simulation in EM.

**Results:** We attempted to contact 277 programs, successfully reaching 244. We received a total of 100 responses (36%). Nearly all responding programs reported access to a dedicated sim center (95.8%), with available high-fidelity manikin simulators (93%) and task trainers (90%). Most programs engage in simulation didactics monthly (50%), followed by more than monthly (22%) and quarterly (19%). Barriers to simulation implementation included funding, simulation lab availability, and equipment. Programs frequently used simulation to perform the majority of rare but required procedures, and about half of the programs responding reported simulation fellowship-trained faculty on staff.

**Conclusion:** Simulation education is an important aspect of EM residency and training. Most residency programs reported dedication and resources to developing and integrating simulation into their curriculum. There is likely room for its further use in residency program training in the coming years as residency programs continue to expand. [West J Emerg Med. 2025;26(6)1530–1535.]

## INTRODUCTION

Simulation-based medical education is an effective educational tool in emergency medicine (EM) training that incorporates experiential learning and deliberate practice to create an engaging learning environment. Simulation encompasses a broad spectrum of activities, which can include high-fidelity clinical simulations, procedural training using task trainers, difficult conversations with standardized patients, in-situ simulations in the actual clinical environment, and, more recently, virtual reality scenarios. Technology-enhanced simulation training has been associated with improved learning outcomes compared to other educational methods.[1]

Simulation-based education plays a particularly important role in EM residency training, where physicians must become proficient in managing high-acuity, low-frequency clinical situations and procedures that may not occur naturally during three or four years of residency.[2] However, there is significant variability in the use of simulation in Accreditation Council for Graduate Medical Education (ACGME)-accredited EM residency training programs nationally.

The most recent national survey regarding the use of simulation in United States EM residency programs was by Okuda et al in 2008 who reported that 91% of programs used simulation, with 43% of programs using simulation more than 10 hours per year.[3] This showed a significant increase from the prior survey performed in 2003 that reported only 29% of EM programs were using high-fidelity simulation.[4] Since then, there has not been a re-evaluation of simulation use in US EM residency programs, although a 2015 survey of pediatric EM fellowships reported using simulation in 97% of programs.[5] In 2011, Heitz et al reported that 79% of EM clerkships were incorporating simulation into their curriculum for third- and fourth-year medical students.[6] A more recent survey of Canadian EM residency programs found 100% of programs reported using simulation for resident education, with a median of 20 dedicated hours per year.[7,8] It is unclear whether these data can be directly translated to US training programs, as Canada's EM programs have been encouraged to transition to a competency-based education residency model that may inherently use simulation more.[9] Simulation fellowship programs have also exhibited significant growth, which may be an indirect marker of an increase in demand for simulation-trained faculty.[10-12]

Over the past 15 years, the landscape of EM resident training has evolved dramatically, especially in an era that confronted a global pandemic and record emergency department (ED) boarding. Anecdotally, the use of simulation education has increased in EM residency training programs over this time, but data are limited on the current amount and methods of implementation. Understanding the role of simulation in EM residencies across the country may allow programs to standardize simulation curricula, motivate formal simulation facilitation training, and offer opportunities for expansion of the learning modality in the context of EM. Our objective in this study was to provide an update of the use of simulation in EM resident training programs in the US.

*Population Health Research Capsule*

What do we already know about this issue?
*Anecdotally, simulation use in emergency medicine training programs has increased over the past decade. However, few data exist to support or quantify this increase.*

What was the research question?
*We sought to assess the current state of simulation use in ACGME-approved EM residency programs in the United States.*

What was the major finding of the study?
*75% of programs use simulation at least monthly, reflecting a notable increase compared to 43% using simulation greater than 10 hours per year in a 2008 survey data.*

How does this improve population health?
*Simulation-based education improves patient safety, and its growing use in EM residencies reflects a strong commitment to safer, high-quality clinical training.*

## METHODS

### Study Design and Population

Approval for this project was obtained from the institutional review board (IRB) (IRB-300008219). We conducted a national survey of EM residency program directors (PD). The survey tool was an expansion and update of earlier surveys administered to EM programs.[3-6]

### Survey Content and Administration

Surveys were sent to 277 PDs of EM residency programs that participated in the 2022 match, as identified by the Council of Residency Directors in EM directory and the National Resident Matching Program.[13] Surveys were distributed via email in August 2022. Each program was solicited to complete a single survey. The email provided a brief introduction regarding the purpose of the survey, the title and role of the survey solicitors, and documentation of IRB approval. A direct link was provided in the email to a web-based survey tool (Qualtrics International Inc, Provo, UT). A second email was sent to the same distribution list in October 2022, as a final solicitation and reminder.

The survey was developed via an iterative process. After initial development, we piloted the survey at our institution with an EM PD and two assistant PDs. Using feedback and suggestions for edits, the revised survey was piloted once more with one PD at a different institution. The final version was distributed to our list of PDs as shown in Addendum 1. The final updated instrument contained program demographic, yes/no, and multiple-choice questions related to the availability and use of simulation in EM residency training. Additional questions pertained to the availability of simulation fellowship-trained faculty, simulation scholarly tracks and research activities, and the accreditation of available simulation centers .

As in prior assessments, we defined a manikin-based, high-fidelity simulator as a computerized full-body robot-manikin. A partial task simulator was defined as specialized equipment for procedures or skills that go beyond typical static trainers. Examples include simulators for central lines, venous access, chest tube placement, bronchoscopy, ultrasound, birthing, and trauma. We defined screen-based computer simulation as case simulations conducted through an interactive computer interface. A tabletop-based simulation was defined as a low-fidelity, discussion-based scenario designed to apply knowledge and/or assess policies, plans, or procedures.[14]

Efforts to minimize non-response bias included sending reminder requests; however, funding constraints prevented us from offering financial incentives to PDs for completing the survey. Additionally, we were unable to calculate non-response bias due to not tracking survey response dates.

### Data Analysis

We analyzed results using simple frequency tabulations; chi-square analysis was employed to compare current and previous survey data.

## RESULTS

Of the 277 programs surveyed, we successfully contacted 244, and 100 PDs completed the questionnaire. This corresponds with a response rate of 36% based on all programs surveyed and 41% based on programs successfully contacted. For consistency, we use the 36% response rate throughout the paper, in alignment with the American Association for Public Opinion Research definition of minimum response rate.[15] Programs from all geographic regions responded (Table 1). Most of the programs that responded were comprised of more than 28 total residents (69.5%).

With regard to equipment, personnel, and resources, approximately half (49.5%) of respondents reported simulation fellowship-trained faculty on staff, most frequently comprised of one (20%) or two (17.9%) individuals. Most (95.8%) programs reported access to a simulation center, 34.7% of which were reportedly accredited by the Society for Simulation in Healthcare. Larger residency programs (those with more than 27 residents) were more likely to have more simulation equipment ($P > .05$). Simulation was most often used monthly (52.6%) or more than once per month (23.2%). A smaller number of programs reported using simulation 3-11 times per year (20%), while one program (1.1%) reported using it 2-3 times per year. Most respondents (74.7%) also reported use of simulation curriculum or education for medical students on their EM rotation.

Simulation was used most frequently to address resuscitation skills, airway management, disease-specific management (eg, myocardial infarction, arrhythmia), procedural skills, professionalism, teamwork, and error avoidance. In most responding programs (85.2%), simulation was used to fulfill training requirements for rare ACGME-mandated procedures, such as pericardiocentesis, cardiac pacing, and cricothyrotomy, **in at least half of the required cases**. In contrast, more routine required procedures, such as central venous line placement, intubation, and lumbar puncture, were simulated **in fewer than 20% of cases** at most (77.9%) programs. Over half of programs (60%) reported engagement in simulation-based research resulting in poster or abstract presentation (55.8%) and/or peer-reviewed journal publication (40%). Ongoing reported barriers to incorporation of simulation included lack of funding, lack of lab or equipment access, and lack of faculty expertise or availability.

## DISCUSSION

Research on the use of simulation-based medical education in US EM residency programs has been sparse since the 2008 study by Okuda et al. Our findings suggest a notable increase in simulation use, with 75% of programs now reporting simulation sessions at least once per month compared to just 42% of programs in 2008, which reported >10 hours of simulation annually.[3] Nearly all programs reported using simulation in general, while more than 90% reported using both manikin-based (97.9%) and task trainer-based (94.7%) simulation for procedural teaching. The 2008 data from Okuda documented that only 60% of respondents reported using task-trainer simulators, while 85% used manikin simulators.[3]

Over half of programs (58.9%) reported access to screen-based simulators compared to 14% in the 2008 survey.[3] The reason for this increase is likely multifactorial, including the increased accessibility and decreased cost of this technology as it has evolved, and potentially due to the need for novel educational methods during the COVID-19 pandemic where traditional teaching modalities were not safe. A future direction of research could involve re-evaluating the prevalence of screen-based simulation activities now that most institutions have returned to in-person educational activities.

We surmise that the increase in simulation use is largely due to the growing recognition of its benefits in medical education, supported by evidence from multiple studies. Most importantly, extensive research has demonstrated improvements in patient safety and the quality of care as a result of simulation-based education.[16-18] The high frequency of using simulation to teach rare clinical procedures (and fulfill ACGME procedure requirements) is not surprising, as most residents likely do not experience enough of those rare procedures in clinical practice alone to be competent and confident. Most respondents indicated access to a simulation center, which is encouraging, although that response rate may have been affected by the large number of responses obtained from university-based EM residency programs.

Simulation appears to be a priority for medical student rotations in EM as about three-quarters of respondents indicated that their students participate regularly in simulation.

**Table 1.** Characteristics of emergency medicine residency programs that participated in a survey of simulation-based medical education.

| Residency Program Characteristic | Programs, n (%) |
|---|---|
| Region | |
| Midwest (IL, IN, IA, KS, MI, MN, MO, NE, ND, SD, OH, WI) | 22 (23.2) |
| Southeast (AL, AR, FL, GA, LA, MS, NC, SC, TN, PR) | 20 (21.1) |
| Southwest (AZ, CA, CO, HI, NV, NM, OK, TX, UT) | 20 (21.1) |
| Mid-Atlantic (DE, DC, MD, NJ, PA, VA, WV) | 16 (16.8) |
| Northeast (CT, ME, MA, NH, NY, RI, VT) | 16 (16.8) |
| Northwest (AK, ID, MT, OR, WA, WY) | 1 (1.1) |
| Residency size | |
| < 18 | 2 (2.1) |
| 18-21 | 13 (13.7) |
| 22-27 | 14 (14.7) |
| 28-33 | 15 (15.8) |
| > 33 | 51 (53.7) |
| Primary residency type/affiliation | |
| University-based | 54 (56.8) |
| Non-university based | 24 (25.3) |
| County/public hospital | 15 (15.8) |
| Military/other | 2 (2.1) |
| Use of ANY simulation equipment | |
| Manikin simulators | 93 (97.9) |
| Partial task simulators | 90 (94.7) |
| Screen-based simulators | 56 (58.9) |
| Tabletop simulators | 59 (62.1) |
| Frequency of simulation didactics or education* | |
| 1 time per year | 0 (0.0) |
| 2-3 times per year | 1 (1.1) |
| 4-11 times per year | 19 (20.0) |
| Monthly | 50 (52.6) |
| More than once a month | 22 (23.2) |

*Three missing responses.

We surmise that simulation can help combat students' inconsistent opportunities to experience diverse clinical scenarios, given an often relatively short EM rotation. During the COVID-19 pandemic when students had less exposure to patients, simulation was recognized as a valuable tool to develop clinical skills previously taught exclusively at bedside.[19] Although students have now reintegrated into in-person clinical practice, the value of simulation as an educational tool appears to be persistent.

About half (49.5%) of responding programs reported having fellowship-trained simulation faculty on staff. While this may represent an increase in simulation-trained faculty and is encouraging for the field of medical simulation, it also highlights a need for training materials and support for non-fellowship-trained faculty at the other half of institutions that are also using simulation-based education. Lack of faculty expertise was also cited as a major barrier to simulation in responding programs, further underscoring the need for continued facilitation training. Anecdotally, there are reports of some facilitators who have not had formal simulation training but, through years of experience, have honed skills that have led them to become exceptional educators. However, the International Nursing Association for Clinical Simulation and Learning (INACSL) Healthcare Simulation Standards of Best Practice suggest that all simulation facilitators should possess "specific skills and knowledge in simulation pedagogy."[20] Additionally, only about a quarter (27.4%) of programs reported having a simulation fellowship or simulation scholarly

track available to residents. This represents an opportunity for programs to expose their residents to simulation theory and facilitation earlier in training to spur their interest and expertise in medical education, debriefing skills, and different applications of simulation.

Major barriers to incorporating simulation included lack of funding, limited access to simulation materials or facilities, and lack of faculty availability and expertise. Not surprisingly, these findings closely mirror those cited by Okuda in 2008.[3] There is a clear need for increased access to simulation training and facilitation resources as well as support for increased fellowship opportunities. As simulation plays an increasing role in most programs' curricula, increased departmental and institutional support will be necessary. Alternate revenue streams such as grants may also be explored to combat some of these barriers. There is also a growing body of free open-access simulation cases online.

## LIMITATIONS

The most prominent limitation is the survey response rate of 36%, not an uncommon interpretive barrier in survey-based projects. Similar survey-based studies targeting medical education program directors report response rates in the 49.5-54% range.[21,22] While our response rate of 36% may introduce significant response bias, the diversity of respondents may still provide valuable insights into current practices.

We suspect multiple factors contributed to the low response rate of our survey. Program directors receive a multitude of emails daily so they could have missed the survey, or their contact information may have changed since the list was generated. Thirty-three of the emails sent were "undeliverable" or "invalid," which limited responses from those programs where alternative contact information could not be located. Five of the surveys were only partially completed and, thus, excluded. Any survey is subject to response bias, and of the responding programs, there was a trend toward larger, academic programs. This likely biases the results as these programs are more likely to have funding and resources for simulation.

Due to the low response rate, our sample is likely subject to an increased risk of selection bias. Specifically, programs with robust simulation programs may have been more motivated to complete the survey, whereas programs without a strong simulation curriculum were less likely to participate. This response pattern could result in an over-representation of programs with established simulation initiatives, artificially inflating the reported prevalence and perceived impact of simulation programs among respondents.

In an effort to include all ACGME-accredited EM programs, the survey was sent to PDs, not specifically simulation faculty, which could have affected some nuances of responses. To our knowledge, there is not a current centralized, comprehensive list of simulation-trained or interested faculty at ACGME-accredited residency programs. There may be an opportunity for development of such a database through national organizations such as the Society of Academic Emergency Medicine Simulation Academy or the Society for Simulation in Healthcare Emergency Medicine Interest Group.

Another limitation of our results is that we collected data on simulation frequency in terms of number of sessions per year rather than in hours spent in simulation. For example, a program offering a four-hour simulation session once per month might be using simulation much differently than a program offering a one-hour simulation once per month, but both programs may have selected "monthly" to characterize their usage. This makes our results difficult to compare directly to prior studies that reported simulation use in hours. Future surveys should consider including this specific variable to better compare simulation curricula longitudinally.

## FUTURE DIRECTIONS

While this survey highlights the increase in use of simulation-based education in EM residency programs, it also highlights the variability in the methods and facilitation of simulation activities. It has recently been suggested that simulation be formalized as a core ACGME requirement; this survey may mobilize increased engagement in this initiative.[23] Further comparisons between programmatic and regional differences and educational outcomes would be useful to prioritize funding and equipment distribution. Formalizing the role of simulation in EM residency curricula may also encourage wider adoption of the INACSL Standards of Best Practice for Simulation.[24] Future directions of research may also explore whether educational outcomes in simulation differ based on facilitator formal training or completion of a fellowship in simulation. Similarly, opportunities for faculty development and cost-effective and timely facilitator training could be explored.

While our findings show increased use of simulation in EM residency programs, and existing literature suggests a link to improved patient outcomes, further research is needed to determine whether increased simulation alone drives better educational results—or whether specific elements of a simulation curriculum are more effective. Such insights could help programs make more informed decisions about how to allocate time and resources.

Notably, this survey was conducted prior to the American Board of Emergency Medicine (ABEM) announcement of the upcoming change in certification examinations to clinical care cases and Objective Structured Clinical Examination cases. Simulation use in EM residency programs has the potential to change or expand in the next several years in conjunction with this change in ABEM examination policies. The increase in simulation use described in the survey results and the anticipated continued trajectory of the field also raise the question whether simulation should be an ACGME requirement for EM residency training programs.

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# Unveiling Humility in Emergency Medicine Chief Residents: A Thematic Exploration of Standard Letters of Evaluation

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**Introduction:** Although humility is a key leadership trait linked to collaboration and trust, current residency application processes lack methods to identify it. By examining whether themes of humility appear in the Standardized Letters of Evaluation (SLOE) of medical students who later became emergency medicine (EM) chief residents, we sought to determine the presence of humility-related traits in SLOEs and explore their potential to inform the identification of applicants with leadership potential during residency selection.

**Methods:** Two independent reviewers examined 104 SLOEs (52 chief, 52 non-chief) from 2015–2021, representing 43 students (21 who later assumed chief resident positions and 22 who did not) between 2018–2024 at a single academic EM residency program. A third reviewer resolved all coding disagreements. Reviewers deductively analyzed all written comments, targeting elements associated with humility as conceptualized by Tangney (2000) and Gruppen (2015). A SLOE was categorized as containing elements of humility if at least one clearly defined construct (such as openness to feedback, recognition of limitations, or concern for others) was identified. Sections of the data displaying the most convergence of humility elements underwent open coding, revealing emerging themes.

**Results:** Nineteen of 21 (90.5%) chief residents had letters encompassing elements of humility compared to only 10 of 22 (45.5%) non-chief residents ($P < .01$). Openness was the most prominent element noted, followed by the need to make changes in performance, concern for others, and confidence. Further analysis of comments that highlighted humility uncovered several other themes including commitment and advocacy, eagerness to learn and improve, and maturity and responsibility.

**Conclusion:** This study highlights specific humility-related traits noted in the Standard Letters of Evaluation of fourth-year medical students who later became chief residents in emergency medicine, offering preliminary insights into how qualitative evaluation tools may capture characteristics associated with future leadership roles. [West J Emerg Med. 2025;26(6)1536–1543.]

## INTRODUCTION

Leadership in medicine requires more than clinical expertise; it demands qualities such as adaptability, collaboration, and emotional intelligence.[1] Humility, often defined as an accurate self-assessment, recognition of one's limitations, openness to new ideas, and appreciation of others' contributions, is increasingly recognized as a cornerstone of effective leadership. Described as "the medical virtue most difficult to understand and practice," humility is far from a sign of weakness. Instead, it reflects self-confidence, self-

awareness, and the ability to transcend ego for the benefit of a team or system.[2-4] According to leadership research, humility in leaders is characterized by their ability to maintain an objective view of themselves, value the strengths and contributions of others, and remain open to new ideas and feedback. Humble leaders demonstrate a willingness to self-reflect, acknowledge the capabilities of those they lead, and show a strong interest in learning from others' perspectives and experiences. This openness and appreciation foster collaboration and adaptability, which are critical traits in effective leadership.[5,6] In medicine, humility fosters a culture of empathy, collaboration, and continuous self-reflection, making it indispensable for both clinicians and leaders.

Although humility is valued in residency selection and leadership, it is not explicitly measured or surfaced in most formal evaluation tools, making it challenging to assess in residency applicants. Most residency selection processes focus on measurable achievements such as academic performance and clinical skills, with little emphasis on intangible traits such as humility. These behaviors are rarely included in formal evaluation rubrics, and in the absence of specific prompts, opportunities to capture humility through narrative comments may be overlooked. To our knowledge, there is no published literature directly evaluating how humility is assessed in residency applicants; however, anecdotally, it is widely regarded as a desirable yet difficult trait to identify during the application process, particularly in the absence of explicit prompts or structured tools. As a result, the absence of established methodologies for systematically identifying themes of humility in residency applicants presents an opportunity for improvement in graduate medical education, especially for programs seeking candidates who excel clinically and embody traits suited for future leadership roles.

While humility is not always explicitly considered in leadership selection, it is frequently cited as a core quality of effective leaders who are self-aware, open to feedback, and capable of fostering team-based success.[7-9] In academic medicine, the appointment of chief residents is often one of the earliest formal recognitions of leadership potential. Although selection criteria vary across institutions, chief residents are typically chosen based on traits that frequently overlap with dimensions of humility: perceived maturity; reliability; emotional intelligence; and the ability to lead peers.[10] We acknowledge that not all chief residents are necessarily more humble than their peers, and our study does not seek to establish that those selected possess greater humility.

Rather, in this study we operated on the assumption that the selection of chief residents reflects an endorsement of leadership potential that may have begun to emerge prior to residency and been further cultivated during training. We use the term "emerging" to refer to qualities that are not yet fully formed but are beginning to be expressed and recognized, such as openness to feedback, self-awareness, and maturity. While some of these attributes may be observable in Standardized Letters of Evaluation (SLOE) submitted during the emergency medicine (EM) residency application process, others may develop over time through mentorship, feedback, and clinical experience. This assumption provides a meaningful lens through which to explore whether humility-related behaviors are identifiable earlier in training.

While it may be intuitive that applicants who display desirable traits in SLOEs could eventually hold leadership roles, this study adds a theory-driven, qualitative approach to identifying one such trait (humility) using established conceptual models. In doing so, it provides preliminary insight into how humility-related behaviors may be expressed in real-world evaluations and offers a foundation for future research on evaluating intangible leadership traits in residency candidates.

*Population Health Research Capsule*

What do we already know about this issue?
*Leadership selection in residency is common, but the characteristics influencing chief resident selection are poorly understood.*

What was the research question?
*How is humility reflected in the Standard Letters of Evaluation (SLOE) of applicants who later become chief residents in emergency medicine?*

What was the major finding of the study?
*90.5% of chief residents vs 45.5% of non-chiefs had humility traits in their SLOEs (P < .01).*

How does this improve population health?
*Understanding valued leadership traits such as humility may help shape more intentional, equity-focused selection and development of residents.*

## METHODS

As emergency physicians with firsthand knowledge of residency training and the chief resident selection process, we acknowledge the importance of reflexivity in qualitative research. The research team includes three women and two men, all of whom are practicing physicians. One team member is currently pursuing a master's degrees in education, two have a Master of Health Professions Educations degree, one holds a Master of Science degree, and one has earned an EdD. All authors had substantial training in qualitative methods, and several have served as chief residents in their own programs, offering perspective on the expectations and

selection processes commonly associated with the chief resident role. Importantly, three of the five authors were not affiliated with the institution during the selection period of the chief residents included in this study, and the remaining two authors held positions in undergraduate medical education that do not involve or influence graduate medical education decisions (including chief resident selection). These factors helped reduce the risk of bias related to participant selection or interpretation of findings. Additionally, we had no conflicts of interest and received no funding to conduct this research.

We conducted a retrospective review of SLOEs of medical students from 2015–2021 who matched into EM and later were selected for chief resident positions from 2018–2024 at a single-site, tertiary academic EM residency program. This range was selected to include all chief residents from our EM program for whom complete, archived SLOEs were available at the time of study initiation. This study adhered to the standards for reporting qualitative research (SRQR), which are synthesized recommendations that aim to improve the transparency of all aspects of qualitative research (see Appendix).[11] We chose the SRQR because it addresses critical aspects of qualitative research, including reflexivity, study design, data analysis, and reporting, making it well-suited for the methodology used in this project.

**Study Design**

We adopted a retrospective, qualitative study design guided by a constructivist framework, which posits that learning is an active process where individuals construct knowledge through their experiences to prioritize an in-depth examination of historical SLOEs to uncover emerging themes of humility. To mitigate potential bias during qualitative analysis, our dataset of SLOE excerpts intentionally excluded demographic information, including sex, age, and graduation year (Table 1) during the analysis. We acknowledge that certain narrative elements, such as descriptions of unique experiences, may still carry identifiable details; however, our focus was on reducing the influence of known demographic characteristics on data interpretation.

**Study Setting and Population**

Conducted within the context of a single-site, academic EM residency program, this study focused on a distinct population: medical students who, between 2015–2021, matriculated into our residency program and were elected to chief resident positions. Our program is a postgraduate year (PGY) 1-3 program within a Level 1, urban, academic medical center in the Northeast. Each class consists of 17 residents, with three chief residents selected each year from the PGY-3 class. Selections are made through a hybrid process consisting of application review, interview scores, professionalism review, and voting by residents and faculty members. Chief residents represent a useful population for exploring the potential early presence of humility-related behaviors, for they are widely regarded as individuals who demonstrate traits that align with key dimensions of humility such as self-awareness, openness to feedback, and respect for others.[10]

**Table 1.** Demographic and characteristics of Standard Letters of Evaluation.

| | Chiefs (All) | Non-Chiefs (Random Sample) |
|---|---|---|
| Men | 12 | 14 |
| Women | 9 | 8 |
| Mean Age | 27.71 | 27.86 |
| Independent SLOEs | 14 | 7 |
| Group SLOEs | 38 | 45 |
| Mean Number of Rotations | 2.48 | 2.36 |

*SLOE,* Standardized Letter of Evaluation.

**Study Protocol**

A total of 104 de-identified SLOEs underwent qualitative analysis. This included 52 SLOEs written for 21 medical students who later assumed chief resident roles, and 52 SLOEs from a randomly selected cohort of students who did not go on to become chief residents. Each resident had between one and four SLOEs included, yielding a total of 104 SLOEs (52 chief, 52 non-chief) in the final analysis. Our analysis was solely focused on the open-ended, qualitative "written comments" section that appears at the end of the SLOE document (Figure 1).

Since the qualitative section has been a consistent component of all versions of the SLOE, we were able to reliably extract qualitative data across multiple years. Two designated members of the research team independently reviewed and deductively coded all SLOEs, guided by the conceptual frameworks of Tangney (2000) and Gruppen (2015). A third team member adjudicated all coding discrepancies to maintain consistency across the dataset. This study was reviewed and exempted by the institutional review board at our university.

**Measurements and Key Outcome Measures**

The primary focus of this study was to identify and characterize humility-related content within the narrative, open-ended portions of SLOEs. The key outcome measure was the presence of language or descriptions that aligned with established humility constructs, including self-awareness, openness to feedback, appreciation of others, and recognition of personal limitations. A SLOE was categorized as containing humility-related attributes if at least one of these predefined constructs was clearly identified in the narrative comments. Additional outcomes included the types and frequency of these humility-related elements, as well as any recurring patterns in how they were described.

**Written Comments: Part D**

Please concisely summarize this applicant's overall candidacy, providing detail on strengths, explaining growth opportunities or lower ratings from above, and highlighting anything else you feel like we should know about this student. (limit your text to 350 words or less):

**Figure 1.** Part D of the Standardized Letter of Evaluation written comments section used to assess emergency medicine applicants: context for thematic analysis of humility in chief residents.

Using a constructivist approach, we conducted a qualitative content analysis of SLOE narratives, emphasizing the interpretive and contextual nature of the data. The analysis began with a deductive coding framework based on established humility constructs, followed by open coding to identify emergent themes beyond the initial framework. Manual coding was performed independently by members of the research team without the use of qualitative analysis software. As this was an exploratory qualitative study, we did not perform statistical testing, and sample size was determined by the bounded study population rather than thematic saturation.

## RESULTS

Our investigation uncovered a significant prevalence of humility-related attributes in the chief residents' SLOEs: 19 of 21 (90.5%) chief residents had letters encompassing elements of humility, compared to only 10 of 22 (45.5%) non-chief residents ($P < .01$, Fisher exact test). Humility-related attributes were significantly more common in SLOEs written for students who became chief residents. When evaluating individual SLOEs, humility appeared in 31 of 52 (59.6%) chief resident SLOEs vs 13 of 52 (25.0%) non-chief SLOEs ($\chi^2(1, N = 104) = 12.76$, $P < .001$).

Openness was the most prominent element noted in chief resident SLOEs, followed by the need to make changes in performance, concern for others, and confidence (Table 2). These four elements represent how the predefined humility constructs—self-awareness, openness to feedback, appreciation of others, and recognition of personal limitations—manifested in the narrative data. For example, "openness" maps directly to openness to feedback, while "need for ongoing performance improvement" reflects both recognition of limitations and self-awareness. "Concern for others" aligns with appreciation of others. Although "confidence" was not part of our original coding framework, it frequently co-occurred with humility-related language and was, therefore, included as a contextual theme relevant to the overall construct.

Each chief resident in the study had between 1-4 SLOEs included in the dataset. A chief resident was categorized as having humility-related attributes if at least one SLOE contained a clearly identifiable construct consistent with our predefined coding framework. This inclusive threshold was chosen given the variability in SLOE count and length across individuals. Of the 21 chief residents, 19 (90.5%) met this threshold. The four primary elements were identified across these 19 individuals as follows: openness (N = 15); need for ongoing performance improvement (N = 13); concern for others (N = 9); and confidence (N = 9). These elements were not mutually exclusive and often co-occurred within the same SLOE or across multiple letters. Each element was counted once per chief resident, meaning that if a resident had more than one SLOE containing the same element, that element was only counted once in the total (N). Among the three chief residents whose SLOEs did not meet the inclusion threshold, no identifiable humility-related constructs were coded. While some comments reflected general positivity or professionalism, they did not include language that clearly aligned with the predefined elements of humility as operationalized in our coding framework.

### Openness

Openness was manifested in various ways across the letters, indicating a consistent pattern of behavior among the prospective chief residents. For instance, a recurring element in the letters highlighted the candidates' ability to interact effectively with diverse patients and tailor discharge instructions to varying levels of understanding within the patient population. Evaluators frequently emphasized the candidates' curiosity and dedication to learning, as one described: "Inquisitive and asks pertinent and appropriate questions in order to further his knowledge. [He/She] wants to learn as much as [he/she] possibly can." Additionally, the language used by the evaluators consistently underscored the candidates' willingness to collaborate, consider alternative approaches, and "ability to adapt," reflecting an openness that transcended individual perspectives. Another dimension of openness is observed in candidates' proactive and eager attitudes toward learning and improvement, demonstrated by their involvement in various procedures, volunteering during crises, and an overarching eagerness to participate in learning opportunities.

### Need for Ongoing Performance Improvement

The SLOEs consistently illuminate candidates' awareness of the need for ongoing performance improvement, underscoring another core theme of humility. One key strength identified in future leaders is their constant search for ways to improve, coupled with a genuine care for the world around them. Letters highlighted the improvement trajectory of several students, demonstrating a proactive attitude toward

**Table 2.** Key elements of humility identified in Standardized Letters of Evaluation for emergency medicine chief residents, with illustrative quotes.

| Humility element | Illustrative quotes |
|---|---|
| Openness (N = 21) | "Inquisitive and asks pertinent and appropriate questions…to further [his/her] knowledge. [He/she] wants to learn as much as [he/she] possibly can." |
| | "Proactive and eager to learn." |
| | "[He/she] was extremely proactive and was always asking to see patients. [He/she] sought out learning opportunities and showed enthusiasm." |
| | "Ability to adapt." |
| Need for Ongoing Performance Improvement (N = 14) | "Eager to continue learning and improving. Engaged, eager to learn, and receptive to feedback and coaching." |
| | "Strong desire to learn and improve throughout [his/her] shifts." |
| | "Receptive to feedback and coaching." |
| | "Improves with each shift, starting to see the big picture. Grew substantially." |
| Concern for Others (N = 12) | "[He/she] truly cares about the world around [him/her]." |
| | "Showed [his/her] commitment to patient care during the COVID-19 crisis in March by volunteering." |
| | "Compassion for patients." |
| | "Strong empathetic personality which allows to interact on a more humane level with [his/her] patients." |
| Confidence (N = 9) | "Strikes an incredible balance of confidence with enthusiastic learner." |
| | "Confident, outspoken, and naturally persuasive with consultants, PMDs, and patients." |
| | "Engaging with a positive and cheerful attitude." |
| | "Energetic, eager, and engaged." |

*PMD,* primary medical doctor.

professional development. For example, "stays late to learn more," "improves with each shift, starting to see the big picture," and "eager to continue improving." These comments signify a maturation process and a commitment to evolving in their role. Similarly, SLOEs consistently expressed student eagerness and receptiveness to feedback, as well as the ability to anticipate needs, demonstrating keen observational traits and an adept understanding of the dynamic environment in EM. The humility to recognize limitations and seek clarification through questions is evident, emphasizing a commitment to continuous learning and improvement.

**Concern for Others**

Another common thread in letters of chief residents was the expression of concern for others, often manifested as candidates going above and beyond to tailor care to the understanding of patients and advocating for their well-being. Instances of volunteering during crises, such as the COVID-19 pandemic, underscore a genuine commitment to patient care during challenging times. Compassion and empathy are consistently highlighted, with comments such as "truly cares about the world around [him/her]" and "great advocate for [his/her] patients." Other comments spoke to students' consistent re-evaluation of patients and independent discussions on care, stating, "[He/she] would consistently re-evaluate patients and independently discuss care with them." Another wrote, "Strong empathetic personality which allows to interact on a more humane level with his patients." Students' consistent re-evaluation of patients, independent discussions on care, and taking true ownership of patient outcomes not only underscore their empathetic approach and dedication to individualized patient well-being but also reflect a humble commitment to continuous improvement and a genuine recognition of the complexities inherent in patient care.

**Confidence**

Although not traditionally conceptualized as a core component of humility, confidence frequently co-occurred with humility-related behaviors in chief resident SLOEs. Letters often described a balanced confidence that was paired with openness to feedback, eagerness to learn, or self-awareness, supporting rather than contradicting the presence of humility. For this reason, confidence was included as a contextual element reflecting how humility was often expressed in conjunction with leadership readiness. In their SLOEs, chief residents' confidence was noted through interactions with consultants, primary care physicians, and patients, where they are described as outspoken, persuasive, and committed to their patients' well-being. Comments include "strikes an incredible balance of confidence with enthusiastic learner," "confident but humble," and "confident, outspoken, and naturally persuasive with consultants."

**Other Themes**

Comment analysis revealed several other minor themes of humility in chief resident letters, including the ability to ask for help/guidance; maintaining perspective; acknowledgment of shortcomings; commitment and advocacy; eagerness to learn and improve; initiative and resourcefulness; teachability and adaptability; empathy and compassion; maturity and responsibility; proactivity and ownership; enthusiasm and positivity; continuous improvement; and dedication to patient care. These themes were identified exclusively in the SLOEs of the 19 chief residents who met our threshold for humility-related content; none were present in the SLOEs of the three excluded individuals. Given the exploratory and qualitative nature of this phase of analysis, our intent was to describe the thematic landscape of humility-related language rather than to quantify the frequency of each individual code.

## DISCUSSION

Our study was grounded in two of the most well-established and frequently cited definitions of humility in the literature: those proposed by Tangney (2000) and Gruppen (2015).[12,13] By incorporating both frameworks, we aimed to comprehensively operationalize the construct of humility and reduce the likelihood of missing key elements within the data. The humility-related themes identified within SLOEs offer a nuanced perspective on the qualities associated with effective and compassionate leadership in EM. While "hard" skills such as clinical knowledge and procedural competencies are vital, the prominence of "soft" skills such as commitment, enthusiasm, teachability, empathy, and proactivity underscores their pivotal role in shaping chief residents. These qualities collectively form a comprehensive framework for assessing humility, emphasizing its dynamic and interconnected nature.

Our findings that most chief residents had several elements of humility threaded through their SLOEs align with existing literature on humility in leadership and medicine. Owens and Hekman discuss emergent humility in the leadership model, emphasizing the importance of humility in leader-follower relationships and organizational development.[6] Rego et al present an empirical study on the perceived impact of leaders' humility on team effectiveness and encourage humility to be included in any authentic leadership agenda.[14] Similarly, Collins and Stoller discuss the concept of "level 5 leadership," which involves the co-occurrence of personal humility and an unwavering commitment to produce long-term results.[15,16] Collectively, these models resonate with our study's identification of openness, concern for others, and the need for ongoing performance improvement as prominent humility-related themes in the SLOEs of chief residents.

Recognizing humility as not only an important trait for leaders but also for successful clinicians, Wadhwa and Mahant illuminate the lived experiences of peer-nominated, excellent clinicians through a qualitative exploration of humility in medical practice. In their study, humility emerges as a key driver for excellence, playing a pivotal role in shaping positive relationships with patients and team members and fostering a collaborative, patient-centric healthcare environment.[3] This underscores the consistent recognition of humility's significance in medical leadership, aligning with our findings in chief residents' SLOEs.

Moreover, humility in chief residents contributes to fostering effective teamwork and creating an inclusive atmosphere within the emergency department. Leaders who acknowledge their limitations set an example for continuous learning and improvement, inspiring a culture of humility among their peers and subordinates. This culture, in turn, can have a ripple effect that may enhance the overall dynamics of a medical team and ultimately lead to improved patient outcomes and a more resilient healthcare system.

Our findings highlight a noteworthy aspect of humility concerning its relationship with confidence, suggesting that these traits are not mutually exclusive but can coexist as complementary attributes. Specifically, our study suggests that confidence, when balanced with humility, may reflect a self-assured yet teachable mindset that can contribute to effective leadership. This interpretation aligns with Chiu et al, who explore how leader humility and team member characteristics influence shared leadership and team dynamics, and with Lombardero et al, who underscore the importance of cultural humility in medical education.[17,18] While our investigation of chief residents' SLOEs suggests a recurring balance of confidence and humility, further research is needed to better understand how these traits manifest in leadership roles. This study provides preliminary insights into the complex interplay between humility and confidence in EM leadership, offering a foundation for future exploration.

Additionally, while we identified humility-related traits in SLOEs written during medical students' fourth year, it remains unclear whether these traits were further developed or reinforced during residency training. Existing literature suggests that having a growth mindset, closely aligned with humility, plays a critical role in creating adaptable leaders.[6,19] This raises an important question about whether residency programs can actively nurture and enhance these traits, potentially shaping individuals into effective leaders over time. Future longitudinal studies could explore how traits like humility evolve and contribute to leadership development throughout residency.

It is also worth considering whether the humility-related elements described in the SLOEs represent authentic traits of the applicants or are instead emphasized by letter writers who recognize that qualities like teamwork and self-awareness are highly valued by residency programs. Narrative letters are subject to both intentional and unconscious bias, and the presence of these elements may reflect strategic framing by the author rather than objective traits of the applicant. Additionally, the observed humility-related elements may reflect qualities that were actively cultivated during residency

rather than being present at the time of selection. As our study included only SLOEs from students who became chief residents, we cannot determine whether these traits were disproportionately present compared to peers who were not selected. Future research comparing SLOEs across different resident cohorts, and assessing traits longitudinally, would help clarify whether early humility indicators correlate with leadership trajectories.

Looking forward, the identification of humility-related themes in SLOEs holds promising implications for the practical aspects of residency program selection processes. Our study brings attention to the challenge faced by residency program directors in navigating through an extensive array of letters to discern applicant attributes, particularly for complex traits like humility. The conventional approach, reliant on explicit mentions of terms such as "humble," may inadvertently overlook the subtler yet crucial aspects that contribute to effective and compassionate leadership. An opportunity to leverage the common threads of humility uncovered in our study certainly exists; establishing a systematic coding system based on these identified themes could provide a structured framework for residency program directors to assess and identify candidates with humility-related attributes. This approach could serve as a valuable tool, offering a more efficient and comprehensive means of evaluating a candidate's potential for effective leadership.

As the healthcare landscape evolves with constant change and uncertainty, the importance of training future leaders who exhibit humility cannot be overlooked. Humble leaders are often more open to new ideas and perspectives, creating environments that support collaboration and problem-solving. In EM, leadership requires not only clinical expertise but also the ability to inspire confidence, foster teamwork, and adapt to challenges. While this study highlights the potential value of identifying humility-related traits during the residency selection process, further research is needed to better understand how these traits contribute to leadership effectiveness.

## LIMITATIONS

While our study provides valuable insights into the theme of humility within chief residents as identified in SLOEs, it is essential to acknowledge its inherent limitations. The SLOE, by nature, is a concise document, and the brevity of written comments poses a challenge in fully capturing the depth and nuances of "soft" skills, such as humility, that play a pivotal role in the selection of individuals for leadership roles. The constrained space may not allow for a comprehensive representation of the multifaceted aspects of humility, potentially limiting the richness of the data obtained from these evaluations.

Due to the conceptual nature of humility, some degree of thematic overlap and redundancy was expected in the results. While we identified humility-related themes and grounded our assumptions in existing leadership literature, it is important to note that not all chief residents may possess humility as a defining trait. This study was not designed to establish causation or predictive relationships. Instead, it sought to explore whether humility-related traits could be observed in SLOEs and whether these narrative evaluations might offer meaningful qualitative insights.

We recognize the potential for bias in SLOEs and chief resident selection, as existing literature highlights disparities in how evaluations are written and interpreted, potentially influenced by implicit bias. To mitigate these concerns, we intentionally anonymized demographic information from our dataset and emphasized reflexivity in our qualitative analysis. We also acknowledge that many of the humility-related phrases identified in our analysis may appear frequently across SLOEs in general, not only in those belonging to eventual chief residents. This raises important questions about the specificity of these elements and their value in identifying future leaders. While our findings suggest that humility-related traits can be captured in narrative comments, further research is needed to determine whether these elements are more prevalent or described differently in evaluations of future leaders compared to their peers.

Our single-site study further limits generalizability. Chief resident selection criteria may vary across institutions and regions due to differences in organizational culture and institutional priorities. While our findings are specific to EM, the use of SLOEs as a standardized evaluation tool is unique to this specialty. Other fields, which rely on traditional letters of recommendation, may not capture similar qualitative data on humility. Future research should explore whether humility and other leadership traits can be systematically identified in evaluations across different specialties and contexts.

Finally, we acknowledge that humility is a dynamic trait that may evolve over time, particularly through leadership experiences such as serving as a chief resident. Our study captures a snapshot of perceived humility-related behaviors during the residency application process but does not evaluate whether these traits were sustained, enhanced, or further developed during training, nor does it follow these individuals longitudinally to assess how these traits evolve or persist through residency and beyond. Future longitudinal studies are needed to better understand how leadership roles may shape or reinforce characteristics such as humility over time.

These limitations highlight the need for cautious interpretation of our findings and underscore the complexity of evaluating "soft" skills such as humility. Future multisite studies incorporating diverse institutional contexts and longitudinal assessments will be crucial to further our understanding of how traits like humility contribute to leadership in medical training.

## CONCLUSION

Our findings emphasize the potential for residency educators, particularly those involved in application review

and trainee mentorship, to recognize and foster qualities such as humility in students and trainees. However, further research is needed to better understand how these traits influence leadership selection and performance. While our study found openness to be the most frequently occurring humility-related element, it is difficult to determine how to interpret the presence of any single behavior, particularly within the context of a small, qualitative study. Meaningful insight is more likely to come from identifying a composite of multiple humility-related traits that are observed consistently across different evaluations and clinical settings. As the medical community continues to prioritize the development of well-rounded and empathetic leaders, these insights may help inform future efforts to refine the evaluation of residency candidates and explore how humility contributes to leadership in emergency medicine.

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# A 30-year History of the Emergency Medicine Standardized Letter of Evaluation

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Thirty years ago, education leaders in emergency medicine (EM) developed a standardized letter of recommendation to address limitations of narrative letters of recommendation in the residency selection process. Since then, multiple iterations and improvements with specialty-wide adoption have led to this letter being cited as one of the most essential pieces of a residency application. Based on the experience and success in EM, many other specialties have also now adopted standardized letters of their own. In this paper, we detail the 30-year history of the EM standardized letter including form changes and technological innovations, research and validity evidence, and discussion of research and administrative priorities for the future. [West J Emerg Med. 2025;26(6)1544–1548.]

## INTRODUCTION

Emergency medicine (EM) was the first specialty to adopt a standardized letter for residency applications. Noting the shortcomings of narrative letters of recommendation featuring lengthy descriptions and heterogenous content and structure, the Council of Residency Directors in Emergency Medicine (CORD) assembled a task force in 1995 to develop a structured assessment to replace narrative letters that was standardized, concise, and discerning.[1] The resulting assessment form became the Standardized Letter of Recommendation (SLOR) and debuted in the 1995-1996 EM residency application cycle.

Over the past 30 years, the EM standardized letter has evolved through multiple iterations and advancements including updates to the items and domains assessed, migrating from disseminated paper forms to a centralized electronic database, and development of form variants for subspecialty and off-service rotations. Now known as the Standardized Letter of Evaluation (SLOE),[2] the EM SLOE has led the way for other specialties that recognized the strength of this approach and developed their own standardized letters of evaluation in subsequent years, such as plastic surgery in 2012, internal medicine and orthopedic surgery in 2017, obstetrics and gynecology in 2022, and more. [3-6] Additionally, the Coalition for Physician Accountability's Undergraduate Medical Education-Graduate Medical Education Review Committee recommended in 2021 that all specialties develop and move to structured evaluation letters instead of narrative letters.[7]

In this paper, we detail the 30-year history of the EM SLOE including form changes and technological innovations in response to evolving needs and priorities of the broader EM community. This history and accompanying context can inform efforts of those responsible for developing, researching, writing, and interpreting SLOEs by standardizing the language used to describe SLOE versions and variants,

summarizing the literature on the topic, and mapping research and administrative agendas for the future.

## STANDARDIZED LETTER VERSIONS

The first version of the EM standardized letter, the SLOR, was produced in 1995 by a task force commissioned by CORD (Table 1).[1] This letter debuted in the 1995-1996 residency application cycle and featured sections assessing qualifications for EM (commitment, work ethic, ability to formulate a differential and plan, personality) in addition to a global assessment, estimated match list position, and comments (Appendix 1A).From 1995-2011 the SLOR became an influential aspect of the EM residency match process, and the original letter format was iterated upon.[8]

In 2011, CORD re-established the SLOR task force to study, re-evaluate and update the letter.[8-10] The result was the second official version of the letter, the 2012 SLOE (Table, Appendix 1B), which debuted in the 2012-2013 residency application cycle. At this time, the name SLOR was changed to SLOE to better represent that the letter's purpose was not necessarily to recommend a student, but rather to provide a standardized evaluation of their performance. In addition to the name change came additions and edits to the letter, such as asking which EM rotation this was for the student and the dates during which the student rotated. In Part B, "Qualifications for EM," the personality question was removed, and questions were added regarding ability to work with a team, ability to communicate a caring nature to patients, and anticipated guidance during residency. The anchors in this section also moved away from adjectives and toward peer comparison. In Part C, "Global Assessment," Question 2 changed the rank-list options from descriptions of likelihood of matching to numeric anchors (eg, "Top 10%"). Question 2 also added a clarifying question, "Are you on the committee that determines the final rank list?" to understand whether the letter writer had experience with such rankings. Lastly, the narrative section now had a reduced word limit of 250 words or less to encourage letter writers to be more concise, and to decrease the common practice of advertising the institution where the rotation was completed.

Throughout the time spanning these first two iterations of the standardized letter, some authors customized or changed the form.[8] This variance weakened the SLOE by straying from one of its core tenets: standardization. Many efforts from 2011–2016 were made by the SLOE task force to increase standardization and prevent customization such as providing author guidelines and training (including lectures, workshops, and discussion groups), and advocating for a non-modifiable electronic template.[9] To further promote standardization in the use of the SLOE, an electronic portal to write and save letters was developed in 2016, in addition to a new letter form referred to as the electronic SLOE (eSLOE) (Table, Appendix 1C).[11] This change ensured that no alterations could be made to the form, thus standardizing SLOE data for review and comparison. This form also introduced a section after the narrative to describe the institution, both to provide context for the reader and preempt the use of the narrative to describe institutional characteristics. Additionally, the eSLOE website saved all letter information. It produced copies in the correct format, making uploading to the Electronic Residency Application Service system easier for authors, and establishing an electronic database amenable to research and quality improvement initiatives.

To allow authors to provide context for the unprecedented pandemic conditions of the 2020 and 2021 application cycles, the SLOE committee added a single narrative question to the evaluation asking how the student's rotation was affected by COVID-19. While this change technically makes the 2020 edition of the eSLOE a different version of the standardized letter (Table, Appendix 1D), it is otherwise the same 2016 eSLOE.

Following the addition of the COVID-19 question in 2020, the SLOE committee again re-evaluated and updated the eSLOE resulting in the 2022 electronic SLOE 2.0 (eSLOE 2.0) (Table, Appendix 1E).[12] The most notable change in the 2022 eSLOE was the addition of criterion-referenced items and removal of some norm-referenced items. This transition was made in step with broader trends in medical education toward assessments that compare performance to a standard as opposed to other trainees. Another competency-based assessment for EM students in use at that time, the National Clinical Assessment Tool for Medical Students in Emergency Medicine (NCAT-EM),[13] provided helpful context as a field-tested, criterion-referenced clinical assessment to emulate in the 2022 eSLOE.[14,15] A question was added to provide more insight into the sources of information used in compiling the SLOE. Authors could also denote whether this evaluation was based on a rotation taken by all students at the letter writers' institution or just by EM sub-interns, as each would presumably result in a different grading breakdown. There was also the ability to denote any changes in grading practices to inform comparisons of grades across years. With the transition of US Medical Licensing Exam Step 1 scores to pass/fail and more institutions moving to pass/fail curricula, the SLOE committee added a section regarding test-taking ability, identifying any standardized testing completed during the rotation (eg, National Board of Medical Examiners shelf exam, Society of Academic Emergency Medicine tests, or home- grown assessment).

Given the growing number of SLOE iterations, it is important to standardize the nomenclature to improve clarity in discussions and future literature on this topic. When referring to these evaluations generally and inclusive of SLOR and SLOE versions, we propose reference to the emergency medicine *standardized letter*. When referring to specific versions of the EM standardized letter, we propose referring to the year the version was first used in practice and either SLOR or SLOE, as appropriate (eg, 1995 SLOR,

2016 SLOE). Modifiers to further distinguish versions (eg, 2016 eSLOE or 2022 eSLOE 2.0) may also be used; however, we recommend still including the year in these cases to avoid potential misunderstanding via errors of omission (eg, omitting "2.0" from "eSLOE 2.0" for brevity or by mistake could lead to the reader interpreting this as the 2016 version when the 2022 version was intended, whereas "2022 eSLOE" is unambiguous).

## STANDARDIZED LETTER VARIANTS

From the use of the SLOR through the 2016 SLOE, writers and reviewers began to identify and report to CORD leadership opportunities where clearer differentiation between types of authors and rotations would be beneficial for writers, reviewers, and researchers. These opportunities for clearer differentiation resulted in the creation of multiple SLOE variants. In 2016, the SLOE for Non-Residency-based EM Physicians was introduced (Table 1). This variant removed the item requiring authors to describe where the candidate would reside on their rank list, noting that this question was inappropriate for physicians not involved in a residency program. This new form allowed students to still receive evaluations from this group of authors but provided additional context for reviewers by clearly describing the source of the letter. Additionally, this separation facilitated more granular data for research and quality assurance initiatives. Also released in 2016, the subspecialty SLOE extended evaluation opportunities to include EM subspecialists in toxicology, ultrasound, pediatric EM, and emergency medical services (Table).

The COVID-19 pandemic in 2020 prompted significant restrictions on visiting clerkships nationwide, resulting in limited opportunities for students to receive outside SLOEs. To create more opportunities for students to receive standardized letters in the absence of additional EM clerkship availability, the Off Service Standardized Letter of Evaluation (O-SLOE) was developed (Table 1, Appendix 2G). The O-SLOE expanded access to standardized letters from off-service faculty in non-EM specialties. At this time a question regarding COVID-19 was also added to both the subspecialty SLOE and the SLOE for non-academic emergency physicians (Table 1, Appendix 2A, 2D).

All three variants of the SLOE were updated by the CORD SLOE Committee again in 2022 to match the updated 2022 SLOE (Table , Appendix 2B, 2E, 2H). The variants were also added to the eSLOE database at that time. The latest addition to SLOE variants in 2024 was a bar at the top of each PDF with a unique color to signify each variant, making it clear to SLOE readers which type of SLOE variant they were reading (Table, Appendix 2C, 2F, 2I).

## RESEARCH

Highlights of SLOE research from author experience and PubMed search for "standardized letter of evaluation" include a broad scope of topics. Past research has highlighted the SLOE's value as one of the most heavily weighted aspects of an applicant's file.[9,13,16] When compared to narrative letters of recommendation, the EM SLOE was interpreted faster by recruitment committees and had higher interrater reliability.[17]

Research investigating the process of how SLOEs are written has noted an increasing proportion of SLOEs authored by groups compared to those authored by individuals.[18] Program directors in EM have cited increased trust of group SLOEs compared to those authored by individuals despite limitations noted in past analysis of group SLOE-authorship processes.[8,9,19] This may be due to slight but statistically significantly higher ratings seen in individual SLOEs compared to group SLOEs, which some may interpret as grade inflation in individual SLOEs. It is worth noting, however, that these score differences are smaller and even reversed when comparing only individual SLOEs written by clerkship directors to group SLOEs, suggesting that clerkship directors authoring individual SLOEs exhibit little to no grade inflation compared to group SLOE authors.[18] Data presented at the 2025 CORD Academic Assembly also has linked the quantity of SLOEs authored per year with rating trends, noting that lower volume SLOE author(s) gave higher mean ratings compared to high-volume author(s) for both individual and group SLOEs.[20]

Trends in ratings by writer experience and home vs away rotations have also been explored, noting higher ratings in less experienced writers and home rotations.[21,22] While it is encouraging that high-volume author(s) and clerkship director ratings are similar to group SLOE ratings on average, optimizing standardization of ratings across all author types remains a potential growth area for the SLOE. Form updates and consistent messaging and training efforts through CORD have been shown to decrease evidence of rating leniency,[11] as has defaulting score selections to the midpoint of the range and creating a pop-up notification for when score extremes are selected[23]; however, recent evidence suggests persistence of variable rating practices across institutions that warrants continued efforts in this area.[24]

The competitiveness of applicants based on SLOE information has also been explored through the lenses of simultaneous goals of (1) optimizing match outcomes for applicants and (2) providing programs with stratifying performance information. Analysis of match outcomes for applicants with lower ratings in one study shows increased risk of not matching, but lower ratings did not preempt a successful match.[25] Another study noted that adherence to rating standards did not seem likely to increase risk of applicants failing to match in EM.[26] Both of these studies support the notion that whole rating scales can and should be used, although with consistency and transparency to decrease the risk that authors see lower rankings as outlier red flags, which has been described in a qualitative study investigating how SLOEs are interpreted.[19]

Multiple recent studies demonstrate a high degree of faculty consensus regarding the level of competitiveness of an applicant based on the SLOE.[13,27,28] These studies also show promise for algorithms to predict consensus levels of competitiveness. These models outperformed artificial intelligence software when comparing their ability to predict faculty consensus rankings of competitiveness.[29] How these algorithms can be operationalized to improve the application process is an ongoing area of discussion, but this could involve applicant-facing applications such as broad competitiveness feedback to tailor application quantity and breadth, or program-facing applications such as competitiveness estimations to which faculty ratings could be compared to assess for potential bias or to cut down on time needed for reviews.

There have been limited investigations into the association of SLOE ratings with future performance.[30–32] Published studies face challenges of small sample sizes and use of unvalidated outcome measures in two studies. In the study assessing the association between SLOE and Accreditation Council for Graduate Medical Education (ACGME) Milestones ratings, only one year of Milestones data was used, which limits the scope of these results.[31] National data presented at the 2025 ACGME conference, however, shows a clear association between algorithm-derived SLOE competitiveness and multiple measures of residency Milestones performance including mean first and last Milestone ratings by competency and the binary outcome of residency completion.[33] Future SLOE research should continue to prioritize studies linking SLOE ratings to future performance.

While many strengths of the EM standardized evaluation have been discovered, areas for improvement have also been identified. Literature suggests that both sex-based and racial bias are demonstrated in certain components of the eSLOE.[34–36] There is also evidence that institutional rating patterns and adherence to written standards vary widely, which has raised long-standing concerns about grade inflation and its impact on the ability to stratify applicant performance.[8,11,24,26,37,38] Additionally, a review of validity evidence for the 2016 SLOE highlights areas of improvement to consider, although more recent research has addressed some of these concerns.[39]

## NEXT STEPS

Emergency medicine has led the field in standardized letters for the residency application process for the past 30 years. Looking forward to how EM can lead in the next 30 years, several areas stand out. These areas include mitigating the influence of bias on standardized letter of evaluation assessments, continuing to adapt the SLOE instructions, questions, data points, and form to improve response processes and data quality (including efforts to curb, or at least track and facilitate adjustment for, grade inflation), and further bolstering the validity evidence for the SLOE through research including measuring the association of SLOE ratings with future performance.

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# Resource Utilization and Throughput in Pediatric Abdominal Pain among Attendings, Residents, and Advanced Practice Clinicians

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**Introduction:** Our goal was to assess the impact of emergency department (ED) clinician category on length of stay (LOS) and resource utilization in children presenting with abdominal pain.

**Methods:** We conducted a retrospective chart review of all subjects 4-18 years of age at a quaternary-care pediatric ED between May 2021–April 2022 presenting with a chief complaint of abdominal pain. Collected data included demographics, LOS, disposition, 72-hour return visits, lab tests and radiology studies, consults, and emergency clinician category. We defined clinician categories as attending only, advanced practice clinician (APC) only, or supervised resident encounters. Medically complex and high-acuity cases were excluded. We performed statistical comparisons with ANOVA, chi-squared, and Kruskall-Wallis tests. Binomial logistic regression addressed the effects of the covariates age, sex, race, and acuity level.

**Results:** We included 3,874 episodes. Of these, 622 (16%) visits were seen by an attending only, 1,018 (26%) by APCs, and 2,234 (58%) by supervised residents. Controlling for covariates, the average APC encounter lasted 17 minutes longer than the average attending encounter (293 minutes vs 276 minutes, $P < .005$, 95% CI -29.9, -4.0) and 21 minutes longer than the average resident encounter (293 minutes vs 272 minutes, $P < .001$, 95% CI 11.4-30.6). There were no significant differences in admission rates (attending: 128/622 [20.6%]; APC: 226/1,018 [22.2%]; resident: 477/2,234 [21.4%]; $P = .63$), or 72-hour return rates (attending: 30/622 [4.8%]; APC: 41/1,018 [4.0%]; resident: 99/2,234 [4.4%]; $P = .61$). Compared to attending-only encounters, APC encounters were more likely to include a consult (127/622 [20.4%] vs 292/1,018 [28.7%]; adjusted odds ratio (aOR) 1.51, 95% CI 1.18-1.93); less likely to include a computed tomography (CT) (13/622 [2.1%] vs 7/1,018 [0.7%]; aOR 0.31, 95% CI 0.12-0.79); more likely to include a radiology study (484/622 [77.8%] vs 873/1,018 [85.8%], aOR 1.64, 95% CI 1.26-2.14); and more likely to include lab testing (329/622 [52.9%] vs 669/1,018 [65.7%], aOR 1.62, 95% CI 1.30-2.00). Compared to supervised resident encounters, APC encounters were more likely to include a consult (518/2,234 [23.2%] vs 292/1,018 [28.7%], aOR 1.35, 95% CI 1.14-1.61); less likely to include a CT (36/2,234 [1.6%] vs 7/1,018 [0.7%], aOR 0.43, 95% CI 0.19-0.98); more likely to include a radiology study (1603/2,234 [71.8%] vs 873/1,018 [85.8%], aOR 2.41, 95% CI 1.97-2.96); and more likely to include lab testing (1,230/2,234 [55.1%] vs 669/1,018 [65.7%], aOR 1.63, 95% CI 1.39-1.92). Attending-only encounters were more likely to include radiology studies compared to resident encounters (484/622 [77.8%] vs 1,603/2,234 [71.8%], aOR 1.47, 95% CI 1.18-1.83), but they were otherwise similar in diagnostic utilization.

**Conclusion:** In our study of pediatric patients with abdominal pain, APC encounters had longer length of stay and were more likely to include lab testing, radiology studies, and consults than resident or attending-only encounters. This suggests that emergency clinician category may be associated with resource utilization, and further research could help optimize healthcare utilization. [West J Emerg Med. 2025;26(6)1549–1558.]

## INTRODUCTION

Emergency department (ED) crowding is a significant health system concern that contributes to increased cost, decreased access, and unfavorable outcomes in pediatric health care.[1,2] While ED crowding is multifactorial, one important factor is ED throughput, defined as the time spent in the ED by a patient, also known as length of stay (LOS).[3] The ED throughput itself is impacted by a variety of factors, including resource utilization and clinician staffing in the ED.

One response to physician staffing shortages has been to increase the use of advanced practice clinicians (APC) such as nurse practitioners (NP) and physician assistants (PA). Research involving general EDs has shown many benefits to adopting this strategy, including decreasing staffing costs and waiting room times without resulting in negative effects on general ED flow, clinical safety, or patient experience.[4,5] An area of growing research in pediatrics is the effect of the ED clinician category on throughput and resource utilization. In one pediatric study, low-acuity pediatric patients evaluated by PAs in the ED had a statistically, but not clinically significant, longer ED LOS when compared to children seen by pediatricians.[6]

Pediatric research has also started investigating resource utilization by chief complaint. A 2021 study on bronchiolitis found that NPs were less likely to order tests or treatments.[7] Variability in resource utilization for high-acuity and diagnostically complex chief complaints, such as abdominal pain, have not yet been studied in pediatric patients. Up to 10% of all pediatric ED visits are for complaints of abdominal pain, with diagnoses varying from benign conditions like constipation to urgent ones such as appendicitis.[8] Evaluation for abdominal pain frequently necessitates time and resource-intensive diagnostics such as laboratory work or advanced imaging (ultrasound or computed tomography [CT]). Hoyt et al reported that APCs triage ED pediatric patients with abdominal pain with the same accuracy as physicians, but no study to date has investigated clinician category association with resource use in pediatric abdominal pain.[9] In adult patients with abdominal pain, a large, multicenter cohort study showed no difference in diagnostic utilization by clinician category.[10] Given this prior general ED data, we hypothesized that there would be no significant difference in LOS or resource utilization when comparing physicians with APCs.

*Population Health Research Capsule*

What do we already know about this issue?
*Abdominal pain accounts for 10% of all pediatric ED visits. In adult abdominal pain there is no difference in testing between advanced practice clinicians (APC) and physicians.*

What was the research question?
*Is there a difference in length of stay or resource utilization when comparing physicians with APCs?*

What was the major finding of the study?
*APC encounters were 17 minutes longer than attending encounters (P <.005, 95% CI -29.9, -4.0) and 21 minutes longer than resident encounters (P <.001, 95% CI 11.4-30.6).*

How does this improve population health?
*Staffing practices by clinician group are another consideration for maximizing efficiency in pediatric emergency care and high-value care.*

## METHODS

### Study Design

We conducted a retrospective cohort study of pediatric patients who presented to a pediatric tertiary- care ED from May 2021–April 2022 with a complaint of abdominal pain. When possible, we followed tenets of optimal retrospective chart review as established by Worster et al, which are further delineated below.[11] Data were acquired directly from the Cerner electronic health record (EHR) (Oracle Health, Kansas City, MO) through the hospital's Clinical Data Warehouse (Worster element 9).[11] As objective data was retrieved directly from the medical record, inter-observer reliability was not applicable (Worster element 7,8).[11] The university's institutional review board reviewed the study and deemed it exempt (Worster element 12).[11]

### Study Setting and Population

The study sample included all ED encounters of patients 4-18 years of age with a chief complaint of abdominal pain (Worster element 2,10).[11] We used this age cutoff to eliminate the infant and toddler patient groups that add additional surgical pathologies to consider, such as pyloric stenosis and intussusception. Subsequent visits for abdominal pain by the same patient were included as an independent encounter. While repeat visits may be more likely to result in higher resource use, this typically does not affect which clinician category sees the patient. We excluded those with the following medical comorbidities, conditions, or outcomes using International Classification of Diseases, 10th Rev, (ICD-10) codes: non-infectious colitis including inflammatory bowel disease; pregnancy; g-tube presence; ventilator dependence; history of abdominal surgery and history of organ transplant, as well as any encounters that resulted in death (Worster element 2).[11] These patients were excluded due to an increased likelihood that they would be evaluated by a physician-only team at the study site. Visits with Emergency

Severity Index (ESI) levels 3, 4, and 5 were selected to best capture non-high acuity patients. This was done to minimize the potential for selection bias by clinician category, as there has been a reported tendency for APCs to avoid higher acuity cases in previous literature (Worster element 2).[11,12]

The study site had three clinical areas, and all areas had equal access to facility resources and diagnostic testing. Attendings primarily see patients on their own in the fast track area and occasionally in the teaching areas. The APCs would generally see patients independently with attending consultation available. For the first six months of employment, all APC patients are staffed with an attending prior to patient discharge. The APCs, residents, and attendings are present in the study ED 24 hours a day, seven days a week. The compensation model for attending physicians at the institution included both a group and individual relative value unit-based incentive plan. The APCs do not have a financial incentive related to patient volume, but their productivity is tracked and compared to national benchmarks.

The chief complaint on presentation was obtained from the EHR. This is selected from a drop-down menu by the triage nurse at the time of arrival to the ED and is based on the patient's or family's provided history. We excluded patients seen initially by students or independently by pediatric emergency medicine (EM) fellows moonlighting as general pediatric attendings, patients who left without being seen, or those who were transferred from another facility. Patients seen only by moonlighting pediatric EM fellows were excluded as they have varying levels of supervision depending on their year of training and individual comfort level.

**Study Protocol**

We collected patient demographics and final ESI level for each encounter. For statistical reasons, ESI levels 4 and 5 were combined due to the low volume of ESI 5 visits. We determined ED clinician category determined by the physician or APC who signed the original note. When a patient was signed out, the clinician category was assigned based on the initial clinician. We defined emergency clinician by one of three categories. The first category was attending only, ie, encounters where the only clinician involved was either a physician board eligible in pediatric EM (PEM) or a general emergency pediatrician (GEP). The second category was APC, ie, encounters where the initial clinician was an APC. (Patients seen by NPs and PAs were combined into the APC clinician category as prior literature has shown no difference on the quality of care or admissions between these groups.[5]) Some APC visits had an attending evaluation when requested by the APC, typically for diagnostically challenging patients or before obtaining certain testing, such as CT). The third emergency clinician category was supervised resident, ie, encounters where the initial clinician was a resident physician. Supervised residents included those training in pediatrics, family medicine, EM, anesthesia, and transitional year interns. All supervised resident encounters included an evaluation by an attending physician before disposition. Some of these supervised resident encounters may have included an additional evaluation by a first- or second-year PEM fellow either separately or jointly with the attending, depending on attending comfort and fellow experience.

Approximately 20% of attending shifts have a dedicated fellow present. Encounters were considered supervised resident encounters for the <1% of visits where first- or second-year fellows saw patients initially and then staffed with an attending on a non-moonlighting shift. During the study period, there were 25 PAs, five NPs, 36 PEM attendings, and three GEPs who evaluated patients in the study ED. In our sample, data abstraction yielded all desired data apart from a few conflicting clinician categories, usually resulting from sign-out of the patient between categories of clinicians. These cases were all assigned to the original treating clinician category after manual chart review (Worster element 11).[11]

**Outcome Measures**

The primary outcome measured was the ED LOS in minutes, obtained from a previously established hospital dashboard. The ED LOS is derived from the time of patient check-in to the ED until the electronic order completing the ED evaluation is placed (Worster element 3).[11] Secondary outcome measures included the disposition of the patient (admitted or discharged), the rate of unplanned 72-hour return to the ED, and resource utilization metrics (Worster element 3).[11] We studied patient disposition, as the decision to admit or discharge a patient can be taken independently by APCs and, thus, may vary between groups. We included as resource use metrics the presence or absence of lab studies, CTs, all other types of imaging studies (radiography, ultrasound, magnetic resonance imaging [hereafter referred to as "radiology studies"]), and specialist consultations. The decision to obtain a specific resource was considered more influential on the primary outcome of ED LOS than the total number of resources used.

Lab studies were limited to those from blood; we excluded urine and nasopharyngeal tests due to the relative ease of procurement. Use of CT was highlighted given the concern for radiation exposure in the pediatric population (Worster element 3).[11] Final ICD-10 diagnosis codes were also collected for each encounter. Diagnostic groups were then created by one of the authors (NP), who consolidated related ICD-10 codes.

**Data Analysis**

Data abstraction was completed by a systems analyst who was part of the hospital data warehouse group, using coded queries through SAP BusinessObjects (SAP SE, Walldorf, Germany), with output provided in Microsoft Excel (Microsoft Corporation, Redmond, WA). These abstractors are employees of the hospital who are trained in

Cerner and SAP BusinessObjects and monitored by the hospital's data warehouse management team (Worster element 1,5).[11] The systems analyst was aware of the study objective but not the study hypothesis as part of the data request (Worster element 6).[11]

We used descriptive statistics, including proportions, medians, and interquartile ranges (IQR) to compare demographics between groups. Given non-normal distributions, the Kruskall-Wallis one-way analysis of variance was used to measure the difference between continuous variables. We assessed proportional differences in patient use metrics using Pearson chi-square tests. Multicollinearity was examined through a variance inflation factor cutoff of 2, and all other assumptions for linear and binominal logistic regression were met. Multivariate linear regression with estimated marginal means was employed to control covariates for ED LOS. Acknowledging the effect of skew on ED LOS data when comparing means instead of medians, we removed outliers, defined as values with *z*-scores ± 3.

When comparing attending visits and APC visits, attending visits were the reference group. For two-way comparisons including supervised resident encounters, resident visits were the reference group. For all resource utilization metrics, we performed binomial logistic regression first without covariates and then with covariates to obtain unadjusted and adjusted odds ratios (AOR). All statistical analyses were conducted in IBM SPSS Statistics 29 (IBM Corp, Armonk, NY), with *P* values < .05 considered statistically significant.

## RESULTS

### Characteristics of Study Subjects

Of 4,716 eligible encounters during the study period, 3,874 (82%) met inclusion criteria (Figure 1). Of these visits, 622 (16%) were seen by an attending only, 1,018 (26%) by APCs, and 2,234 (58%) by supervised residents. Demographic and use characteristics of the sample are described in Table 1. The median ED LOS was 268 minutes; 831 (22%) encounters resulted in admission; and there were 170 (4%) 72-hour return visits. While 2,960 encounters (76%) had radiology studies and 2,228 (58%) had labs obtained, only 56 (1%) had CT.

### Main Results

We found a significant difference in ED LOS by clinician categories, although there was no significant difference in rates of admission or 72-hour return visits. All resource utilization metrics studied were significantly different between the groups including rate of obtaining lab tests, CT, consultations, and radiology studies (Table 2).

The APC encounters had a longer ED LOS (median 286 minutes, IQR 217-364) when compared to attending- only encounters (median 259 minutes, IQR 192-340) and supervised resident encounters (median 263 minutes, IQR 194-340). These differences remained significant when comparing mean ED LOS among groups and controlling for the covariates of age, sex, race, and acuity. (Table 3)

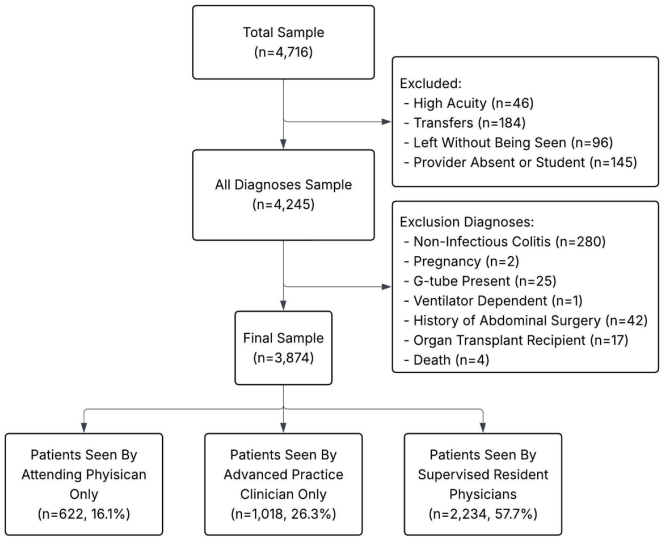


**Figure 1.** All patients 4-18 years of age who presented with a chief complaint of abdominal pain in the study period.

Figures 2-4 present unadjusted and adjusted ORs calculated when comparing rates of resource utilization among attending only, supervised resident, and APC encounters. When compared to attending encounters, APC encounters were more likely to obtain a consult (aOR 1.51, 95% CI 1.18-1.93); less likely to obtain a CT (aOR 0.31, 95% CI 0.12-0.79); more likely to obtain a radiology study (aOR 1.64, 95% CI 1.26-2.14); and more likely to obtain a lab test (aOR 1.62, 95% CI 1.30-2.00) (Figure 2). The only significant difference when comparing attending only encounters to supervised resident encounters was that an attending- only encounter was more likely to include a radiology study (aOR 1.47, 95% CI 1.18-1.83) (Figure 3). Comparing APC encounters with supervised resident encounters showed that APC encounters were more likely to include a consult (aOR 1.35, 95% CI 1.14-1.61); less likely to obtain a CT (aOR 0.43, 95% CI 0.19-0.98); more likely to obtain a radiology study (aOR 2.41, 95% CI 1.97-2.96); and more likely to obtain a lab test (aOR 1.63, 95% CI 1.39-1.92) (Figure 4).

When comparing subspecialty consults, lab tests, and radiology studies, analysis was controlled for age, sex, race, and acuity. When analyzing rates of obtaining CT, acuity was removed as a covariate due to low counts (one CT obtained in acuity level 4+5).

### Analysis by Diagnostic Groups

The most common ICD-10 diagnosis was unspecified abdominal pain (R10.9) accounting for 617 (15.9%) of the sample population. Table 4 shows the five most common diagnostic groupings. Attendings had a higher relative proportion of visits for constipation (14.5% of all attending

**Table 1.** Demographic and visit characteristics of ED patients presenting with abdominal pain by clinician category.

| Sample Size | Total N=3,874 (100%) | Attending Only n=622, (16%) | APC n=1,018 (26%) | Supervised Resident n=2,234 (58%) | P-value |
|---|---|---|---|---|---|
| Age, median (IQR), Years | 11 (7-15) | 10 (7-14) | 11 (7-14) | 11 (7-15) | **<.005*** |
| Female Sex, n (%) | 2,351 (61) | 345 (56) | 634 (62) | 1,372 (61) | **.01*** |
| Race, n (%) | | | | | .63 |
| White | 2,875 (74) | 459 (74) | 767 (75) | 1,649 (74) | |
| Black | 706 (18) | 108 (17) | 185 (18) | 413 (19) | |
| Asian | 176 (5) | 34 (6) | 40 (4) | 102 (5) | |
| Other | 117 (3) | 21 (3) | 26 (3) | 70 (3) | |
| ESI Level, n (%) | | | | | .07 |
| 3 | 3,321 (86) | 515 (83) | 891 (88) | 1,915 (86) | |
| 4 | 527 (14) | 100 (16) | 120 (12) | 307 (14) | |
| 5 | 26 (1) | 7 (1) | 7 (1) | 12 (1) | |

*Indicates statistical significance at $P < .05$,
*APC,* advanced practice clinician; *ED,* emergency department; *ESI,* Emergency Severity Index; *IQR,* interquartile range.

visits, vs 10.1% of all APC visits, $P = .02$); and APCs had a higher relative proportion of encounters for appendicitis (7.9% of all APC visits vs 5.6% of all attending visits, $P = .04$).

Resource utilization comparisons were repeated for the unspecified abdominal pain diagnostic group and compared to the total sample (Figure 5). For consults, the adjusted OR was higher in the unspecified abdominal pain group than the total sample when comparing APCs and attendings (aOR 1.65, 95% CI 1.08-1.79, vs aOR 1.51, 95% CI 1.18-1.93) and when comparing APCs and residents (aOR 1.37, 95% CI 1.03-1.82, vs aOR 1.35, 95% CI 1.14-1.61). For obtaining a radiology study this was also true when comparing APCs and attendings (aOR 1.92, 95% CI 1.22-3.02, vs aOR 1.64, 95% CI 1.26-2.14) and when comparing APCs and residents (aOR 2.96, 95% CI 2.09-4.2, vs aOR 2.41, 95% CI 1.97-2.96). For obtaining a lab test, the adjusted OR was lower for the unspecified abdominal pain group as compared to the total sample when comparing APCs and attendings (aOR 1.39, 95% CI 1.01-1.92, vs aOR 1.62, 95% CI 1.30-2.00) and equivalent when comparing APCs and residents (aOR 1.63, 95% CI 1.29-2.07, vs aOR 1.63, 95% CI 1.39-1.92). We did not compare use of CT due to the low number done in the unspecified abdominal pain group (n = 12).

## DISCUSSION

This single-center study compared clinician categories based on their LOS and rates of resource utilization in the evaluation of pediatric ED encounters for complaints of low-acuity and low-complexity abdominal pain. Abdominal pain can be difficult to diagnose but is a common chief complaint, encompassing a wide range of potential etiologies and outcomes. The potential diagnostic uncertainty of pediatric abdominal pain resulted in 1,711 (44%) patient encounters in our sample being given a final diagnosis of

**Table 2.** Throughput, disposition, and resource use of emergency department patients presenting with abdominal pain by clinician category.

| Sample Size | Total N=3,874 (100%) | Attending Only n=622 (16%) | APC n=1,018 (26%) | Supervised Resident n=2,234 (58%) | P-value |
|---|---|---|---|---|---|
| ED LOS median (IQR), minutes | 268 (199, 348) | 259 (192,340) | 286 (217, 364) | 263 (194, 340) | **<.001**** |
| Return visit, n (%) | 170 (4) | 30 (5) | 41 (4) | 99 (4) | .61 |
| Admitted, n (%) | 831 (22) | 128 (21) | 226 (22) | 477 (21) | .63 |
| Laboratory test obtained, n (%) | 2,228 (58) | 329 (53) | 669 (66) | 1,230 (55) | **<.001**** |
| CT obtained, n (%) | 56 (1) | 13 (2) | 7 (1) | 36 (2) | **.04*** |
| Consult obtained, n (%) | 937 (24) | 127 (20) | 292 (29) | 518 (23) | **<.001**** |
| Radiology study obtained, n (%) | 2,960 (76) | 484 (78) | 873 (86) | 1,603 (72) | **<.001**** |

*Indicates significance at $P < .05$.
**indicates significance at $P < .001$.
*APC,* advanced practice clinician; *CT,* computed tomography; *ED,* emergency department; *IQR,* interquartile range; *LOS,* length of stay.

**Table 3.** Pairwise comparisons of mean emergency department length of stay in minutes by clinician category.

| | ED LOS (Minutes) | | | | ED LOS (Minutes) | | |
|---|---|---|---|---|---|---|---|
| Unadjusted comparisons[+] | Mean difference | P-value | 95% CI | Adjusted comparisons[+▽] | Mean difference | P-value | 95% CI |
| Attending vs APC | -22.8 | <.001** | (-36.0, -9.6) | Attending vs APC | -16.9 | < .005* | (-29.9, -4.0) |
| Attending vs Supervised Resident | -1.5 | .96 | (-13.1, 10.4) | Attending vs Supervised Resident | 4.1 | 1.0 | (-7.5, 15.6) |
| APC vs Supervised Resident | 21.5 | <.001** | (11.4, 31.5) | APC vs Supervised Resident | 21 | <.001** | (11.4 30.6) |

[+]Last group is reference group.
[▽]Controlling for age. sex, race and acuity.
*Indicates significance at $P < .05$.
**Indicates significance at $P < .001$.
*APC,* advanced practice clinician; *ED,* emergency department; *LOS,* length of stay.

"unspecified abdominal pain," by far the most common final diagnosis group. Adding to the difficulty of evaluating this chief complaint, both benign and dangerous etiologies were frequent, as both constipation (second most common, n = 444, 11.5%) and appendicitis (fourth most common, n = 241, 6.2%) were among the top five diagnosis groups. There were significant differences in the proportions of constipation and appendicitis seen by each clinician category. To investigate the effect of this difference on our results, all analyses were repeated for the sample, first excluding patients with constipation and next excluding patients with appendicitis. In the repeat analyses, all results retained the original directionality and remained statistically significant.

Compared to encounters conducted by physicians, those conducted by APCs as the primary clinician had statistically significant longer visits. The average APC encounter was 8.7% longer than the average supervised resident encounter, and 10.4% longer than the average attending-only visit. The clinical significance of this difference in throughput becomes more apparent when considering the frequency of abdominal pain as a chief complaint. Abdominal pain accounts for approximately 10% of all pediatric ED visits.[8] Given that our average daily census for the study period was 230 encounters, this would equate to 23 visits for abdominal pain and a 391-minute (APC vs attending) to 483-minute (APC vs resident) difference in LOS per day. We believe that this would be a meaningful clinical difference when evaluating ED LOS metrics.

Most APC encounters in the study ED are seen independently, whereas all resident encounters are discussed with an attending who then also personally evaluates the patient. Attending-only encounters often occur concurrently with resident supervision. If these findings are reproduced more broadly, it would indicate an important consideration when staffing additional APCs in lieu of physicians: labor costs may be lower, but clinical care may be less efficient and more costly, potentially offsetting savings in salary. Our findings were for low-acuity and low-complexity patients; if reproduced across larger samples and different centers, this would suggest a reassessment of staffing "fast track" areas

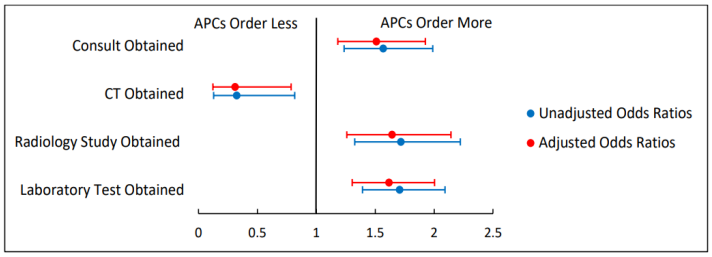


**Figure 2.** Rates of resource utilization of emergency department encounters for abdominal pain seen by attendings compared to those seen by advanced practice clinicians. Adjusted odds ratios control for the covariates of age, sex, race, and acuity level. *APC,* advanced practice clinician; *CT,* computed tomography; *ED,* emergency department.

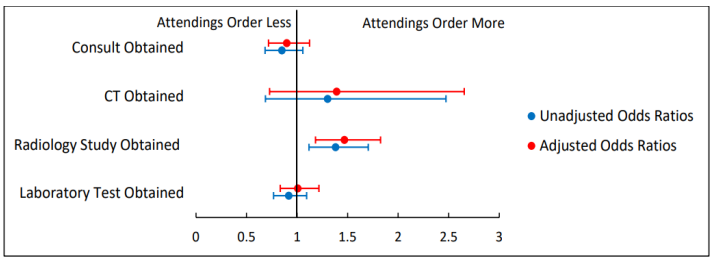


**Figure 3.** Rates of resource utilization of emergency department encounters for abdominal pain seen by supervised residents compared to those seen by attendings. Adjusted odds ratios control for the covariates of age, sex, race, and acuity level. *CT,* computed tomography; *ED,* emergency department.

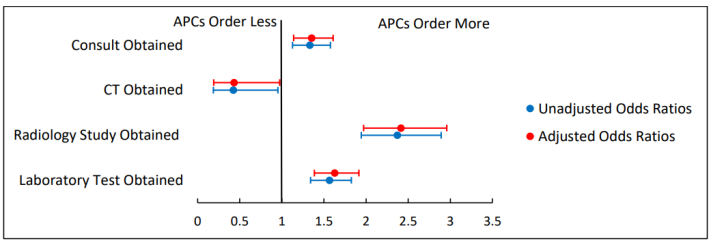


**Figure 4.** Rates of resource utilization of emergency department encounters for abdominal pain seen by supervised residents compared to those seen by advanced practice clinicians. Adjusted odds ratios control for the covariates of age, sex, race ,and acuity level.
*APC,* advanced practice clinician*; CT,* computed tomography; *ED,* emergency department.

with APCs, as 86% of academic EDs do.[13] Some of the difference in LOS is likely associated with the higher rates of resource utilization for these encounters by APCs, as APCs were more likely to obtain consults, radiology studies, and lab studies than those with supervised residents or those with attending physicians only.

Data on throughput differences by clinician group in adult EDs remain mixed. A multicenter study across 94 EDs involving 13 million visits found that APCs saw patients at half the rate of physicians.[5] In contrast, a national survey of 95,000 visits reported shorter LOS for patients seen by APCs.[14] Regarding resource utilization, findings are similarly variable. One ED-level study reported higher admission and imaging rates in EDs with APC coverage.[15] However, broader literature suggests that independently practicing APCs may use fewer diagnostic tests.[14,16] When focusing specifically on adult abdominal pain visits, Pines et al found no significant differences in lab or imaging use between clinician groups.[10]

In pediatric EDs, existing literature has primarily focused on respiratory and low-acuity complaints. A 2021 study on bronchiolitis found that NPs were less likely to order tests or treatments when compared to physicians.[7] However, the study did not adjust for illness severity, and the large difference in admission rates (2% for NP patients vs 31% for physician patients) indicates this may have influenced the results. A 2012 two-site study of 150,000 low-acuity encounters found no differences in testing by clinician type.[17] More recently, a single-center study (2017–2020) reported longer LOS for PAs compared to pediatricians in low-acuity cases.[6] Although sensitivity analyses by chief complaint were conducted, results were only reported on respiratory complaints.

When comparing throughput and resource utilization between physician groups, there was little difference between attending-only encounters and those including supervised residents. This is consistent with prior general ED data from teaching hospitals.[18] This was an expected finding in our cohort, given that low- acuity patients seen in the study ED are typically evaluated by a resident and discussed with the attending prior to a care plan being enacted.

Interestingly, the data revealed that at our site, attendings were more likely to order a radiology study when conducting a visit alone compared to visits with a resident. This may be due to time constraints faced by the attendings, as most attendings who see patients on their own do so while also supervising residents. Reassurance is a core aspect of pediatric medicine but can be time intensive and emotionally consuming.[19] When deliberating between a lengthy discussion about the utility of a radiographic test or simply ordering it, time constraints may outweigh an attempt at reassurance or shared decision-making. This principle is likely more applicable for radiography studies since no pain is caused to the patient (compared to lab testing) and there is often little (radiograph) to no (ultrasound) radiation to the patient. Adequate reassurance is also easier to provide when sharing the encounter with a resident, who can provide repetition and spend more time with the patient and family. This efficiency of multiple clinicians may explain why there was no difference in ED LOS between attending and resident encounters despite the additional requirement of staffing

**Table 4.** Five most common diagnostic groupings by final *International Classification of Diseases, 10th Rev*, code in emergency department patients presenting for abdominal pain.

| Diagnostic Group | Included ICD-10 Codes | Number of Encounters | Percentage of Sample | P-value |
|---|---|---|---|---|
| Unspecified Abdominal Pain | R10.9, R10.31, R10.33, R10.13, R10.32, R10.11, R10.30, R10.84, R10.12, R10.10, R10.813 | 1,711 | 44.2% | .27 |
| Constipation | K59.00, K59.09, K59.04, | 444 | 11.5% | **.02*** |
| Viral Infections | A08.4, B34.9, U07.1, J06.9, B27.9, A09, B19.9, B27.00, B30.8 | 258 | 6.7% | .15 |
| Appendicitis | K35.8, K35.32, K35.3,K35.33, K35.890, K35.2, K35.21, K35.891 | 241 | 6.2% | **.04*** |
| Vomiting Unspecified | R11.10, R11.2, R11.0, R11.14 | 165 | 4.3% | .11 |

*Indicates statistical significance at $P < .05$.
*ED,* emergency department; *ICD-10, International Classification of Diseases, 10th Rev.*

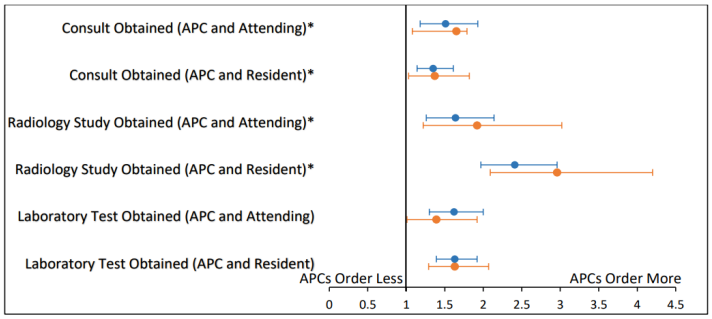


**Figure 5.** Comparing rates of obtaining consults, radiology studies, and lab orders between clinician categories in the total sample and the unspecified abdominal pain sub-group. *Indicates that the previously seen association in the total sample became stronger within the unspecified abdominal pain sub-group. *aOR,* adjusted odds ratio; *APC,* advanced practice clinician; *CT,* computed tomography.

patients for resident visits.

In contrast to the other resources studied, our results showed that visits with APCs were less likely to include CT when compared to either physician group. This could be a balancing outcome of the higher number of labs and consults obtained by APCs, allowing them to correctly triage the need for a CT. This is supported by APCs not having a higher rate of 72-hour ED return visits compared to the attending-only or supervised resident groups. Another potential explanation is the cultural feature of our site where most APCs would discuss a patient with a physician prior to ordering a CT, adding another step of deliberation.

We conducted further analysis of our two most common diagnosis groups (unspecified abdominal pain and constipation) to identify themes to maximize efficient and high-value care of pediatric patients with abdominal pain. These analyses revealed two areas for investigation: variations in clinician comfort with diagnostic uncertainty; and a recommitment to high-value care. Comfort with uncertainty applies to encounters with a final diagnosis of unspecified abdominal pain, which is used when no other etiology is found. When considering encounters with a final diagnosis of unspecified abdominal pain, differences in resource utilization between APCs and physicians were stronger than in the overall data set for obtaining both consults and radiology studies (Figure 5). The effect of varying comfort with diagnostic uncertainty becomes more convincing when considering prior work in bronchiolitis. When evaluating bronchiolitis in the pediatric ED, a condition with less diagnostic uncertainty than abdominal pain, APCs were shown to use fewer resources compared to physicians.[7]

Although diagnostic uncertainty can be uncomfortable for any clinician, the results in Figure 5 indicate stress from uncertainty may be associated with ordering practices in APC encounters more than physician encounters at our center. This finding is consistent with adult ED research that showed no association between imaging orders for abdominal pain and physician stress with uncertainty,[20] while Navandan et al found that APCs had higher anxiety due to uncertainty scores, a higher reluctance to disclose uncertainty, and used more resources to evaluate pediatric respiratory complaints.[21] Formal didactics around uncertainty in medicine are being introduced for medical students,[22] and tools such as an uncertainty communication checklist[23] could be a valuable addition to the curriculum for APCs practicing in the high-uncertainty environment of the ED.

When investigating encounters with a final diagnosis of constipation, there was no significant difference in median LOS ($P = .23$) or any of the utilization metrics between clinician categories. Our rates of imaging in encounters resulting in a diagnosis of constipation were high (80.6%), regardless of the clinician category. Imaging in pediatric constipation is associated with a higher incidence of misdiagnosis[24] and is not recommended by the American Academy of Pediatrics as part of the "Choosing Wisely" campaign.[25,26] Certain encounters likely require some diagnostic evaluation before constipation can be chosen as the final diagnosis, and rates of imaging are higher in the ED setting (70%) compared to outpatient clinics (5%).[27] Encouragingly, our findings represent an improvement from rates obtained at the same hospital 11 years prior (80.6% vs 92.1%, $P < .001$). However, further improvement could come from the introduction of an educational module, such as the one Kurowski and colleagues implemented in a similar site that successfully reduced imaging when making the diagnosis of constipation.[28] Given that our 72-hour return rate of 4% is still within the previously reported range for pediatric EDs (2.1%-5.2%)[29] despite our higher rates of imaging, it is unlikely that the additional imaging is preventing missed diagnoses.

## LIMITATIONS

There were several limitations to our study. As a single-center study, although clinician categories were not small, some of the differences found may be more related to individual-level characteristics as opposed to professional background. However, testing this assumption on average ED LOS did show that neither the APC nor the attending-only group had any outliers with a $z$-score outside ±3. Unsurprising given the more than eight residency programs that help staff the ED, the supervised resident group did have nine outliers outside a $z$-score of ±3. The exclusion of these outliers changed the median ED LOS for the supervised resident group by less than one minute.

A related limitation to be incorporated in future studies is that years of experience were not considered, which may[30] or may not[31] be associated with tolerance for uncertainty. Another aspect that could contribute to throughput and resource

utilization that was not considered here was the time of day at presentation. While all three clinician groups provide continuous coverage, the staff-to-patient ratio decreases overnight. This includes clinicians as well as ancillary staff such as radiology techs and lab techs. This may influence the selection and turnaround time of laboratory and radiology testing. Attendings, supervised residents, and APCs all staff the ED 24/7, which should mitigate this potential effect when comparing among clinician categories.

Another limitation of the study was that the results of lab testing and imaging studies were not studied. While this would be especially informative when assessing the value of these studies, it was outside the scope of this study. Additionally, we attempted to control for medical complexity by eliminating patient encounters with certain comorbidities thought to influence patient selection; however, this was not an exhaustive list. Additionally, ESI is an imperfect tool to capture patient acuity and reflects anticipated resource utilization. While it successfully limited high-acuity patients (< 1% admitted to the intensive care unit), only the final ESI level was collected, which could have been changed during the encounter to reflect estimated resource use. Our CT-related findings should also be considered in the context of a low sample size, as only 1.4% of encounters had a CT performed.

Finally, some APC encounters included an attending physician evaluation by APC request based on site-specific culture. In our dataset, there was no reliable way to delineate which APC encounters included discussion with an attending physician, potentially before diagnostic tests such as CT were ordered, although this would be uncommon. An APC request for additional review by the attending physician may also have contributed to some increase in length of stay. We were also unable to definitively attribute testing to the correct clinician category if sign-out occurred during the encounter. In the study site, most sign-outs occur between like clinician categories.

## CONCLUSION

In this single-center, retrospective study, we found an association between clinician category and ED throughput and resource utilization in low-acuity pediatric patients presenting with a chief complaint of abdominal pain. The encounters staffed by advanced practice clinicians were on average 17 minutes longer than attending encounters and 21 minutes longer than supervised resident encounters. They were also more likely to include lab testing, radiology studies, and consults than resident or attending-only encounters. Further multicenter research may minimize the effects of individual-level characteristics, and educational efforts across all levels of medical professionals can promote adherence to evidenced-based care. These interventions may reduce unnecessary imaging and testing for common pediatric conditions such as constipation, thereby optimizing throughput and resource utilization.

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# Comparison of Emergency Physicians' and Hospitalists' Attitudes Toward Fecal Occult Blood Testing in Gastrointestinal Bleeding

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**Introduction:** The guaiac fecal occult blood test, originally designed for colorectal cancer screening, is frequently used in emergency departments (ED) to detect occult gastrointestinal (GI) bleeding. However, the test has low sensitivity and specificity, leading to potential false positives and negatives. This study evaluates the current practices and perceptions of emergency physicians and hospitalists regarding the utility of the guaiac test in the setting of suspected GI bleeding in the ED.

**Objective:** Our primary aim in this study was to evaluate the current practice and views of emergency physicians and hospitalists on the utility of the stool guaiac test in the ED.

**Methods:** We conducted a multicenter survey from January 3–April 3, 2024, across four hospital systems, targeting attending physicians in the ED and hospitalists. Participants were asked to rate their agreement with statements about the stool guaiac test on a scale of 1 (strongly disagree) to 5 (strongly agree).

**Results:** Response rates were 47/93 (50.5%) for emergency attendings and 9/18 (50%) for hospitalists. Emergency attendings were significantly less likely than hospitalists to agree that stool guaiac testing is important for evaluating GI bleeding (31% vs 67%, P < .001). More than half of emergency attendings (55%) reported often performing the test, while 44% of hospitalists reported frequently requesting it before accepting a patient. Although 70% of emergency attendings believed that guaiac results influence hospitalists' admission decisions (P = .02), 67% of hospitalists stated they would accept a patient with suspected GI bleeding even without a result. Despite rating the test as important, only 33% of hospitalists felt that stool guaiac testing frequently changes management during hospitalization. Overall, the groups showed distinct attitudes regarding the utility and impact of stool guaiac testing.

**Conclusion:** The guaiac fecal occult blood test remains widely used despite skepticism among emergency attendings regarding its importance. Hospitalists were more likely to request the test but acknowledged it rarely changes patient management. These findings highlight the need for re-evaluation of guaiac testing in acute care settings and improved communication between ED and inpatient teams. Further research should explore the clinical impact of removing routine stool guaiac testing.[West J Emerg Med. 2025;26(6)1559–1563.]

## INTRODUCTION

Guaiac-based fecal occult blood tests were initially developed and approved as a screening tool for colorectal cancer.[1] However, in the emergency department (ED), they are frequently used to assess for occult blood in the stool when evaluating patients with suspected gastrointestinal (GI) bleeding. Despite their widespread use, guaiac tests have significant limitations in this context. A 2024 study analyzing hospitalized patients with suspected GI bleeding found that guaiac-based fecal occult blood tests were frequently

used inappropriately and rarely contributed to changes in management, highlighting its limited clinical utility in the inpatient setting.[2] Additionally, a 2020 systematic review and meta-analysis found that guaiac-based fecal occult blood tests had a pooled sensitivity of 58% and specificity of 84% for detecting GI sources of iron deficiency anemia, underscoring the potential for both false negatives and false positives.[3]

Studies have also demonstrated high false-positive rates in the ED, often due to dietary factors, medications, or other non-GI sources of blood that are difficult to control for in emergent situations.[4] Furthermore, false negatives can occur, particularly in cases of intermittent or slow bleeding, further complicating clinical decision-making. A retrospective chart review similarly concluded that the guaiac-based fecal occult blood test is not useful as a diagnostic test in symptomatic patients, reinforcing concerns about its limited utility in acute care settings.[1]

Our primary aim in this study was to evaluate the current practice patterns and perceptions of physicians regarding the utility of stool guaiac testing. We surveyed both emergency physicians and inpatient hospitalists to explore their reliance on this test for patients presenting with suspected GI bleeding in the ED. We hypothesized that despite its limitations, stool guaiac testing remains a widely used and valued tool among emergency physicians and that hospitalists continue to request the test upon patient admission.

*Population Health Research Capsule*

What do we already know about this issue?
*Stool guaiac testing is used in the ED for gastrointestinal (GI) bleeding, despite concerns about poor sensitivity, specificity, and limited impact on clinical management.*

What was the research question?
*How do emergency physicians' and hospitalists' attitudes differ toward guaiac testing for GI bleeding?*

What was the major finding of the study?
*33% of emergency attendings vs 67% of hospitalists valued testing (absolute difference 34 %, 95% CI 0.5-67, P = .02)*

How does this improve population health?
*This study highlights the need to re-evaluate routine guaiac testing in acute care, aligning practice with evidence to reduce unnecessary testing and improve care.*

## METHODS

This was a multicenter, survey-based study involving four hospital systems. Our institution is a large, urban, tertiary-care center; the other hospitals were Mount Sinai Miami, Jackson North Medical Center, AdventHealth Kissimmee, and Newark Beth Israel. To collect information for this study, we used a Google survey (Google. LLC, Mountain View, CA) from January 3–April 3, 2024. One survey was sent specifically to emergency attending physicians while one survey was sent only to hospitalists. A hospitalist, for the purpose of our study, was defined as a physician who admits patients to the inpatient floors. Critical care physicians were not surveyed nor was any physician who practiced solely outpatient. Exclusion criterion was an incomplete survey. On both surveys, we collected the respondent's number of years post residency training as well as the name of the hospital in which the participant practiced.

Survey respondents' identities remained anonymous, as the survey was designed to avoid collecting any personally identifiable information. Participants were then asked a series of questions and were asked to choose an answer between 1-5, with 1 being strongly disagree and 5 corresponding to strongly agree.

### Emergency Attending Survey Questions

1. It is very important to do a guaiac test in the evaluation of a GI bleed.
2. I often do a guaiac test on a patient with suspicion of GI bleeding in the ED.
3. Guaiac test results frequently change the management or disposition of my patient.
4. The admitting team is often influenced by a guaiac result.

### Hospitalist Survey Questions

1. Obtaining a guaiac test is important in the evaluation of a GI bleed.
2. I would accept a patient that presents with signs of GI bleed without a guaiac test result.
3. I often ask for a guaiac test before accepting a patient for admission for suspected GI bleed.
4. Guaiac test results frequently change the management of my patient throughout their hospital course.

### Data Analysis

We conducted all statistical analyses using Python (Python Software Foundation, Wilmington, DE). Descriptive statistics were used to summarize survey responses. We compared categorical responses between emergency attendings and hospitalists using chi-square tests or Fisher exact tests, where appropriate. A two-tailed *P*-value of < .05 was considered statistically significant.

## RESULTS

We received 47 responses from emergency physician attendings (50.5% response rate) and nine responses from

hospitalists (50% response rate), of a total 93 emergency attendings and 18 hospitalists who were sent surveys. When comparing the two groups, 31% of emergency attendings agreed or strongly agreed that the stool guaiac test is important for GI bleed evaluation, compared to 67% of hospitalists. Slightly more than half (55%) of emergency physician attendings reported that they often perform the test on patients with suspected GI bleeding, while 44% of hospitalists reported that they often ask for a stool guaiac test before accepting a patient for admission. Additionally, 70% of emergency attendings agreed or strongly agreed that the admitting team is influenced by guaiac test results, compared to only 33% of hospitalists who felt that the test frequently changes management throughout a patient's hospital course. Despite the perceived importance, 67% of hospitalists agreed or strongly agreed that they would accept a patient with signs and symptoms of GI bleeding even without a stool guaiac test result.

Although only some group differences reached statistical significance—specifically, the emergency physician attendings' lower valuation of the test's importance ($P < .001$) and their perception of its influence on admission decisions ($P = .02$)—the overall trends highlight notable differences in attitudes between emergency attendings and hospitalists regarding the use of stool guaiac testing in clinical decision-making.

The Figure 1 bar chart displays the percentage of responses to four Likert-scale items assessing emergency attendings' perceptions and practices regarding guaiac fecal occult blood testing in patients with suspected GI bleeding. The survey was distributed across four hospital systems.

Figure 2 presents the distribution of hospitalist responses to four Likert-scale survey questions evaluating their views on the role of stool guaiac testing in patients presenting with suspected GI bleeding. The questions address test importance, its necessity for admission, likelihood of requesting it before admission, and whether it influences patient management. Results are shown as percentages across agreement levels, allowing comparison of hospitalists' perspectives on the clinical utility of the test.

## DISCUSSION

We sought to evaluate the current practices and perceptions of emergency physicians and hospitalists regarding the utility of the stool guaiac test in patients with suspected GI bleeding in the ED. The findings of our study resonate with the ongoing debate in the literature regarding the utility of guaiac testing in GI bleeding. Previous research has highlighted the significant limitations of stool guaiac testing, including its low sensitivity and specificity, especially in the emergency setting where dietary and medication restrictions cannot be controlled.[1] Despite these limitations, our results show a continued reliance on this test, reflecting ingrained practice patterns and complex decision-making dynamics in acute care settings.

The survey results revealed a complex perception of stool guaiac testing among emergency attendings. While 70% agreed or strongly agreed that guaiac test results influenced admitting team decisions ($P = .02$), only 31% felt the test was important for GI bleed evaluation ($P < .001$). This dichotomy suggests that while emergency physicians may not place high diagnostic value on the test, they recognize its impact on interdepartmental communication and disposition decisions; 34% of emergency attendings still frequently performed the test, suggesting that its use persists, potentially due to ingrained practice habits or the perceived expectations of inpatient teams. In contrast, hospitalists demonstrated a stronger inclination toward stool guaiac testing, with 67% agreeing on its importance, although this was not statistically significant ($P = .51$). Interestingly, 67% of hospitalists indicated they would accept a patient with suspected GI bleeding without a guaiac test result,

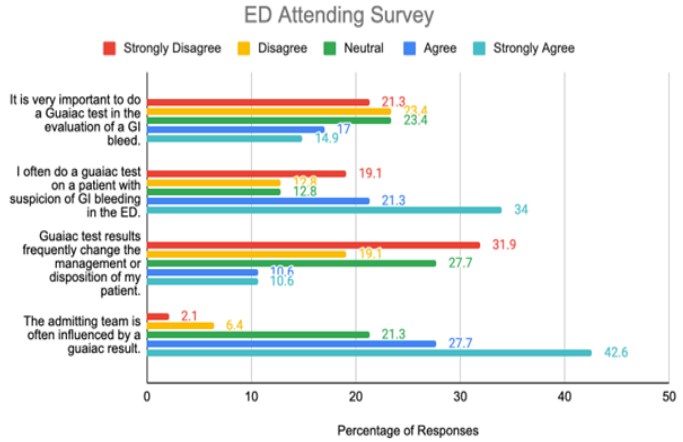


**Figure 1.** Attitudes of attending emergency physicians toward guaiac fecal occult blood testing for gastrointestinal bleeding based on a multicenter survey.
*ED,* emergency department; *GI,* gastrointestinal.

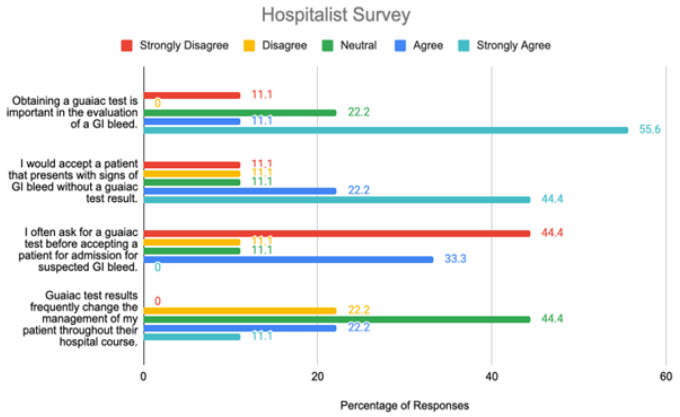


**Figure 2.** Attitudes of hospitalists toward guaiac fecal occult blood testing for gastrointestinal bleeding based on a multicenter survey.
*GI,* gastrointestinal.

highlighting a pragmatic approach that aligns with literature advising against overreliance on the test.[4] The discrepancy between perceived importance and willingness to admit without a result suggests hospitalists may view stool guaiac testing as part of a broader clinical picture rather than a decisive factor in management.

The persistent use of stool guaiac testing in both emergency and inpatient settings highlights a disconnect between clinical practice and evidence-based recommendations. Despite well-documented limitations, many clinicians continue to rely on guaiac fecal occult blood testing in the evaluation of GI bleeding. Research consistently cautions against the routine use of this test in symptomatic patients due to its high rates of false positives and false negatives.[2] Some institutions have recognized these shortcomings and have taken steps to eliminate in-hospital fecal occult blood testing altogether. Notably, these initiatives have often been spearheaded by gastroenterologists advocating for practice changes based on the test's poor diagnostic accuracy and limited clinical utility.[5] The push to discontinue routine use reflects a growing awareness that the risks of false reassurance, unnecessary testing, and potential delays in care outweigh any perceived benefits of stool guaiac testing in acute settings.

One of the major flaws of stool guaiac testing is its susceptibility to external factors, leading to unreliable results. Certain foods and medications can cause false positives, further complicating its utility in emergent evaluations. For instance, foods such as red meat, turnips, broccoli, cauliflower, and radishes have been shown to trigger false-positive results. Additionally, medications including nonsteroidal anti-inflammatory drugs and anticoagulants are known to interfere with test outcomes.[1] Given the unpredictable nature of ED presentations, it is impractical to expect patients to adhere to the strict dietary and medication restrictions required for accurate test interpretation. This inherent limitation makes the test unreliable for guiding real-time clinical decision-making. The high false-positive rate can lead to a cascade of unnecessary interventions, including endoscopic procedures, excessive resource utilization, and prolonged hospitalizations, all of which contribute to increased healthcare costs and potential patient harm.

Beyond its susceptibility to false positives, stool guaiac testing is also limited by its poor sensitivity in detecting significant GI pathology. A 2020 systematic review and meta-analysis analyzing 22 studies found that guaiac fecal occult blood testing had poor sensitivity for detecting iron deficiency anemia due to GI blood loss. The study revealed that 42% of patients with identifiable causes of iron deficiency anemia had false-negative fecal occult blood testing results, emphasizing the test's inability to reliably detect GI bleeding.[3] Another study found that over 25% of patients with overt GI bleeding experienced delays in specialist referral because clinicians were waiting for fecal occult blood testing results before proceeding with further evaluation.[1] These findings illustrate that inappropriate use of this test has the potential to delay necessary patient care. Despite these limitations, we found that more than 30% of hospitalists still believe that stool guaiac testing frequently influences patient management, underscoring the persistence of outdated practice patterns.

The most recent survey-based study assessing the use of stool guaiac testing in the ED was conducted in 2020.[6] This study sought to evaluate whether emergency physicians could accurately predict the results of guiac-based fecal occult blood tests and whether the test influenced patient disposition. Interestingly, the survey found that emergency physicians were unable to consistently predict test results, which some interpreted as a potential justification for using the guaiac-based fecal occult blood test as a confirmatory tool in clinical evaluation. However, the study did not assess actual patient outcomes, and given the test's known low sensitivity and specificity, its unpredictability only further reinforces its lack of clinical value.[6]

Our findings align with this conclusion, as most of the emergency physicians in our study reported using the guaiac-based fecal occult blood test primarily to reinforce clinical impressions for the admitting team rather than as a decisive diagnostic tool. Notably, the 2020 survey also revealed that emergency physicians were more likely to anticipate that guaiac-based fecal occult blood test results would alter patient disposition before performing the test, but this likelihood decreased after the test was completed.[6] This suggests that clinicians initially expect the guaiac-based fecal occult blood test to provide useful information, only to find that the results rarely impact their clinical decision-making in a meaningful way.

These findings collectively highlight the need for a reassessment of the role of stool guaiac testing in acute care settings. Although historical practice may have supported its use, increasing evidence indicates that discontinuing routine guaiac-based fecal occult blood testing in symptomatic patients has the potential to streamline patient care, reduce unnecessary interventions and costs, and promote adherence to evidence-based practice; however, our study was not designed to demonstrate this effect.

## LIMITATIONS

Our study's findings are limited by the overall small response rates from both hospitalists and emergency attendings, which constrains our ability to generalize the results across inpatient and ED settings. Additionally, as participation was voluntary, there is potential for selection bias, as those with stronger opinions on stool guaiac testing may have been more likely to complete the survey. However, previous research suggests that low response rates do not inherently compromise the validity or reliability of survey-based findings if the responding sample is reasonably

representative of the target population.[7-9] Lastly, our study evaluates physician perceptions and self-reported practice patterns but does not assess actual patient outcomes or the direct clinical impact of stool guaiac testing on management decisions.

The results suggest a need for re-evaluation of the routine use of stool guaiac testing in the ED, with a focus on enhancing education and communication between emergency physicians and hospitalists regarding its limitations. Future research assessing the impact of its removal by comparing clinical practices and outcomes before and after discontinuation could provide valuable insights.

## CONCLUSION

The guaiac-based fecal occult blood test remains widely used in emergency departments, despite skepticism among emergency attendings regarding its clinical value. Hospitalists were more likely to request the test, although they acknowledged it infrequently changes patient management. These findings suggest a need to re-evaluate the routine use of guaiac testing in acute care settings and to strengthen communication between ED and inpatient teams about its role in clinical decision-making. Future research should focus on outcomes associated with the removal of routine stool guaiac testing to better align practice with the available evidence.

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*Conflicts of Interest*: By the WestJEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. No author has professional or financial relationships with any companies that are relevant to this study. There are no conflicts of interest or sources of funding to declare.

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# Emergency Department Disposition and Point-of-Care Ultrasound in Biliary Disease: Propensity-Weighted Cohort Study

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**Introduction:** Biliary tract disease is a frequent cause of abdominal pain among emergency department (ED) patients and accounts for a significant portion of hospital admissions and return visits. Our objective was to compare ED outcomes for patients ultimately diagnosed with biliary tract disease based on the use of point-of-care ultrasound (POCUS) during their initial visit. We specifically analyzed patients admitted after an unscheduled return visit within 72 hours vs those admitted directly from the ED.

**Methods:** In this retrospective cohort study we used propensity score weighting and included 1,228 adults admitted for biliary tract disease, either during their initial ED visit (n = 1,120, 91.2%) or following an unscheduled return visit within 72 hours (n = 108, 8.8%) at a tertiary center in Taiwan between 2021–2023. Outcomes included ED length of stay (LOS), costs, hospital LOS, intensive care unit (ICU) admission, and in-hospital mortality. We used multivariable regression models with inverse probability of treatment weighting adjustment to account for baseline differences.

**Results:** Initial discharge followed by admission after an unscheduled return visit was not associated with worse clinical outcomes compared to direct admission. There were no significant differences in in-hospital mortality (0.93% vs 1.16%; odds ratio [OR] 0.59, $P = .56$) or ICU admission (0.93% vs 0.71%; OR 1.78, $P = .61$). While the initial ED LOS was shorter (mean: 4 hours vs 15.6 hours; regression-adjusted difference -6.66 hours, $P < .001$) and the initial ED costs were lower (mean: NT5477 vs NT$16,269, a 66% savings; regression-adjusted difference: -NT$6,548, $P < .001$), this reflects an expected early discharge. Among patients ultimately requiring admission after an unscheduled return visit, those who received POCUS at their index visit had a significantly shorter initial ED LOS (mean: 2.97 hours vs 4.78 hours; regression-adjusted difference -1.42 hours, $P = .006$) and lower initial ED costs (mean: NT$3,248 vs NT$7,149; a 55% saving; regression-adjusted difference -NT$3,271, $P < .001$) compared to those who did not. This initial POCUS use did not increase adverse events; only one of the 108 patients in the unscheduled return visit group required ICU admission (0.9%, 95% CI, 0.02-5.1%), and no deaths occurred (0%, 95% CI, 0-2.78%).

**Conclusion:** Initial discharge following ED assessment appears safe for many low-risk patients ultimately diagnosed with biliary tract disease on repeat visit within 72 hours. Incorporating POCUS during the initial evaluation may shorten ED LOS and reduce costs for patients who later require admission, without apparent measurable negative effects on mortality, hospital, or ICU length of stay. [West J Emerg Med. 2025;26(6)1564–1574.]

## INTRODUCTION

Biliary tract disease is a frequent cause of abdominal pain among emergency department (ED) patients and accounts for a significant portion of hospital admissions and return visits.[1] Delayed or missed diagnoses can lead to serious complications, including sepsis, biliary obstruction, and organ failure.[2-4] Consequently, there is a critical need for diagnostic strategies that support timely identification and management of biliary tract disease in the ED.

Point-of-care ultrasound (POCUS), often described as the "ultrasound stethoscope," has become an essential bedside tool for emergency physicians.[5] Prior research has demonstrated its effectiveness in enhancing diagnostic accuracy, expediting care, and reducing ED length of stay (LOS) in various conditions such as renal colic, soft tissue infections, and bowel obstruction.[6, 7] In biliary tract disease specifically, POCUS has shown high sensitivity and specificity, particularly for detecting cholelithiasis,[8] and enables clinicians to rapidly identify pathology, potentially reducing reliance on computed tomography (CT) and other resource-intensive imaging modalities.[9]

Efficiency in the ED is a key determinant of patient safety and overall system performance.[10] Crowding is linked to delays in care, increased healthcare costs, and adverse outcomes, including in-hospital cardiac arrest.[11, 12] Thus, reducing ED LOS and optimizing throughput are high priorities.[12] Point-of-care ultrasound may serve as a frontline imaging strategy that facilitates faster decision-making, lowers costs, and improves patient flow,[13] especially when compared to CT, which may be less readily available or involve longer wait times.[9, 14, 15]

Unscheduled return visits within 72 hours are commonly used as a quality-of-care metric and are often viewed as indicators of premature discharge, diagnostic error, or suboptimal treatment.[16, 17] While many unscheduled return visits are unavoidable, a substantial proportion are preventable,[18-21] and can contribute to ED crowding and increased healthcare expenditures.[22, 23] In the context of biliary tract disease, patients discharged from the ED may experience progression of disease, requiring admission upon return.[24, 25] Comparing outcomes between patients admitted directly and those admitted following an unscheduled return visit can offer insights into whether early discharge, particularly after POCUS-based evaluation, compromises patient safety.[26]

Although existing studies support the diagnostic accuracy and cost effectiveness of POCUS for biliary tract disease,[15, 27] limited evidence exists on its role in guiding safe discharge decisions. Specifically, the association between POCUS and patient outcomes for those discharged after the initial visit but later readmitted has not been well characterized.

We hypothesized that POCUS-guided discharge decisions do not adversely affect patient outcomes and may contribute to more efficient ED resource utilization in patients ultimately diagnosed with biliary tract disease. In this study we aimed to evaluate the association of POCUS at the initial ED visit with ED LOS, medical costs, and safety outcomes in patients admitted for biliary tract disease after an unscheduled return visit, compared to those admitted directly at their initial ED presentation.

*Population Health Research Capsule*

What do we already know about this issue?
*ED discharge decisions for patients with non-specific abdominal pain are complex.*

What was the research question?
*What is the association of initial ED point-of-care ultrasound (POCUS) with outcomes for biliary tract disease patients admitted directly or after revisit?*

What was the major finding of the study?
*In admissions of patients with biliary tract disease after an unscheduled return visit, initial POCUS use had a shorter ED LOS (-1.42 hours, P = .006) and lower costs by 55%.*

How does this improve population health?
*Integrating POCUS into ED assessment enhances efficiency, reduces costs, and allows safe discharge for low-risk patients with biliary tract disease.*

## METHODS

### Study Design

This retrospective cohort study used propensity score weighting with data from the electronic health record (EHR) of a tertiary medical center in Taiwan with more than 160,000 ED visits annually, between January 1, 2021–December 31, 2023. The database is de-identified but contains a unique, encrypted personal identifier that allows researchers to link claims between ED and inpatient databases. This study was approved by the Institutional Review Board of China Medical University Hospital (CMUH113-REC2-008), and informed consent was waived. We followed STROBE guidelines for observational studies, and all elements in the checklist for cross-sectional studies are presented in content and structure.[28]

All data were initially extracted by the staff in the hospital's information department according to our application form. Further data were extracted by a trained research assistant (RA), following 12 recommended criteria for medical record review studies.[29] The RA was blinded to the study hypotheses and had a 30-minute training session on the ED

medical record abstraction process. According to the inclusion criteria and definition of subgroups, the number of cases extracted by RA was compared with that of the researchers through data selection in Excel (Microsoft Corporation, Redmond, WA). There was 100% interobserver reliability of the variables of interest for this cohort.

**Population and Setting**

This retrospective study was based on a larger group of adults (≥ 18 years of age) who presented at the ED with non-traumatic abdominal pain. We then selected those who were diagnosed with biliary tract disease (*International Classification of Diseases, 10th Revision* [*ICD-10*] codes K80–K83) either at their initial hospital admission or admission after an unscheduled return visit within 72 hours, regardless of whether they were pregnant or not. Patients were excluded if they were < 18 years of age, had traumatic abdominal pain, were transferred from other EDs, or had been discharged against medical advice from other clinics or hospitals.

We characterized patients into two groups: 1) those discharged after the index ED visit but subsequently admitted with a biliary tract disease diagnosis upon an unscheduled return visit within 72 hours (n = 108); and 2) those admitted directly during the index visit with a biliary tract disease diagnosis (n = 1,120). In total, 1,228 patients were included in the core analysis.

All physicians performing POCUS had completed mandatory residency training, standard in Taiwan since 2012, which requires a standardized hands-on assessment and regular refresher courses under certified instructors, and are responsible for performing and interpreting all examinations. There has been no radiology ultrasonography available in our ED for at least seven years.

In this study, POCUS was not limited to evaluating a specific organ or confirming a diagnosis. Instead, it was used to address the clinical questions that arise during patient care, often requiring a comprehensive assessment across multiple organs and systems based on the patient's presenting symptoms. All physicians at this tertiary center had received standardized POCUS training and could apply any protocol or technique they had learned to guide their clinical decisions. Take the example of biliary POCUS. It must include longitudinal and transverse views of the gallbladder, including the gallbladder neck, with or without the echo-Murphy sign, pericholecystic edema. It should also include a measurement of the thickness of the gallbladder wall and an assessment of the common bile duct.[30] We examined the association between POCUS and admission, ED LOS, and related medical costs after an unscheduled return visit, by comparing patients who underwent POCUS at the index visit with those who did not.

We defined an index visit as an ED visit without a prior ED visit or hospitalization in the preceding 72 hours. A return visit was defined as any ED revisit within 72 hours of discharge; for patients with multiple revisits, only the first was included. The unit of analysis was the visit; a single patient could contribute multiple index visits during the study period. We focused on early revisits (within 72 hours), as these cases are generally more preventable and more responsive to ED- or hospital-based quality improvement interventions.[31]

To assess the role of POCUS in patient safety, we compared patients in the POCUS-only group at the index visit who required admission after an unscheduled return visit with patients in the CT group admitted directly at the index visit. Furthermore, to examine the cost and efficiency of POCUS, we compared patients in the POCUS-only group at the index visit who required admission after an unscheduled return visit with patients who received neither POCUS nor CT at the index visit who required admission after an unscheduled return visit.

**Variables**

The EHR contains information on patient demographics, visit date and time, triage level, comorbidities, *ICD-10* diagnostic codes, POCUS, CT, ED disposition, ED LOS, costs, and hospital LOS. The Taiwan Triage and Acuity Scales system is a computerized, five-level system with acuity levels 1-5 indicating resuscitation, emergent, urgent, less urgent, and non-urgent, respectively.[32]

**Outcome Measures**

The outcome measures were ED LOS, ED costs, inpatient mortality, intensive care unit (ICU) admission, hospital LOS, and total ED and inpatient costs in New Taiwan dollars (NT$). The ED LOS was defined as the period from the patient's initial presentation to the ED, as documented by the triage nurse, to the patient's discharge from the ED. We calculated ED LOS at the following five points: discharge from the ED; discharge from the observation room; admission to the general ward; admission to the ICU; and ED mortality. The hospital LOS of patients admitted to the general ward or ICU was documented as a secondary outcome to evaluate the prognosis of patients.

**Data Analysis**

Summary statistics are presented as means (with standard deviations). We examined bivariate associations using the Student *t*-test, and chi-square tests, as appropriate. We analyzed the clinical outcomes (mortality and ICU admission) and resource use (LOS and cost) by comparing the patients admitted for biliary tract disease after an unscheduled return visit to those admitted directly after the index visit, and the POCUS-only group admitted after an unscheduled return visit to the CT-only group in patients who were admitted directly after the index visit, and to patients who did not receive POCUS at the index visit who required admission after an unscheduled return visit as a sensitivity analysis. Only seven missing data points were found, all of which were limited to

**Table 1.** Demographics of the study population on quality of care in patients with biliary tract disease.

| | Before IPTW | | | After IPTW | | |
|---|---|---|---|---|---|---|
| | Admission after index visit, N = 1,120 | Admission after an unscheduled return visit n = 108 | *P*-value | Admission after index visit (%) | Admission after an unscheduled return visit (%) | SMD |
| Age | 59.2 ± 17.0 | 53.5 ± 15.1 | < .001 | 58.7 ± 17.8 | 58.3 ± 55.7 | 0.008 |
| Sex | | | .04 | | | |
| Male | 583(52.1) | 67(62.0) | | 52.9 | 49.5 | -0.094 |
| Female | 537(48.0) | 41(38.0) | | 47.1 | 50.5 | 0.098 |
| BMI | 25.2 ± 4.6 | 26.0 ± 3.9 | .04 | 25.3 ± 4.9 | 25.7 ± 12.5 | -0.038 |
| Triage | | | .006 | | | |
| 1 | 16(1.4) | 0(0.0) | | 1.3 | 0.0 | -3.866 |
| 2 | 268(23.9) | 12(11.1) | | 22.8 | 24.4 | 0.095 |
| 3 | 820(73.2) | 95(88.0) | | 74.5 | 74.6 | 0.001 |
| 4 | 16(1.4) | 1(0.9) | | 1.4 | 1.1 | -0.869 |
| 5 | 0(0.0) | 0(0.0) | | 0.0 | 0.0 | - |
| Heart rate | 90.0 ± 19.9 | 78.6 ± 13.5 | < .001 | 89.9 ± 20.8 | 78.2 ± 44.2 | 0.338 |
| Systolic blood pressure | 136.6 ± 25.3 | 144.4± 27.7 | .002 | 136.6 ± 26.4 | 145.2 ± 91.8 | -0.126 |
| Diastolic blood pressure | 80.5 ± 14.2 | 84.8 ± 15.2 | .003 | 80.7 ± 14.9 | 83.2 ± 47.6 | -0.071 |
| Body temperature (°C) | 36.9 ± 1.0 | 36.4 ± 0.6 | < .001 | 36.9 ± 1.0 | 36.5 ± 2.1 | 0.267 |
| Respiratory rate | 19.6±1.6 | 19.5 ± 1.4 | .39 | 19.6 ± 1.7 | 19.5 ± 4.7 | 0.030 |
| History of comorbidities | 774(69.1) | 69(63.9) | .26 | 68.6 | 68.5 | -0.002 |
| POCUS | 475(42.4) | 71(65.7) | <0.001 | 42.6 | 64.9 | 0.594 |
| CT | 960(85.7) | 29(26.9) | <0.001 | 85.7 | 31.3 | -1.326 |

This table presents the baseline characteristics of patients included in the study examining the quality of care for biliary tract disease in the emergency department, comparing those who received POCUS to those who did not. After IPTW adjustment, the groups achieved acceptable covariate balance, defined as SMD < 0.1. Before adjustment, patients who were admitted after an unscheduled return visit were generally younger, more often male, and had a higher BMI, lower triage-assessed severity of illness, higher rates of POCUS use, and lower rates of CT ordering. Data are presented as frequency (percentage) or mean ± SD.
*BMI,* body mass index; *CT,* computed tomography; *IPTW,* inverse probability of treatment weighting; *LOS,* length of stay; *SMD,* standardized mean difference; *POCUS,* point-of-care ultrasound.

vital signs and anthropometric measures (ie, weight, height, and body mass index [BMI]). We excluded these data points from the calculations of means and standard deviations.

To account for differences in baseline characteristics, we employed multivariable logistic and linear regression models, adjusting for potential confounders including age, sex, triage level, BMI, and comorbidities. To further reduce confounding bias in group comparisons, we applied inverse probability of treatment weighting (IPTW) based on propensity scores derived from a logistic regression model using the aforementioned covariates. Stabilized weights were used to minimize the influence of extreme propensity scores. We evaluated covariate balance before and after weighting using standardized mean differences, with values < 0.1 indicating negligible imbalance and 0.1-0.2 suggesting minimal imbalance. We did not include POCUS as a variable in the propensity score model, as it was an outcome of interest rather than a baseline characteristic.

We analyzed group differences in LOS and cost using linear regression models within the IPTW-adjusted cohort. Results are presented as odds ratios (OR) or beta coefficients, each with 95% confidence intervals. All statistical analyses were performed using SAS software v9.4 (SAS Institute Inc., Cary, NC). Two-sided *P*-values < .05 were considered statistically significant.

## RESULTS

### Baseline Demographics

A total of 1,228 adult patients admitted with the diagnosis of biliary tract disease were included in the study, comprising 1,120 (91.2%) patients admitted during the index ED visit and 108 (8.8%) patients admitted after an unscheduled return visit within 72 hours (Figure 1).

After IPTW adjustment, baseline characteristics between groups achieved acceptable balance (standardized mean differences < 0.1). Even after adjustment, patients admitted after an unscheduled return visit had significantly more POCUS and fewer CTs at the initial visit. Before adjustment, patients admitted after an unscheduled return visit were younger (53.5

vs 59.2 years, $P < .001$), more likely to be male (62.0% vs 52.1%, $P = .04$), and had a higher BMI, lower severity of illness at triage, more POCUS, and less CT ordered.

### Quality of Care

As shown in Table 2, after IPTW adjustment, patients admitted after an unscheduled return visit had a significantly shorter initial ED LOS compared to those admitted during the index visit ($P < .001$). The ED LOS was reduced by approximately 400 minutes. ED costs at the index visit were also lower in the unscheduled return visit admission group ($P < .001$). The ED costs represented a saving of approximately 66%. No significant differences were observed between groups in total hospitalization costs, hospital LOS, ICU admission, or in-hospital mortality. This suggests that even though patients admitted after an unscheduled return visit had a shorter initial ED LOS and lower costs, patient safety was not compromised.

### Safety of Point-of-care Ultrasound in Patients Admitted after Unscheduled Return Visit

As shown in Table 3, the POCUS-guided discharge at the index visits in patients admitted for biliary tract disease after an unscheduled return visit exhibited a significantly shorter initial ED LOS ($P < .001$) and lower initial ED costs ($P < .001$) compared with patients who underwent CT and were admitted directly at the index visit. No significant differences were observed in admission costs, total costs, hospital LOS, or ICU LOS. As only one patient (0.9%, 95% CI, 0.02-5.1%) who received POCUS alone at the index visit and was admitted to the ICU for two days after an unscheduled return visit and no patients died (0%, 95% CI, 0-2.78 %), the ICU admission OR and in-hospital mortality OR could not be estimated due to the low event rate, suggesting that the use of POCUS did not compromise patient safety.

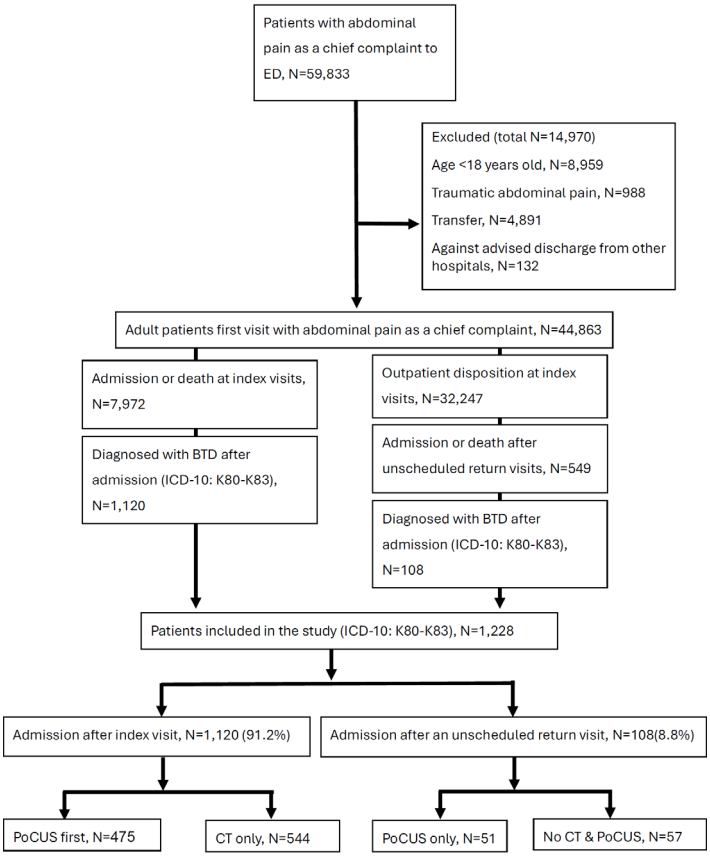


**Figure 1.** Flow diagram of study population selection. *ED,* emergency department; *BTD,* biliary tract disease; *POCUS,* point-of-care ultrasound; *CT,* computed tomography.

### Cost and Efficiency of Ultrasound in Patients Admitted After an Unscheduled Return Visit

As shown in Table 4, among patients admitted for biliary tract disease after an unscheduled return visit, those who received POCUS during the index visit (n = 51) had significantly shorter initial ED LOS ($P = .006$) compared with those who did not receive POCUS or CT (n = 57). The ED LOS was reduced by approximately 85 minutes. The initial ED costs were also significantly lower in the POCUS group (NT$3,248 vs NT$7,149; $P < .001$). The ED costs represented a saving of approximately 55%. However, no significant differences were observed in hospital LOS, admission costs, or total healthcare costs. These results highlight POCUS as a cost-efficient diagnostic tool that reduces initial ED resource use without adversely affecting patient outcomes.

## DISCUSSION

This study evaluated the association of POCUS with resource utilization and safety outcomes in patients admitted for biliary tract disease after an unscheduled return visit. A key finding is that admission did not correlate with worse clinical outcomes or increased overall costs compared to patients admitted during their index visit. This suggests that initial discharge decisions, facilitated by standard ED assessment, potentially augmented by POCUS, effectively identify many low-risk patients without compromising safety. Furthermore, our results indicate that POCUS-guided management during the initial ED encounter was associated with reduced ED LOS and initial ED costs, without adversely affecting patient safety metrics upon subsequent admission. These findings support the potential of POCUS as a valuable tool for risk stratification and resource optimization in the evaluation of adult patients presenting with non-traumatic abdominal pain.

### Outcomes of Patients Admitted After Unscheduled Return Visit

While delays in surgical intervention for acute biliary conditions can lead to complications,[33] our cohort of patients admitted for biliary tract disease after an unscheduled return visit did not demonstrate increased overall hospital LOS, costs, ICU admission rates, or mortality compared to those admitted

**Table 2.** Quality of care in patients admitted for biliary tract disease after an unscheduled return visit.

| | | After IPTW | |
|---|---|---|---|
| Outcome measures, point estimate (95% CI) | Admission after the index visit | Admission after an URV | *P*-value |
| Initial ED LOS (hours) | Ref. | -6.66 (-8.60 to -4.71) | < .001 |
| Initial ED costs (NT$) | Ref. | -5,647.9 (-7,260.1 to -4,035.8) | < .001 |
| Total costs (NT$) | Ref. | -5,078.8 (-15,083.9 to 4,926.4) | .31 |
| Hospital LOS (day) | Ref. | -1.12 (-2.41 to 0.17) | .08 |
| ICU, OR | Ref. | 1.78 (0.19 to 16.45) | .61 |
| Expired in ED, OR | Ref. | 0.18 (0.02 to 2.12) | .17 |
| Expired after admission, OR | Ref. | 0.59 (0.10 to 3.45) | .56 |

After adjustment using IPTW, the analysis showed that patient safety was not compromised, despite patients having a shorter LOS during the initial ED visit and incurring lower associated costs. Results were adjusted for age, sex, triage level, BMI, and comorbidities. *BMI,* body mass index; *CT,* computed tomography; *ED,* emergency department; *ICU,* intensive care unit; *IPTW,* inverse probability of treatment weighting; *LOS, length of stay*; *OR,* odds ratio; *NT$,* new Taiwan dollar; *Ref.,* reference.

directly. These patients included those who were initially diagnosed with biliary tract disease and discharged for outpatient follow-up, and those who first presented with nonspecific abdominal pain and were later diagnosed with biliary tract disease on return. These scenarios reflect the diagnostic complexity of biliary tract disease in the ED. Patients discharged after an initial diagnosis for biliary tract disease often lack signs of acute inflammation or obstruction, making outpatient management appropriate. Conversely, patients with initially vague symptoms may only be diagnosed with biliary tract disease upon re-presentation, underscoring the condition's potential to progress or evolve diagnostically over time.

Including both patient types provides a comprehensive view of how POCUS can support early identification and risk stratification of biliary tract disease, even when symptoms are atypical or biliary tract disease is not initially suspected. Our findings suggest that POCUS can enhance diagnostic accuracy across the full spectrum of ED presentations, reinforcing the value of the initial evaluation in identifying patients suitable for non-emergent outpatient care.

Importantly, unplanned return visits are not always avoidable. A study in New York State revealed that 48.6% of patients with biliary colic may not require surgery within five years, and one-third undergo cholecystectomy elsewhere.[34] This demonstrates that the disease may progress and that we cannot avoid all unplanned return visits. Patient loyalty to our ED for return visits may indicate trust in care quality. Although unscheduled return visits. can occur, potentially due to disease progression[35] or patient factors,[34] our data suggest that these return admissions for biliary tract disease are not necessarily indicative of substandard initial ED care, a point supported by literature showing ED care quality is often not the primary driver for return admissions.[36] Hospital management should avoid penalizing EDs for biliary tract disease readmissions, as these are not reliable quality metrics. Ensuring timely outpatient surgical follow-up remains a crucial component of managing symptomatic biliary colic effectively.[37]

**Point-of-care ultrasound and Emergency Department Efficiency**

Consistent with prior research, our findings suggest that POCUS enhances ED efficiency in the context of suspected biliary tract disease.[15, 38] By providing real-time imaging, POCUS expedites gallstone detection (a reliable application, although operator-dependent).[38] Common errors, such as misinterpreting artifacts or failing to visualize the gallbladder neck,[27] underscore the need for ongoing training. In the past, clinicians could order an ultrasound performed by a radiologist to aid in the diagnosis. However, this is time-consuming, and recent evidence suggests that obtaining an ultrasound by a radiologist after a positive POCUS by a qualified emergency physician requires additional time and may increase diagnostic uncertainty.[39] Targeted ultrasound education can further optimize ED workflow, but clinicians must recognize POCUS limitations, including false negatives in conditions like appendicitis or challenges in obese patients. Clear protocols for when to pursue adjunctive imaging (eg, CT) are essential to ensure diagnostic accuracy.

**Point-of-care Ultrasound as a Decision-Making Tool**

Abdominal pain poses a diagnostic challenge in the ED due to its diverse etiologies. Point-of-care ultrasound augments clinical assessment with immediate bedside imaging, facilitating rapid differentiation of patients requiring hospitalization vs discharge.[40-42] This immediate imaging capability facilitates the timely differentiation of patients requiring advanced diagnostics or hospitalization and holds potential for reducing healthcare expenditures.[43] Existing evidence underscores the diagnostic accuracy of POCUS, demonstrating comparability to standard imaging for identifying critical conditions such as aortic aneurysm and

**Table 3.** The safety of ultrasound-guided discharge at the index visits in patients admitted for biliary tract disease after an unscheduled return visit.

| | | After IPTW | |
|---|---|---|---|
| Outcome measures, point estimate (95% CI) | Admission after index visit with CT N = 544 | Admission after an unscheduled return visit with POCUS only N =. 51 | *P*-value |
| Initial ED LOS (hours) | Ref. | -13.71 (-15.19 to -12.22) | < .001 |
| Initial ED costs (NT$) | Ref. | -13,566.8 (-14,907.2 to -12,226.4) | < .001 |
| Admission costs (NT$) | Ref. | -12,938.2 (-28,793.2 to 2,916.9) | .10 |
| Total cost (NT$) | Ref. | -8,553.2 (-25,851.6 to 8,745.2) | .33 |
| Hospital LOS (day) | Ref. | -1.45 (-4.20 to 1.30) | .30 |
| ICU LOS (day) | Ref. | -2.25 (-5.45 to 0.96) | .15 |
| Expire, OR | Ref. | | |

This table presents patient safety outcomes in the study evaluating the use of POCUS at the index visit among patients admitted for biliary tract disease after an unscheduled return visit to the ED. After adjustment using IPTW, POCUS-guided discharge at the index visit, with subsequent admission after an unscheduled return visit, was not associated with compromised patient safety when compared with patients who underwent computed tomography and were admitted directly at the index visit. Analyses were adjusted for age, gender, triage level, body mass index, and comorbidities.
*ED,* emergency department; *ICU,* intensive care unit; *IPTW,* inverse probability of treatment weighting; *LOS,* length of stay; *NT$,* new Taiwan dollar; *OR,* odds ratio; *POCUS*, point-of-care ultrasound; *Ref.,* reference.

gallbladder pathology.[44] Furthermore, the integration of POCUS into the diagnostic workflow is associated with improved clinical decision-making by significantly narrowing the differential diagnosis, guiding management strategies, and reducing the need for ancillary testing.[45] The POCUS findings directly informed timely disposition decisions, reduced diagnostic uncertainty, and improved workflow. However, POCUS must complement a comprehensive evaluation, including history, physical examination, and laboratory results. Evidence-based guidelines are needed to standardize POCUS indications and clarify when advanced imaging is warranted, ensuring accurate and timely diagnoses.

**Point-of-care Ultrasound and Emergency Department Costs**

Point-of-care ultrasound offers potential economic advantages in the ED by mitigating the need for resource-intensive advanced imaging.[46,47] Studies demonstrate its potential, such as reducing subsequent CT utilization for abdominal pain,[48] and POCUS demonstrates diagnostic advantages over radiography for certain conditions like small bowel obstruction, potentially replacing CT or MRI in select cases.[49] These shifts in diagnostic pathways can decrease direct imaging costs. In this study, almost no patients admitted for biliary tract disease at our hospital were managed with POCUS alone. Therefore, we did not compare the cost and efficiency of POCUS in patients admitted directly for biliary tract disease at the index visit. However, focusing on patients admitted for biliary tract disease after an unscheduled return visit, we found that index-visit management using POCUS alone was associated with lower initial ED LOS and costs compared to patients not receiving index-visit POCUS. This observed reduction in LOS aligns with literature suggesting POCUS can shorten ED LOS and optimize resource utilization, potentially reducing demand on beds, staff, and supplies.[50]

It is also important to consider that physicians comfortable and willing to perform POCUS may inherently be more proactive in their diagnostic approach, a factor that could contribute to the observed reductions in LOS and resource utilization.[51, 52] When used selectively in appropriate clinical scenarios, POCUS offers meaningful opportunities for both cost savings and improved care delivery for patients with abdominal pain, without compromising patient safety. These results support health policy initiatives that expand POCUS training and certification for emergency physicians. Due to its portability, affordability, and versatility, POCUS is well-suited for scalable adoption across a range of ED environments, including rural and resource-limited settings. Standardizing POCUS use and incorporating it into national quality metrics could further strengthen diagnostic pathways and optimize emergency care.

## LIMITATIONS

This study has several limitations. First, as a retrospective cohort study, it is subject to selection bias and unmeasured confounders. Despite statistical adjustments, residual confounding may still affect the results. Certain clinical details, such as specific symptoms, patient flow, and physicians' discretion in selecting POCUS or CT, were not documented. Second, this study was conducted at a single, tertiary medical center in Taiwan, which may limit its generalizability to other healthcare settings, particularly

**Table 4.** The association of cost and efficiency and point-of-care ultrasound in patients admitted for biliary tract disease after an unscheduled return visit.

| Outcome measures, point estimate (95% CI) | Admission after an unscheduled return vist without CT and POCUS, N = 57 | After IPTW: Admission after an unscheduled return visit visit with POCUS only, N = 51 | *P*-value |
|---|---|---|---|
| Initial ED LOS (hours) | Ref. | -1.42(-2.44 to -0.41) | .006 |
| 2nd ED LOS (hours) | Ref. | -1.08(-6.98 to 4.82) | .71 |
| Total LOS in ED (hours) | Ref. | -2.51(-8.31 to 3.29) | .39 |
| Initial ED costs (NT$) | Ref. | -3,270.7(-4,505.1 to -2,036.3) | < .001 |
| 2nd ED costs (NT$) | Ref. | 2,026.9(-3,058.7 to 7,112.7) | .43 |
| Admission costs (NT$) | Ref. | -1,370.1(-20,661.9 to 17,921.6) | .88 |
| Total costs (NT$) | Ref. | -4,675.4(-26,028.8 to 16,677.9) | .66 |
| Hospital LOS | Ref. | -0.07(-3.19 to 3.06) | .96 |

This table presents findings from the study evaluating the association of cost and efficiency and POCUS use during the index ED visit in patients who were later admitted for biliary tract disease following an unscheduled return visit. After IPTW adjustment, patients who received POCUS during the initial ED visit had significantly lower ED LOS and reduced initial ED costs compared with those who did not receive POCUS and computed tomography. Analyses were adjusted for age, sex, triage level, body mass index, and comorbidities. *ED,* emergency department; *ICU,* intensive care unit; *IPTW,* inverse probability of treatment weighting; *LOS,* length of stay; *OR,* odds ratio *NT$,* new Taiwan dollar; POCUS, point-of-care ultrasound; *Ref.,* reference.

non-Asian or resource-limited EDs with different POCUS training standards, protocols, resources, and patient demographics. The study population included patients with more severe comorbidities, and a higher proportion of those with malignancies underwent CT-only evaluation, potentially influencing imaging choices and outcomes.

Third, physician-related factors, such as variation in diagnostic interpretation and POCUS expertise, were not captured and may have influenced outcomes. As an operator-dependent tool, the effectiveness of POCUS is closely tied to clinician experience and training.[53] This study did not distinguish between POCUS performed by highly experienced physicians and that performed by less experienced users, potentially introducing variability. Additionally, the choice of diagnostic imaging could have been influenced by individual physicians' familiarity with POCUS or a prevailing preference for CT, which some clinicians consider more reliable for evaluating abdominal pain. Fourth, we did not assess the diagnostic accuracy of POCUS or the impact of training level on clinical decision-making. However, all POCUS examinations and discharge decisions by residents were supervised by attending physicians, which likely mitigated variability. Moreover, attending physicians retained full discretion to order confirmatory CT imaging when clinical uncertainty remained.

Fifth, we did not exclude patients with a known history of biliary tract disease, which may have influenced the decision to perform POCUS. For instance, in patients with prior interventions such as percutaneous transhepatic cholangial drainage or gallbladder drainage, clinicians may prefer laboratory testing or abdominal CT. In contrast, POCUS remains a viable first-line imaging modality in patients with a history of cholelithiasis or cholecystectomy. Including these patients reflects routine ED practice and enhances the generalizability of our findings on POCUS use in abdominal pain. Sixth, our definition of the index visit, no prior ED visit or hospitalization within 72 hours, aligns with standard definitions of unscheduled return visits in ED. While this short interval may allow for some confounding from recent encounters, it is widely used in studies focused on potentially avoidable, short-term revisits. A longer washout period (eg, 30-60 days) might reduce this risk but could also limit the generalizability of findings by excluding patients with unrelated prior care.[54,55]

Seventh, we analyzed only the first return visit within 72 hours for each patient during the study period. This approach ensures analytic consistency but may underrepresent patients with multiple revisits, who could signal a higher-risk subgroup. Nonetheless, the first return visit is generally more indicative of potentially preventable issues directly related to the initial ED evaluation. Subsequent revisits tend to reflect more complex or evolving conditions, less influenced by initial decision-making. Eighth, our dataset lacked detailed clinical variables such as lab results, imaging findings, and symptom severity scores, limiting our ability to fully explain revisit causes or isolate the causal effect of POCUS. To address this limitation, we applied propensity score weighting to balance baseline characteristics between groups, achieving standardized mean differences < 0.1.

Ninth, because our study focused on patients with biliary tract disease, inclusion of POCUS exams for non-biliary indications could introduce bias. However, in the ED setting, POCUS is typically used in a broad, question-driven manner without rigid protocols.[56] This reflects real-world diagnostic workflows and supports the generalizability of our findings.

Lastly, there was an imbalance in the number and severity of patients between groups, which may have introduced selection bias. This discrepancy reflects real-world practice, where emergency physicians often have individual preferences for using ultrasound or CT during evaluations. Implementing a randomized study design could help eliminate this bias and provide a more accurate assessment of the clinical efficacy of POCUS and CT.

## CONCLUSION

Our analysis revealed two key findings: First, patients admitted for biliary tract disease following an unscheduled return visit had lower resource utilization during their initial ED visit without apparent safety compromise. Second, implementing discharge decisions for undifferentiated non-traumatic abdominal pain guided by point-of-care ultrasound significantly reduced ED length of stay and costs without increasing adverse outcomes or total hospital costs, even among those later admitted for biliary tract disease. These results imply that current ED assessment strategies, enhanced by POCUS, can effectively risk-stratify patients, improving departmental efficiency and value.

Point-of-care ultrasound appears particularly useful for bolstering diagnostic confidence and expediting disposition decisions. However, widespread adoption requires targeted emergency physician training and robust guidelines. Prospective, multicenter studies are warranted to validate these findings across diverse emergency settings and patient populations and to further define the role of POCUS in optimizing care for patients with suspected biliary tract disease.

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# Biological Sex Is Associated with Pre-Tibial Subcutaneous Tissue Depth for Intraosseous Catheter Insertion

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**Introduction:** Intraosseous (IO) vascular access is commonly used when critically ill patients require rapid indirect venous access for the infusion of fluids and medications. The proximal tibia (PT) IO insertion site has been shown to be associated with the highest first-attempt placement success rates. However, inadequate catheter length continues to contribute to failure of IO line placement. In this study, we compared patient characteristics to the depth of soft tissue at the PT insertion site, to determine whether any specific patient subgroup may be at high risk for excessive pre-tibial soft tissue depth.

**Methods:** Patients were enrolled retrospectively from the medical records of adult (≥ 18 years old) subjects who had undergone computed tomography (CT) imaging of the lower extremity. We calculated the pre-tibial soft tissue depth according to a predefined method using CT images. Data were abstracted into a standardized data collection form prior to analysis. Variables including side, age, sex, body mass index (BMI) and comorbidities (i.e., hypertension, diabetes mellitus, atherosclerosis, coronary artery disease, osteoarthritis) were collected and analyzed.

**Results:** A total of 368 patients were included in the final data analysis. Increased BMI, height and weight had a statistically significant increase in pre-tibial soft tissue depth. Analyzing patients within groups based on this tissue depth (>40 mm, 20-40 mm, <20 mm) showed that height was the only quantitative variable to have a significant association with pre-tibial soft tissue depth measurements between the >40 mm and 20-40 mm groups with a negative correlation. While female sex was associated with a statistically significant increase in pre-tibial soft tissue depth, no such effect was seen with any of the recorded comorbidities.

**Conclusions:** Female sex, short height, and high weight / BMI appear to be correlated with increased soft tissue thickness at the proximal tibial intraosseous insertion site. Longer catheter sizes may be required for proximal tibial intraosseous cannulation in obese patients, and for female patients when compared to male patients with the same BMI. [West J Emerg Med. 2025;26(6)1575–1580.]

## INTRODUCTION

Intraosseous (IO) indirect venous access is a common alternative to peripheral intravenous access for a variety of life-threatening conditions, and is endorsed by the Advanced Trauma Life Support, Advanced Cardiac Life Support and Pediatric Advanced Life Support guidelines.[1] These

devices can be placed by a wide variety of emergency care personnel, including physicians, nurses and paramedics.[2] Many different insertion sites are available for IO catheter insertion, including the proximal tibia (PT) and the proximal humerus . The proximal humerus gives another option for rapid, effective vascular access, especially in patients where peripheral intravenous access or central venous catheter access is difficult to obtain.[3]

The proximal humerus is closer to the central circulation, leading to belief that higher flow rates can be achieved at this site. However, the proximal humerus has not consistently demonstrated a statistically significant difference in flow rates in humans[4] and has the additional disadvantage of being close in proximity to other resuscitative procedures during cardiopulmonary resuscitation. Some studies have demonstrated comparable success rates between the proximal humerus and the PT[4], while others have demonstrated higher first-attempt placement success rates at the PT.[5] Additionally, the most common site reported in the medical literature is the PT.[5] While the PT site has been associated with shorter mean placement times than either the proximal humerus intraosseous insertion site or peripheral intravenous access among critically ill patients, this may relate to increased provider familiarity with the traditional PT site.[5]

Despite the advantages of the PT IO insertion site, complications including line placement failure are still seen. One common cause of failed intraosseous catheter placement is catheter dislodgement, often due to excessive depth of overlying soft tissue depth resulting in inadequate advancement of the catheter.[6] Catheter dislodgement can lead to extravasation of fluids and medication, potentially increasing the risk of compartment syndrome and necrosis of the surrounding soft tissues.[3,6] One landmark study focused upon the proximal humerus site found that 40% (i.e., 10/25 subjects) of 25-mm intraosseous catheters became dislodged before the patient left the resuscitation bay, compared to 20% (i.e., 1/5 subjects) with a 68-mm length catheter.[3] Although the frequency of IO catheter displacement at the PT site is not well-studied, it is estimated to occur in 7.8% (5/64) of cases when the 25-mm catheter is used.[5] Thus, proper catheter sizing may improve the safety of IO line placement and use, as well as saving time and effort by providers and avoiding catheter waste at all sites.

Both the EZ-IO (Teleflex, Inc, Wayne, PA) and SAM IO (SAM Medical Inc, Tualatin, OR) device systems provide catheters in 15-, 25- and 45-mm sizes. Current manufacturer recommendations suggest the use of 15-mm catheters for patients between 3 and 39 kg, with consideration of the 25-mm device for patients 3 kg and above and use of the 45-mm catheter at the proximal humerus or when excessive soft tissue is present overlying any site.[7] Understandably, these recommendations can lead to ambiguity when selecting a catheter size for individual patients and contributes to the potential risk of selecting an inappropriately sized catheter.

*Population Health Research Capsule*

What do we already know about this issue?
*A serious complication of failed intraosseous access is dislodgment, which increases the risk of compartment syndrome and localized tissue necrosis.*

What was the research question?
*Are any demographics associated with pre-tibial subcutaneous tissue depth?*

What was the major finding of the study?
*Higher Body mass index, shorter stature, and female sex were associated with statistically greater pre-tibial subcutaneous tissue depth (P-value < .001).*

How does this improve population health?
*Our study raises awareness of factors that affect pre-tibial subcutaneous tissue depth and identifies a potential avenue to improve catheter sizing for patients.*

While it has been suggested that obesity may contribute to greater soft tissue depth at the PT IO insertion site, no data are available to describe the effect of obesity on pre-tibial soft tissue depth. These data are needed to avoid attempted insertion of the wrong IO catheter length, which can lead to wasted devices, failed IO insertion attempts (thereby ruining a site for additional attempts), and device failure due to dislodgement with associated extravasation. Our aim in this study was to determine whether certain demographic factors, including sex and body mass index (BMI) as reported in the electronic medical record (EMR) were associated with a patient's pre-tibial soft tissue depth.

## METHODS

Data were abstracted from the EMR by trained abstractors (research assistants within the department of emergency medicine) according to the methods outlined by Worster et al[8] into a standardized data collection form prior to analysis. We included all subjects for whom all the necessary data points could be obtained from the EMR. Abstractors were blinded to the study hypothesis and were monitored by the principal investigator (JHP), who reproduced all imaging measurements and EMR data collection for a random sample of 20% (75) of charts and compared measured depth of soft tissue between the senior author and abstractor and found 100% interrater reliability (IRR) with the abstracted data with an accuracy of 1-mm. No data were imputed, as subjects with inadequate data were excluded from the study.

Retrospective chart review was performed for adult patients (i.e., ≥ 18 years old) who received computed tomography (CT) imaging of the lower extremity at one of four different hospitals within a major healthcare system, including levels 1 and 2 trauma centers, in Detroit, MI over the five-year period from January 1, 2012 to December 31 2016. Approval was provided through an expedited review by the Wayne State University Institutional Review Board. Patients were excluded if there was documented traumatic injury at the site of insertion, or if anthropomorphic data were incomplete (i.e., age, sex, weight, and height). For purposes of this study, the pre-tibial soft tissue depth was defined as the distance from the skin surface to the anterior surface of the proximal tibia at the recommended IO insertion site (2-cm inferior and 1–2-cm medial to the tibial tuberosity (TT) along the flat aspect of the bone), as recorded in millimeters.

To determine the CT slice to be reviewed for data extraction, we identified where the tibial tuberosity appeared to be most prominent, which we felt would likely correlate to the portion the clinician would palpate for identification when determining the IO insertion site. After determining this, we made the measurements at the axial slice 2-cm inferior to the most superficial TT slice. The CT images were reviewed by trained abstractors utilizing a standardized protocol including a priori methods for depth measurement. Images were viewed utilizing our institution's Change Healthcare Stratus Imaging Picture Archiving and Communication System (Change Healthcare, Nashville, Tennessee). Figure 1 displays a radiographic representation of how pre-tibial soft tissue depth was calculated from images.

Patient characteristics analyzed in reference to pre-tibial soft tissue depth include side, age, sex, height, weight, BMI defined in kg/m$^2$, hypertension, diabetes, atherosclerosis, coronary artery disease, and osteoarthritis. Quantitative data were separated into groups based on measured pre-tibial soft tissue depth (i.e., < 20 mm, 20-40 mm, > 40 mm) and compared using ANOVA between all three groups and a two-sample t-test assuming unequal variances between each group. Qualitative data were grouped by pre-tibial soft tissue depth (< 20 mm, 20-40 mm, > 40 mm) and compared using a chi-squared test. All p-values were compared to an alpha of 0.05. We presented data using standard techniques, including mean values.

## RESULTS

We collected data for a total of 373 patients, although five were excluded due to lack of BMI data, leaving 368 patients for the final data analysis. Of the patients included in the analysis, 54.6% of CT imaging was of the left lower extremity and 51.4% of patients were male. The mean age was 59.8 years, mean BMI was 31.2 kg/m$^2$, mean height was 170.5 cm, and mean weight was 91.3 kg. Regarding comorbidities, 52.7% of patients had hypertension, 23.6% had diabetes mellitus, 11.1% had atherosclerosis, 11.7% had coronary artery disease and 67.9% had osteoarthritis.

We identified 158 males and 76 females in the < 20 mm group and within this group 40 males and 10 females were found to have a pre-tibial soft tissue depth < 10 mm. We identified 30 males and 96 females in the 20-40 mm group, and seven females and one male in the > 40 mm pre-tibial soft tissue depth group. As Table 1 demonstrates, the only quantitative variable that did not demonstrate a statistically significant effect on pre-tibial soft tissue depth was age.

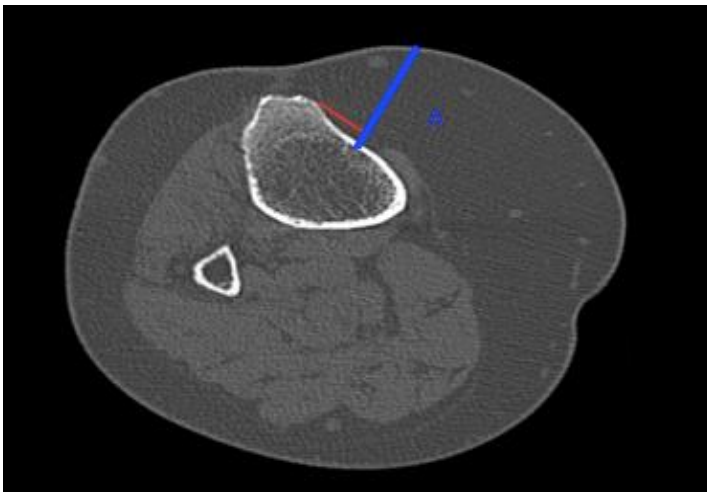

**Figure 1.** Radiographic representation of the pre-tibial soft tissue depth. The blue line represents tissue depth (i.e., perpendicular distance from the appropriate intraosseous insertion site to the skin surface, at a right-angle from the plane of the bone surface). The red line represents a line parallel to the surface of the tibia.

**Table 1.** Quantitative variables mean values by pre-tibial soft tissue depth group and single factor ANOVA *P*-values.

| Variable | Pre-tibial soft tissue depth Group | Means | P-value (ANOVA) |
|---|---|---|---|
| Age | < 20 mm | 59.4 | .71 |
| | 20-40 mm | 60.6 | |
| | > 40 mm | 58.0 | |
| BMI | < 20 mm | 28.7 | < .001* |
| | 20-40 mm | 35.1 | |
| | > 40 mm | 43.6 | |
| Height | < 20 mm | 172.4 | < .001* |
| | 20-40 mm | 167.6 | |
| | > 40 mm | 161.9 | |
| Weight | < 20 mm | 86.1 | < .001* |
| | 20-40 mm | 99.5 | |
| | > 40 mm | 112.6 | |

*Indicates statistical significance.
*BMI,* body mass index.

**Table 2.** Quantitative variables *t*-test *P*-values between three pre-tibial soft tissue depth groups.

| Variable | Groups | P-value |
|---|---|---|
| Age | < 20 mm, 20-40 mm | .43 |
| Age | 20-40 mm, > 40 mm | .65 |
| Age | < 20 mm, > 40 mm | .80 |
| BMI | < 20 mm, 20-40 mm | < .001* |
| BMI | 20-40 mm, > 40 mm | .09 |
| BMI | < 20 mm, > 40 mm | .01* |
| Height | < 20 mm, 20-40 mm | < .001* |
| Height | 20-40 mm, > 40 mm | .002* |
| Height | < 20 mm, > 40 mm | .04* |
| Weight | < 20 mm, 20-40 mm | < .001* |
| Weight | 20-40 mm, > 40 mm | .19 |
| Weight | < 20 mm, > 40 mm | .02* |

*Indicates statistical significance.
*BMI,* body mass index.

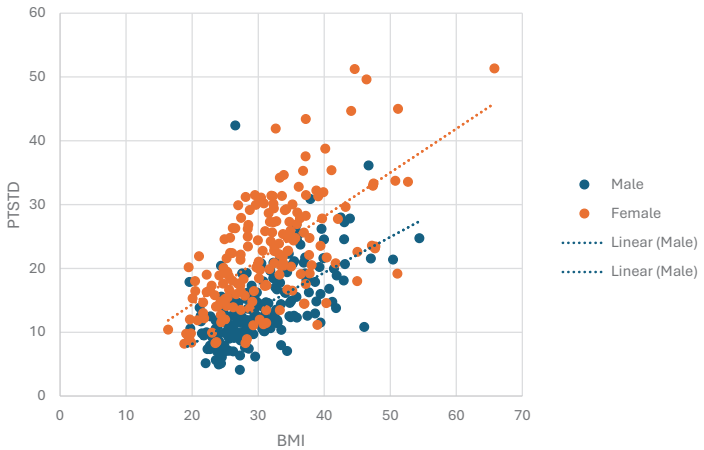


**Figure 2.** Pre-tibial subcutaneous tissue depth vs body mass index. Patients were analyzed separately based on reported sex with lines of best fit. Equations for the lines of best fit are Males: y = 0.5587x - 3.0166; Females: y = 0.6883x + 0.6004. Correlation coefficients for lines of best fit are Males: 0.3666; Females: 0.3899.
*PTSTD,* pre-tibial soft tissue depth; *BMI,* body mass index

As displayed in Table 2, age had no statistically significant effect between any of the 3 pre-tibial soft tissue depth groups. Between BMI, height and weight, only height had a statistically significant effect between the >40 mm and 20-40 mm groups.

As shown in Table 3, the only qualitative variable to have a statistically significant effect on pre-tibial soft tissue depth was sex.

A plot of pre-tibial soft tissue depth versus BMI according to sex with corresponding line of best-fit (Figure 2), demonstrates that females had higher average pre-tibial soft tissue depth within this study population.

Using equations derived from the linear regression model shown in Figure 2, calculated pre-tibial soft tissue depth values according to sex for the BMI range of 20-40 are provided in Table 4.

## DISCUSSION

To our knowledge, this is the first study that has attempted to identify factors associated with the depth of soft tissue overlying the PT IO insertion site according to demographic data for an adult population. One similar study evaluating chest wall depth needed for needle decompression in obese patients found that 51-mm (i.e., standard needle length for peripheral intravenous access) was inadequate in 35% of cases.[9] However, this study did not evaluate patient demographics potentially contributing to increased chest wall depth (PT depths may likely differ from variability observed at the chest wall.[9]) The PT is the most common IO catheter insertion site described in the medical literature[5], and that site provides a flat area of bone with a relatively thin layer of soft tissue that is often readily identifiable on external examination.

**Table 3.** Qualitative variables obtained from a chi-squared test.

| Variable | Cramer V Effect Size | P-value |
|---|---|---|
| Side | .08 | .31 |
| Sex | .43 | < .001* |
| Hypertension | .07 | .39 |
| Diabetes | .05 | .59 |
| Atherosclerosis | .08 | .30 |
| Coronary artery disease | .08 | .34 |
| Osteoarthritis | .028 | .87 |

*Indicates statistical significance.

At least one study has reported that IO catheter placement at the PT is associated with a greater first-attempt placement success rate and lower rate of catheter dislodgment when compared to the proximal humerus site.[10] However, catheter dislodgment (with or without subsequent fluid extravasation) is the most common complication reported in the literature, with rates ranging from 1-22%.[6] Improper catheter sizing—both too long and too short—has been cited as a cause of extravasation, underscoring the need for a method of predicting soft tissue depth in advance of skin puncture.[6] Once the skin and soft tissue have been punctured and pre-tibial soft tissue depth has been found to be excessive, the catheter is no longer sterile and must be discarded. If the realization of excessive pre-tibial soft tissue depth is found after bone puncture has been performed, the catheter should not be used, and the site is no longer available for further attempts due to the risk of extravasation through the initial bone puncture. Extravasation can lead to fluid accumulation, which can lead to serious complications including tissue necrosis and compartment syndrome.[6] For this reason, it is critical that

providers use appropriate IO catheter sizes at all candidate sites.

The longest IO catheter currently available for emergent vascular access from any manufacturer is 45-mm. Manufacturer recommendations suggest that at least 5-mm of the catheter should remain visible above the skin after skin puncture, but before bone puncture, to ensure that the catheter will be able to penetrate through the full thickness of the bony cortex and be positioned at least a few millimeters inside of the medullary space. This is believed to reduce the risk of extravasation or dislodgement. Thus, the required length of catheter at the PT site should be at least 5-mm greater than the pre-tibial soft tissue depth. In other words, a 45-mm catheter should not be used for pre-tibial soft tissue depths greater than 40-mm. This was our rationale for considering the >40-mm subgroup to be at high risk of extravasation and deserving of special attention. Similarly, a 25-mm catheter should not be used for subjects with pre-tibial soft tissue depth > 20-mm; patients in the 20-40 mm subgroup would require a 45-mm catheter, but there is no existing evidence that such precautions are taken in routine clinical practice.

Among the participants in our study, two hundred and thirty-four (63.6%) had measured pre-tibial soft tissue depth < 20 mm meaning that the 25-mm catheter would be of adequate length for IO fluid and medication administration. One hundred and twenty-six (34.2%) had measured pre-tibial soft tissue depth between 20 and 40 mm meaning that the 45-mm catheter would be the appropriate length for this group. We found that eight (2.2%) of the 368 subjects had measured pre-tibial soft tissue depth > 40-mm, suggesting that the 45-mm catheter would not be adequate to safely infuse IO medications or fluids at this site. As IO catheters > 45-mm in length are currently not available for vascular access, this may represent a significant safety issue for these patients according to current manufacturer recommendations.

In this study, we did not include a group for pre-tibial soft tissue depth < 10 mm a priori as the current manufacturer recommendations essentially limit use of that catheter size to pediatric patients (i.e., patients < 40 kg in weight), and only adult patients were included in our study. However, we found that 50 patients (13.6%) had a pre-tibial soft tissue depth < 10-mm, which would make the 15-mm catheter an appropriate choice. We decided not to adjust our statistical analyses to include this group separately after the data were analyzed as none of these patients weighed < 40 kg; therefore, re-analysis would not lead to a change in clinical decision-making if current manufacturer recommendations were to be followed.

In Figure 2 and Table 4, BMI was used in the linear regression model for calculating pre-tibial soft tissue depth as it seemed intuitive that higher BMI would be associated with more subcutaneous tissue. Additionally, BMI was used instead of height or weight because BMI incorporates both values and therefore may be more strongly associated with whole-body habitus than either value when considered alone.

**Table 4.** Calculated male and female pre-tibial soft tissue depth from the linear regression model in Figure 2 based upon BMI values.

| BMI Range | Mean Male Associated PTSTD | Mean Female Associated PTSTD |
|---|---|---|
| 20-24 | 9.275 | 15.743 |
| 25-29 | 12.068 | 19.185 |
| 30-34 | 14.862 | 22.626 |
| 35-39 | 17.655 | 26.068 |
| 40-44 | 20.449 | 29.509 |
| 45-49 | 23.242 | 32.951 |

*BMI,* body mass index*; PTSTD,* pre-tibial soft tissue depth.

When analyzing sex differences in pre-tibial soft tissue depth with the Cramer V effect size, we found a significant difference in the mean values between men and women as shown in Table 3. This value ranges from 0-1, with 0 meaning no association and 1 meaning a perfect association. While not a perfect association, the effect size of sex is drastically larger than any other qualitative variable and the p value of less than 0.001 shows a statistically significant effect. While current manufacturer recommendations are based on weight, these results indicate that the best predictive model should incorporate sex into these sizing recommendations. Figure 2 shows that, on average, women had a higher pre-tibial soft tissue depth than men. This may be in part due to differences in fat distribution between sexes. It has been previously shown by other groups that females have a statistically significant higher amount of extremity fat, with an adjusted ratio of 1.53.[11]

Factors associated with pre-tibial soft tissue depth, based upon the relationship between BMI and sex reflected in Figure 2, was found to be significantly higher in female subjects. The correlation coefficients of the male and female linear regression models reflect a similar degree of variability within pre-tibial soft tissue depth of both sexes. A larger sample size is needed to potentially reduce variability within both males and females and determine if this model is accurate enough to incorporate sex into official sizing recommendations. The data from Table 4 suggest that a standard 25-mm IO catheter would be long enough for safe use in an average 40 kg/m$^2$ male in our study population but not long enough for use in a female with a BMI above 30 kg/m$^2$.

The data from Table 4 also illustrate our finding that sex may have proportionally less effect on the difference in pre-tibial soft tissue depth between males and females as BMI increases. For example, females in our study group had a 70% higher factors associated with pre-tibial soft tissue depth than males in 20-24 kg/m$^2$ range but only a 42% higher factors associated with pre-tibial soft tissue depth in 45-49 kg/m$^2$ range. As shown in Table 2, height was the only quantitative

variable that was found to have a statistically significant effect on pre-tibial soft tissue depth between the middle and highest pre-tibial soft tissue depth groups of patients. While subgroup analysis shown in Table 2 demonstrated that weight and BMI did not appear to have a statistically significant effect on pre-tibial soft tissue depth, these two variables did appear to have a significant effect on pre-tibial soft tissue depth when considering the entire study population (Table 1).

Limitations of the study include a small number of patients, including only eight patients in the > 40 mm pre-tibial soft tissue depth category, which limits the generalizability of our results. Further studies with larger sample sizes are needed to create a decision tree for providers to select the most appropriate IO size for an individual patient while taking into account the variables included in our study. As our study was retrospective in nature, these findings may be limited by the accuracy of data obtained from the EMR. We were also potentially limited by technique, as our method of measuring pre-tibial soft tissue depth has not been previously validated.

We did not assess cortical thickness for individual patients in this study, which may vary as well. It is currently unknown how far into the medullary cavity an IO catheter should extend to avoid extravasation, although we have found anecdotally that the bony cortex generally measures 2-3 mm at the PT IO site, suggesting that we may be underestimating the required catheter length at the PT IO site if the goal of insertion is to achieve placement of the catheter tip near the center of the medullary space. Future studies should consider both soft tissue depth and cortical thickness to determine optimal tip placement, ideally combined with clinical complications data to assess how far the tip should be inserted into the medullary space to avoid dislodgement and/or fluid extravasation. In the absence of clear data, we suggest that clinicians consider the manufacturer recommendation of a visible 5-mm mark above the skin before bone puncture is performed to be a minimum requirement. In fact, it may be prudent to consider utilizing the 10-mm mark in adult subjects as this may permit a more central position of the catheter tip without significant risk of penetrating the opposite bony cortex.

## CONCLUSIONS

Female sex and higher BMI appear to be associated with increased pre-tibial soft tissue depth in this patient population. Although the 25- and 45-mm IO catheters currently available for clinical use may be adequate for the majority of patients, longer catheters are clearly needed for certain obese patients, especially females. Further studies are needed with larger cohorts to better characterize how pre-tibial soft tissue depth can be associated with identifying factors in adult patients and to determine the optimal proximal tibia intraosseous catheter insertion depth for diverse subjects.

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*Conflicts of Interest*: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. No author has professional or financial relationships with any companies that are relevant to this study. There are no conflicts of interest or sources of funding to declare.

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# Demographic and Clinical Characteristics of Pediculosis-associated Severe Anemia in the Emergency Department

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**Introduction:** Infestation with Pediculus species, or common lice, is frequently diagnosed in the emergency department (ED). Because lice ingest human blood, prolonged and heavy infestation can plausibly lead to iron deficiency anemia. Severe anemia attributable to lice infestation has infrequently been reported to date. Our objective in this study was to retrospectively review cases of lice-related anemia at a single public hospital to identify risk factors and associated demographic and clinical features of this disease process.

**Methods:** We screened the medical records for patients presenting to the ED of an urban public hospital between 2016–2024 for the diagnoses of lice infestation and severe anemia (hemoglobin < 7 grams per deciliter (g/dL). Cases were reviewed for clinical and demographic characteristics.

**Results:** A total of 932 patients were diagnosed with pediculosis infestation in the ED during the study period; 332 (35.6%) of those patients had a complete blood count obtained by the treating team. Thirty-seven cases of severe anemia were identified (3.9% of total pediculosis cases, 11.1% of those for whom a complete blood count was obtained); 84% were microcytic, indicating iron deficiency anemia. Twenty-five patients (68%) were undomiciled, and nine patients (24%) were shelter domiciled. Twenty-three patients (62%) had comorbid psychiatric diagnoses, and 21 (51%) had substance use disorders. The median hemoglobin was 4.4 g/dL (range 2.4-6.9 g/dL). Thirty patients (81%) were admitted to a medical floor and seven patients (19%) to an intensive care unit, each with a comorbid primary condition.

**Conclusion:** In this cohort, anemia secondary to lice infestation was seen in patients with unstable housing, substance use disorders, and psychiatric disease. Most patients were hemodynamically stable, consistent with the proposed mechanism of chronic blood loss. The prevalence of this condition may be higher than previously noted among this vulnerable population. Emergency physicians should be aware of this rare but potentially serious disease process. [West J Emerg Med. 2025;26(6)1581–1589.]

## INTRODUCTION

*Pediculus humanus capitis* is a parasitic arthropod that lives on the human scalp and feeds on the host's blood.[1] It is closely related to *P humanus corporis,* or body lice, which lives on fomites and moves to the body for meals.[1] Typically, lice infestation causes pruritus as a result of a localized allergic reaction to the insect's saliva. Although most cases are mild and can be managed via anti-parasitic medications,

systemic illness such as trench fever (*Bartonella quintana*), relapsing fever (*Borelia recurrentis*), and epidemic typhus (*Rickettsia prowazekii)* can ensue.[1]

Lice consume human blood for nutrition, with a typical meal being 0.008 mL per louse.[2] In cases of mild infestation with dozens of lice, this typically represents a clinically insignificant volume of blood loss of 0.7-2.3 mL per day. There are, however, reports in the literature of chronic anemia attributed to severe, longer term lice infestation with prolonged blood loss. There are multiple case reports and a single case series of five adult patients with anemia attributed to severe lice infestation.[3-8] Moreover, several pediatric cases of anemia caused by severe lice infestation in the context of neglect have been reported.[9-12] The veterinary literature has also established severe species-specific lice infestation as a cause of anemia in large mammals (cattle) and spider monkeys.[13-18]

While a causal link has not been established, social determinants of health (ie, limited access to food; neglect; unstable housing) and associated psychiatric pathology that limit the ability to care for oneself are frequently present in published cases of severe anemia associated with lice infestation. The association between housing status, psychiatric disease, and lice infestation has been previously demonstrated.[19] To date, no large population-based studies have been performed to further quantify the prevalence of severe lice infestation and associated risk factors for concomitant anemia or to describe the clinical characteristics of patients presenting with pediculosis-associated anemia.

*Population Health Research Capsule*

What do we already know about this issue?
*Lice infestation is common in vulnerable populations and has been reported in rare cases to cause iron deficiency anemia.*

What was the research question?
*What are the prevalence, clinical, and demographic features of lice-related severe anemia in emergency department patients?*

What was the major finding of the study?
*3.9% of lice-infested patients had severe anemia requiring hospitalization (37 cases); 84% were microcytic. The median hemoglobin was 4.4 g/dL.*

How does this improve population health?
*Lice-associated severe anemia requiring hospitalization may be more common than previously reported, especially in vulnerable patient populations.*

## METHODS

### Study Setting and Population

This was a retrospective study of patients presenting to the emergency department (ED) at a single, urban, public ED between January 1, 2016–January 1, 2024. The ED sees an annual volume of about 110,000 patients per year and is staffed primarily by residents and attending physicians who are board-certified in emergency medicine. A large proportion of patients come from a medically underserved population including a significant unhoused population. The study was approved by the institutional review board of the affiliated school of medicine.

### Study Design and Data Analysis

We performed a retrospective, observational study of adult patients presenting with both lice infestation and anemia severe enough to warrant admission and blood transfusion. Inclusion criteria were the clinical diagnosis of lice infestation, made by direct visual identification of characteristic organisms on the patient by the treating emergency physician, and severe anemia requiring transfusion and admission—defined as a hemoglobin < 7 grams per deciliter (g/dL) during the ED encounter. We queried electronic health record (EHR) data from the Epic Clarity database (Epic Systems Corporation, Verona, WI) using Oracle SQL Developer (Oracle Corporation, Nashville, TN), and we then reviewed candidate charts to ensure they met the above inclusion criteria. We excluded patients < 18 years of age.

Charts were reviewed manually to extract patient demographic data including age, sex, race, housing status, past medical history, comorbid psychiatric pathology, history of gastrointestinal (GI) bleeding, anticoagulation history, substance use disorders, and medications, as well as clinical characteristics including presenting vital signs, chief complaint on arrival to the ED, number of units of red blood cells transfused, disposition level of care from the ED, length of inpatient stay, gastroenterology consultation (if obtained), and discharge destination from inpatient stay. We also extracted relevant initial laboratory values including hemoglobin, hematocrit, mean corpuscular volume, platelets, total iron, total iron-binding capacity, ferritin, folate level, B12 level, lactate dehydrogenase, albumin, international normalized ratio, partial thromboplastin time, and bicarbonate. Charts were reviewed by four emergency physicians; elements of optimal chart review were followed, including the following: Abstractors were trained prior to review; we defined case selection criteria and variables of interest; a data abstraction form was used; and missing data elements (ie, if a lab was not obtained) were recorded. For practical reasons, abstractors were not blinded to the study hypothesis. Inter-

rater reliability was not formally calculated, but charts were re-reviewed by a senior author to assure accuracy.[20]

We calculated descriptive statistics to analyze the dataset using Microsoft Excel (Microsoft Corporation, Redmond, WA). Median hemoglobin values for patients admitted to the floor vs intensive care unit were compared using a Mann-Whitney U test. Using the Kruskal-Wallis test, we compared median length of stay (LOS) for patients who left the hospital against medical advice, were discharged from the medicine service, or were transferred to inpatient psychiatry. *P*-values < .05 were considered statistically significant. We followed Strengthening the Reporting of Observational Studies in Epidemiology guidelines for this retrospective study.[21]

## RESULTS

A total of 932 patients were diagnosed with pediculosis infestation in the ED during the study period; of those, 332 had a complete blood count ordered for any reason by the treating team. A total of 37 cases met the study inclusion criteria during the study period. Thirty patients (81%) were male, and seven (19%) were female. The average age was 54.7 years of age (range 26-71). Twenty-five patients (68%) were undomiciled, and nine patients (24%) were shelter domiciled. Twenty-three patients (62%) had comorbid psychiatric diagnoses, and 21 patients (57%) had concurrent substance use disorders. Two patients (5%) had a prior documented history of GI bleeding, and no patients were on any form of anticoagulation. The full demographic data for the studied patients are detailed in Table 1.

**Table 1.** Demographic characteristics of patients diagnosed with pediculosis-associated severe anemia (n = 37).

| Yearly Mean Age (Range) | 54.7 (26 - 71) |
|---|---|
| Sex (%) | |
| Male | 30 (81%) |
| Female | 7 (19%) |
| Race (%) | |
| White | 11 (30%) |
| Black | 18 (49%) |
| Hispanic | 7 (19%) |
| Asian | 1 (2%) |
| Housing Status (%) | |
| Undomiciled | 25 (68%) |
| Shelter domiciled | 9 (24%) |
| Domiciled | 3 (8%) |
| Psychiatric Disease (%) | |
| Schizophrenia | 16 (43%) |
| Bipolar | 2 (5%) |
| Personality disorder | 5 (14%) |
| None | 14 (38%) |
| Substance Use Disorder (%) | |
| Yes | 21 (57%) |
| No | 16 (43%) |
| History of Gastrointestinal Bleeding (%) | |
| Yes | 2 (5%) |
| No | 35 (95%) |
| History of Chronic Kidney Disease (%) | |
| Yes | 1 (3%) |
| No | 36 (97%) |
| Anticoagulation | |
| Yes | 0 (0%) |
| No | 37 (100%) |

The mean hemoglobin was 4.79 g/dL (range 2.4-6.9 g/dL). The average mean corpuscular volume (MCV) was 73.55 fluid ounces (fL). Only one patient had an MCV > 100 fL (102 fL); 31 patients (84%) were diagnosed with microcytic anemia, defined as an MCV < 80 fL, and five patients (14%) were normocytic, defined as a MCV between 80-100 fL. Figure 1 visually delineates the severity of anemia across the full patient cohort.

The mean systolic and diastolic blood pressures on presentation were 121 and 67 millimeters of mercury (mm Hg), respectively. Eight patients (22%) were hypertensive with a systolic pressure > 135 mm Hg. Three patients (8%) were hypotensive with a systolic pressure < 90 mm Hg. The remaining 26 patients (70%) were normotensive. The presenting mean heart rate was 92 beats per minute (bpm). Thirteen patients (35%) had a heart rate > 100 bpm, two patients (5%) were bradycardic to 53 and 55 bpm, and 24 patients (65%) had a normal heart rate between 60-100 bpm.

Seven patients (19%) were admitted to the intensive care unit (ICU) from the ED; the remainder of the patients were admitted to a regular floor bed. Of the seven patients admitted to the ICU, six had a comorbid, primary indication for ICU level of care: four for sepsis/septic shock; and two for environmental hypothermia. The final patient was admitted to the ICU briefly for hypotension; after blood transfusion, his blood pressure improved, and he was transferred back to a regular bed within 24 hours. The median hemoglobin for floor admissions was 5 g/dL, and the median hemoglobin for ICU admissions was 3.8 g/dL. This difference was not significant (*P* = .23). Figure 2 shows the distribution of hemoglobin levels by floor- vs ICU-admitted patients.

Gastroenterology consultation was obtained during inpatient hospitalization in 11 patients (30%) to evaluate for the possibility of GI bleeding. Although endoscopy was recommended in seven of these patients, five refused, and only two underwent luminal endoscopy, each without finding evidence of acute GI bleeding. The remaining 26 patients (70%) did not receive GI consultation due to a lack of clinical

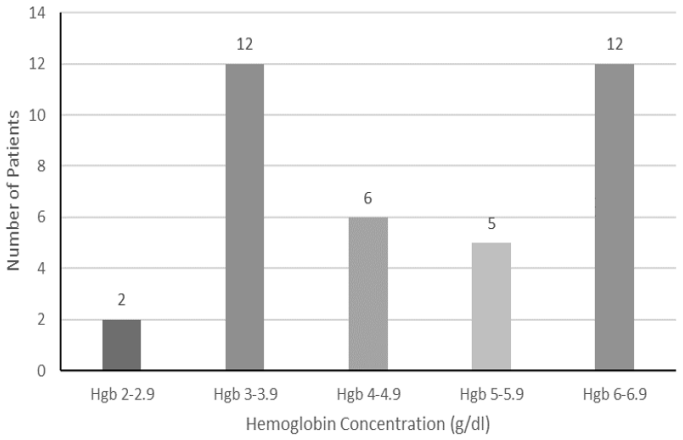


**Figure 1.** Distribution of hemoglobin concentration in patients with pediculosis-associated severe anemia.
*g/dL*, grams per deciliter; *Hgb*, hemoglobin.

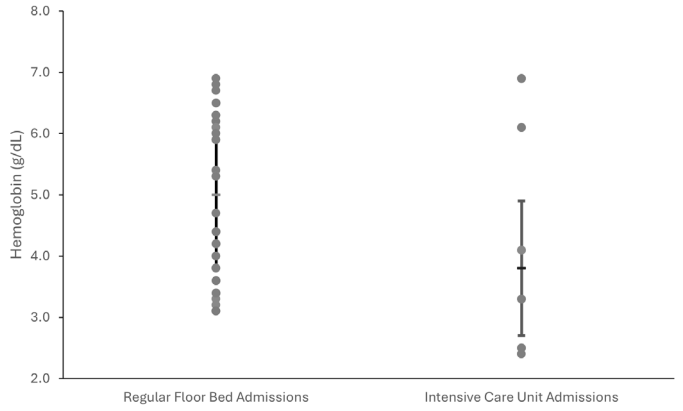


**Figure 2.** Scatter dot plot of hemoglobin values for patients admitted to the hospital for pediculosis-associated anemia to regular floor beds compared to intensive care unit beds, with median and interquartile ranges displayed via error bars. The difference in median hemoglobin between the two groups was not significant (P = .23).

concern for acute GI bleeding. No patients in the cohort had any overt clinical signs of GI bleeding, such as bright red blood per rectum, melena, or hematemesis during their hospitalization.

Thirteen patients (35%) left the hospital against medical advice, with a median LOS of six days. Fifteen patients (41%) were medically cleared for discharge, with a median LOS of 13 days. Nine patients (24%) were transferred to an inpatient psychiatry floor at the end of their medical hospitalizations, with a median LOS on the medicine service of 19 days. There was a statistically significant difference between each group ($P < .01$). Figure 3 illustrates the disposition and average LOS on the medical service for each of these groups. Notably, no patients died during their hospital course.

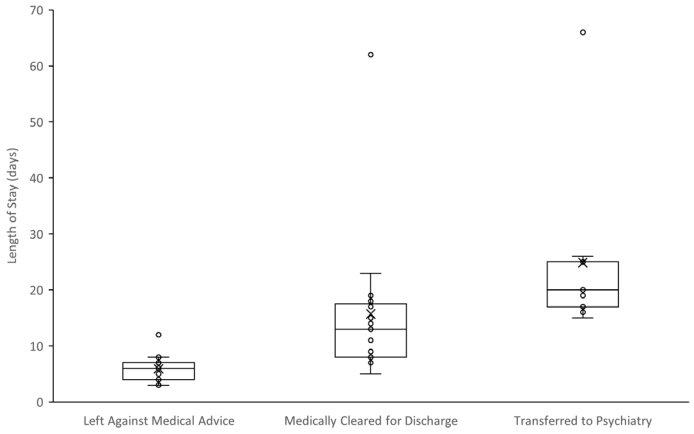


**Figure 3.** Median and box-and-whisker plot of hospital length of stay on medical service for patients admitted with pediculosis-associated severe anemia, by hospital disposition.

Additional patient specific clinical data are presented in Table 2.

## DISCUSSION

While anemia can often be multifactorial in nature, several aspects of this study group should be highlighted that point to pediculosis as a primary contributor to blood loss and resulting anemia. No clear alternate cause for anemia was found in any patient. No patients had any overt signs of GI bleeding, and the patients who did receive endoscopies had no evidence of bleeding. Only one patient had a history of chronic kidney disease, another common etiology of chronic anemia; however, it was not end stage, when severe anemia is typically seen. While chronic alcohol use disorder was common, it is typically associated with a macrocytic anemia, which was observed in only one patient in the study population (patient 3). Two female patients were premenopausal and theoretically could have had anemia due to menorrhagia, but no history of such was documented. Malnutrition may be a contributing factor to anemia and is frequently comorbid with homelessness, but it is unlikely to explain the degree of anemia observed in this cohort.[22,23]

Length of stay varied widely between patients who left the hospital against medical advice, those who were discharged to the community, and those transferred to an inpatient psychiatric unit at the end of their medical hospitalization. Patients requiring inpatient psychiatric hospitalization had significantly longer LOS than the other two groups, but all patient groups had substantial LOS in hospital. The psychiatric and social comorbidities we found associated with this disease process are likely significant contributors to the prolonged LOS observed in the cohort. The presence of significant psychiatric disease has previously been associated with longer LOS for somatic disease than similarly ill patients without comorbid psychiatric disease.[24] These results suggest the value

**Table 2.** Case-specific demographic and clinical characteristics of patients with pediculosis-associated severe anemia.

| Patient | Age (years) | Sex | Ethnicity | Housing Status | Psychiatric Diagnoses | Comorbid Medical Diagnoses | Substance Use Disorder |
|---|---|---|---|---|---|---|---|
| 1 | 62 | M | White | Undomiciled | Schizophrenia | monocular blindness | N |
| 2 | 65 | M | Black | Shelter Domiciled | None | hypertension, asthma, dementia | N |
| 3 | 64 | F | White | Domiciled | Schizophrenia | breast cancer, chronic kidney disease, hyperlipidemia, stroke | N |
| 4 | 33 | M | Black | Undomiciled | Schizophrenia | none | Y |
| 5 | 71 | M | Black | Domiciled | Personality Disorder | dementia | N |
| 6 | 62 | M | Hispanic | Shelter Domiciled | Personality Disorder | diabetes mellitus, stroke | N |
| 7 | 61 | F | White | Undomiciled | None | none | N |
| 8 | 62 | F | White | Undomiciled | Schizophrenia | hyperlipidemia | N |
| 9 | 68 | M | White | Undomiciled | None | none | Y |
| 10 | 50 | M | Black | Undomiciled | Schizophrenia | hypertension, coronary artery disease | N |
| 11 | 33 | M | Hispanic | Undomiciled | None | none | Y |
| 12 | 58 | M | White | Undomiciled | None | none | Y |
| 13 | 65 | M | Black | Undomiciled | Bipolar Disorder | none | Y |
| 14 | 69 | F | White | Undomiciled | Schizophrenia | unspecified anemia | N |
| 15 | 29 | F | Black | Undomiciled | Bipolar Disorder | none | Y |
| 16 | 57 | M | Hispanic | Undomiciled | None | none | Y |
| 17 | 71 | M | Hispanic | Undomiciled | Schizophrenia | diabetes mellitus | Y |
| 18 | 27 | M | Black | Shelter Domiciled | Schizophrenia | seizure disorder | N |
| 19 | 26 | M | Asian | Undomiciled | Schizophrenia | peripheral vascular disease | Y |
| 20 | 63 | M | Black | Undomiciled | None | hypertension, seizure disorder | Y |
| 21 | 62 | M | Hispanic | Shelter Domiciled | None | diabetes mellitus | Y |
| 22 | 48 | M | Black | Undomiciled | Schizophrenia | lupus | N |
| 23 | 62 | M | White | Shelter Domiciled | None | cirrhosis | Y |
| 24 | 33 | M | Black | Undomiciled | Schizophrenia | none | N |
| 25 | 65 | M | White | Undomiciled | None | none | N |
| 26 | 71 | F | Black | Domiciled | Schizophrenia | none | N |
| 27 | 49 | M | Hispanic | Undomiciled | None | cirrhosis, diabetes mellitus | Y |
| 28 | 54 | M | Hispanic | Undomiciled | None | cognitive impairment, pituitary macroadenoma | Y |
| 29 | 68 | M | White | Shelter Domiciled | None | diabetes mellitus, hypertension | Y |
| 30 | 61 | M | Black | Shelter Domiciled | Schizophrenia | hypertension | N |

**Table 2.** Continued.

| Patient | Age (years) | Sex | Ethnicity | Housing Status | Psychiatric Diagnoses | Comorbid Medical Diagnoses | Substance Use Disorder |
|---|---|---|---|---|---|---|---|
| 31 | 30 | F | Black | Shelter Domiciled | Personality Disorder | none | N |
| 32 | 65 | M | Black | Undomiciled | None | hypertension, peripheral vascular disease, blindness | Y |
| 33 | 58 | M | Black | Undomiciled | Personality Disorder | stroke, traumatic brain injury, seizure disorder, hypertension | Y |
| 34 | 30 | M | Black | Undomiciled | Schizophrenia | None | Y |
| 35 | 65 | M | Black | Undomiciled | Schizophrenia | venous thromboembolism | Y |
| 36 | 53 | M | White | Undomiciled | Personality Disorder | uveitis, blindness | Y |
| 37 | 53 | M | Black | Shelter Domiciled | Schizophrenia | none | Y |

of preventative care, access to psychiatric care, and post-discharge support for these vulnerable populations in terms of preventing potentially lengthy, avoidable admissions.

Hemodynamic instability was rare in the cohort. Only two patients presented with hypotension, coincidentally both with a hemoglobin of 3.8 g/dL. More severe anemia was not associated with admission to the ICU, and all but one patient admitted to the ICU had an alternative primary pathology—either sepsis or severe environmental hypothermia. These findings are consistent with the proposed mechanism of chronic blood loss that allows for physiologic compensation for the anemia. In previously reported cases, hypotension was slightly more frequent; when blood pressure was reported, hypotension was seen in two of eight adults and two of three children.[4-6,8-10,12] However, in the case series that most parallels ours by Guss et al, which described five homeless patients with alcohol use disorder and anemia from lice infestation, all five patients were normotensive.[6]

When analyzing the demographics of this cohort, profound anemia associated with lice infestation occurred almost exclusively in patients who had unstable housing, psychiatric disease leading to an inability to care for oneself, or both. Schizophrenia, in particular, was diagnosed in 16 patients (43%), despite being found in just 0.25-0.46% of the United States population.[25] Diagnostic criteria for schizophrenia include a loss of the ability to care for oneself as a result of disorganized behavior, as was observed in this cohort.[26] As is seen in other diseases, schizophrenia and severe mental illness appear to be associated with worsened outcomes compared to the general population suffering from lice infestations.[27] These findings are consistent with the previously reported cases in adults where either substance use, psychiatric disease, or both, were noted.

Most of the adult patients in those cases also lacked housing. One patient was housed but suffered from severe depression, and the other was psychiatrically ill but taken care of by family members. In three pediatric case reports, either extreme poverty or neglect were noted leading to a delay in treatment for lice infestation.[9,10,12] Similarly, in this cohort, all but three patients were either in the shelter system or undomiciled. Of those three patients who did have housing, two were later diagnosed with schizophrenia and the third with dementia.

The common thread among these cases is an inability to engage in sufficient self-care prior to the development of severe anemia. In this cohort, patients with substance use disorders, unstable housing, and psychiatric disease either did not or could not seek timely medical care, leading to the development of severe chronic anemia. Social determinants of health such as these are frequently a major contributor to medical illness.[28] In unhoused populations, a number of factors increase the risk of lice infestation and may worsen the severity and/or duration of infestation: inability to reliably launder clothing and bedding; lack of access to hygiene and shower facilities; and frequently communal shelter arrangements that can facilitate transmission of infectious disease.[29-32] Coupled with barriers to accessing routine medical care, and substance use and psychiatric comorbidities, these patients are uniquely vulnerable to severe and prolonged infestations that can cause a chronic severe anemia. The ED often serves as the "safety net" for these patients, providing the primary point of contact for undomiciled patients within the healthcare system.[33] Other primary medical processes that could contribute to inability to fully care for self were also observed in the cohort. Blindness, cognitive impairment, dementia, and primary stroke were also noted in a handful of patients.

**Table 2.** Continued.

| Patient | Presenting Blood Pressure (mm Hg) | Presenting Heart Rate (beats/minute) | Hemoglobin (g/dL) | Admission Destination | Mean Corpuscular Volume (fL) | Total Iron (mcg/dL) | Ferritin (ng/mL) | Total Iron-binding Content (mcg/dL) |
|---|---|---|---|---|---|---|---|---|
| 1 | 169/84 | 77 | 6.7 | floor | 65.6 | 16 | 35 | 308 |
| 2 | 127/70 | 95 | 3.8 | floor | 60.8 | 9 | 5 | 437 |
| 3 | 115/94 | 84 | 6.3 | floor | 102.3 | 43 | 47 | 227 |
| 4 | 125/75 | 112 | 3.1 | floor | 71.3 | 19 | 17 | 287 |
| 5 | 122/68 | 98 | 4.2 | floor | 79.1 | not obtained | not obtained | not obtained |
| 6 | 111/47 | 101 | 3.8 | floor | 70.3 | 15 | 18 | 214 |
| 7 | 107/54 | 113 | 3.6 | floor | 80.1 | 7 | 7 | 329 |
| 8 | 150/91 | 116 | 6.8 | floor | 71.1 | 11 | 38 | 280 |
| 9 | 99/59 | 104 | 4.7 | floor | 77.4 | 12 | 15 | 220 |
| 10 | 110/50 | 111 | 3.3 | floor | 60 | 8 | 12 | 342 |
| 11 | 134/67 | 118 | 3.4 | floor | 67.4 | <20 | 39 | <20 |
| 12 | 87/62 | 53 | 3.3 | ICU | 88.1 | 231 | 14 | Unable to calculate |
| 13 | 76/45 | 73 | 3.8 | floor | 64.7 | 34 | 12 | 347 |
| 14 | 102/41 | 84 | 2.4 | ICU | 65.2 | 91 | 5 | 373 |
| 15 | 119/52 | 120 | 2.5 | ICU | 82.9 | 12 | 12 | 294 |
| 16 | 125/83 | 99 | 6.9 | floor | 65.7 | <20 | 12 | <20 |
| 17 | 96/51 | 99 | 6.2 | floor | 64.9 | 20 | 6 | 284 |
| 18 | 103/54 | 96 | 4 | floor | 59.7 | 11 | 2 | 443 |
| 19 | 106/56 | 119 | 5.4 | floor | 56.1 | 21 | 216 | 140 |
| 20 | 128/67 | 82 | 3.2 | floor | 77 | <20 | 40 | <10 |
| 21 | 111/47 | 101 | 3.8 | floor | 70 | 14 | 18 | 223 |
| 22 | 114/57 | 100 | 5.3 | floor | 92 | 21 | 38 | 244 |
| 23 | 163/96 | 66 | 6.3 | floor | 99 | 12 | 123 | 127 |
| 24 | 127/76 | 94 | 3.1 | floor | 71 | 19 | 17 | 287 |
| 25 | 85/28 | 77 | 3.8 | ICU | 64.7 | 34 | 12 | 347 |
| 26 | 107/58 | 106 | 4.2 | floor | 79.1 | 68 | 78 | 267 |
| 27 | 160/109 | 117 | 5.9 | floor | 81 | 53 | 101 | 166 |
| 28 | 124/76 | 80 | 6.9 | ICU | 88 | 12 | 197 | 151 |
| 29 | 109/67 | 92 | 6.1 | floor | 70 | 11 | 18 | 382 |
| 30 | 134/71 | 91 | 6.3 | floor | 94 | 31 | 195 | 256 |
| 31 | 103/62 | 75 | 6.5 | floor | 65 | 16 | 67 | 328 |
| 32 | 154/74 | 85 | 6.1 | ICU | 77 | 14 | 32 | 256 |
| 33 | 160/97 | 78 | 6 | floor | 68.9 | <20 | 90 | <20 |
| 34 | 114/71 | 93 | 4.4 | floor | 75.6 | 12 | 14 | 286 |
| 35 | 134/84 | 55 | 4.1 | ICU | 63.5 | 7 | 31 | 218 |
| 36 | 141/77 | 83 | 5.9 | floor | 70 | not obtained | not obtained | not obtained |
| 37 | 141/67 | 80 | 5.3 | floor | 62.7 | 6 | 4 | 415 |

*dL,* deciliter; *Fl,* fluid ounces; *g,* gram; *mcg*, microgram; *mm Hg,* millimeters of mercury; *ng,* nanogram.

The association of this disease process with lack of housing is of particular importance. In New York City, over 80,000 people are experiencing homelessness, the most of any city in the US.[34] Emergency departments serve as the primary access to healthcare for these patients, but they frequently experience bias from clinicians despite being at greater risk for serious injury and illness than the general population.[35,36] Patients with lice infestation may experience further bias and avoidance from clinicians due to the visible nature of the disease and resulting fear of transmission to staff. The typical treatment for severe lice infestation is delousing, which is often done before any further medical evaluation or admittance into the ED. The data presented here suggest that patients with severe infestations may have significant anemia that warrants urgent investigation.

The cohort reviewed here exceeds the total number of reported cases in the literature and were found over an eight-year period at a single center, suggesting a higher prevalence of lice-associated severe anemia than has previously been recognized. While the etiology of the severe anemia observed in this cohort may be multifactorial—in some cases beyond the possible causes assessed in this study—there exists a plausible mechanism by vulnerable groups with severe deficits in self-care that may present with a primarily lice-mediated anemia. Emergency physicians should be aware of the possibility of severe anemia in undomiciled patients or patients with severe psychiatric disease presenting with severe lice infestations.

## LIMITATIONS

There are several important limitations to this study. Given the retrospective nature of this project, it would be incorrect to assume that lice infestation alone was the sole etiology of anemia. Malnutrition and alcohol use disorder are common in patients with psychiatric disease and likely contributed to anemia in many cases. We could not assess for the possibility of pre-existing anemia from other possible causes (eg, as a side effect of psychiatric medication). Moreover, the diagnosis of lice infestation in each case was made clinically by the emergency physician without definitive entomological identification of the organism found on the patient.

Additionally, most patients did not receive upper and lower endoscopies to definitively rule out an occult GI hemorrhage, although no patient included in the series had clinical evidence of overt bleeding and GI bleeding was clinically ruled out in most cases. Lastly, it is unknown how many patients with severe lice infestation were deloused with no further lab tests performed and, thus, were not included in this study. It is likely that lice infestation causing severe anemia meeting transfusion criteria is underdiagnosed, and cases are often missed.

## CONCLUSION

This study suggests that patients with unstable housing, comorbid psychiatric disease, and/or substance use disorders who present with lice infestation may have severe anemia despite apparent hemodynamic stability. The prevalence of this condition may be higher than previously described, especially among these vulnerable populations. Future research directions should include prospective studies that help to further elucidate the prevalence and characteristics of lice-associated anemia.

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# Anticoagulation Treatment in Patients with Septic Thrombophlebitis of the Internal Jugular Vein

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**Introduction:** Septic thrombophlebitis of the internal jugular vein (STIJV), or Lemierre syndrome, is a rare, life-threatening condition. Anticoagulant use for managing STIJV remains unclear due to ambiguous diagnostic criteria and a lack of robust evidence. We evaluated the clinical benefits and risks of anticoagulants in patients with STIJV.

**Methods:** In this retrospective study we used data from over 1,700 hospitals, retrieved from a nationwide Japanese database. We used multivariate logistic regression and propensity score matching to adjust for confounding variables (age, sex, Charlson Comorbidity Index, level of consciousness, use of mechanical ventilation, use of disseminated intravascular coagulation, admission to intensive care unit, history of diabetes, use of noradrenaline, diagnosis of acute renal failure, and diagnosis of cerebral infarction). We also conducted instrumental variable estimation to account for the impact of unmeasured covariates. The primary outcome was in-hospital mortality; the secondary outcomes were 90-day mortality, major bleeding events, and length of stay (LOS) in hospital.

**Results:** Among the 523 patients diagnosed with STIJV between April 1, 2014–March 31, 2022, 343 (65.6%) were excluded due to lack of appropriate treatment initiation for STIJV. Overall, 180 patients (34.4%) met the inclusion criteria; the data of 156 patients (31.1%) were ultimately analysed. Of these, 86 (55.1%) received anticoagulants, which neither significantly improved nor worsened survival outcomes. The in-hospital mortality was 3.39% and 1.69% and 90-day mortality was 2.54% and 1.69%, respectively, in patients who did and did not receive therapy, ($P$ = .56 and .99, respectively). The adjusted odds ratio (AOR) for in-hospital and 90-day mortality was 0.858 (95% CI, 0.126-5.826, $P$ = .88) and .991 (95% CI, .932-1.055, $P$ = .79), respectively. The LOS was longer in those receiving anticoagulants (mean, 29.2 vs 21.8 days, AOR 11.7 days longer, 95% CI, 4.11-19.20, $P$ < .01), potentially due to dose adjustment or clinical decision-making. Subgroup analysis comparing unfractionated heparin and direct Xa inhibitors showed similar in-hospital mortality outcomes: 4.54% in the unfractionated heparin group (AOR 2.361, 95% CI, 0.32-17.40; $P$ = .40) and 3.03% in the direct Xa inhibitor group (AOR 0.444, 95% CI, 0.032-6.23; $P$ = .55), respectively.

**Conclusion:** In the largest study of septic thrombophlebitis of the internal jugular vein to date, we found that early initiation of anticoagulation treatment was not statistically associated with survival. Therefore, anticoagulant use should be determined based on individual patient characteristics. Further research is warranted to improve the quality of evidence for this rare disease. [West J Emerg Med. 2025;26(6)1590–1597.]

## INTRODUCTION

Septic thrombophlebitis of the internal jugular vein (STIJV), or Lemierre syndrome, is a rare but life-threatening condition.[1] It typically follows an oropharyngeal infection, leading to local invasion of the pharyngeal space and IJV, resulting in septic thrombophlebitis within one to three weeks.[2,3] Despite its severity, STIJV management and outcomes remain poorly understood owing to its rarity[4] and inconsistent diagnostic criteria.[5] Some studies define STIJV based on the presence of *Fusobacterium necrophorum,* regardless of symptoms,[6,7] while others base it on septic emboli findings, irrespective of the pathogen.[3,8]

These inconsistencies complicate clinical decision-making. Clinicians often face challenges when the causative pathogen is unclear and evidence-based guidance is lacking.[9] A long-debated issue[7,9-11] is whether anticoagulation treatment should be initiated. Although this therapy is frequently used,[9,12] its efficacy and safety lack robust evidence.[13,14] In this study, we aimed to evaluate the clinical benefits and risks of anticoagulation therapy in patients with STIJV, regardless of the causative pathogen. This study provides clinicians with evidence-based tools to manage this challenging condition.

*Population Health Research Capsule*

What do we already know about this issue?
*Septic thrombophlebitis of the internal jugular vein (STIJV) is a rare but severe infection. Despite the use of anticoagulants their benefit remains uncertain.*

What was the research question?
*Does anticoagulation improve mortality or clinical outcomes in patients with STIJV?*

What was the major finding of the study?
*Anticoagulation use was not statistically association with survival (OR 0.858; 95% CI, 0.126-5.826; P= .88); hospital stay was 11.7 days longer with anticoagulants (P < .01).*

How does this improve population health?
*Evidence supports tailored use of anticoagulants in STIJV, helping reduce harm and resource use.*

## METHODS

### Study Design

In this retrospective study we assessed whether anticoagulation therapy could confer a survival advantage. We used multivariate logistic regression and propensity score matching (PSM) to adjust for intergroup baseline differences. The primary outcome was in-hospital mortality, while the secondary outcomes were 90-day mortality, major bleeding events during hospitalization, and hospital length of stay (LOS). This study complied with all 12 quality improvement strategies proposed by Worster et al.[15] The results were reported according to the Strengthening the Reporting of Observational studies in Epidemiology (STROBE) guidelines (Appendix 1).

### Ethics Approval and Consent to Participate

The study adhered to the principles of the 1975 Declaration of Helsinki and its subsequent revisions. Ethical approval was granted by the institutional review board of our institution (#788; April 2020). The requirement for informed consent was waived owing to the retrospective nature of the study and use of anonymous patient and hospital data.

### Data Resources

We extracted data from the Japanese Diagnosis Procedure Combination (DPC) system, a nationwide case-mixed patient classification framework designed to standardize electronic claims processing and enhance transparency in hospital performance. Over 1,700 hospitals, including 82 academic institutions, participate in the system, which also streamlines electronic payment systems and fosters accountability in healthcare operations. The database captures the following elements: 1) major diagnosis categories with detailed diagnostic groupings; 2) hospitalization details, including the location and method of admission; 3) patient demographics; 4) surgical procedures performed; 5) medications and other adjuvant therapies administered; and 6) associated comorbidities and complications.[16-18]

### Study Population

In this study we registered hospitalized patients diagnosed with STIJV between 1 April 1, 2014– March 31, 2022. To ensure the accuracy of the diagnostic labels, we included only patients who showed evidence of appropriate intervention at the time of diagnosis. Specifically, we excluded individuals without records of submitted blood cultures or without antibiotic treatment initiated on the day of diagnosis. The exclusion criteria were as follows: 1) incomplete data for any variable included in the analysis; 2) < 16 years of age; 3) pregnancy; and 4) discharge within 48 hours of admission. We applied the last criterion to address the immortal time bias because disease severity was assessed based on the treatment intensity provided during this period.

### Data Collection

The selection criteria and variables required for the analysis were provided to an abstractor specializing in database management, who was blinded to the study hypothesis. Data

collection was carried out using abstraction forms. We confirmed the reliability of the process by achieving perfect interrater agreement. The collected covariates included age, sex, consciousness level at admission (alert, comatose, or other), Charlson Comorbidity Index (CCI), concurrent diagnosis at admission, hospitalization location, and use of mechanical ventilation and vasopressors. We also collected data on post-admission complications, LOS, and discharge status (alive or deceased) to evaluate patient prognosis.

**Patient Groups and Treatment Protocols**

The anticoagulant treatment group included patients who had received warfarin, unfractionated heparin, dalteparin, edoxaban, rivaroxaban, apixaban, or fondaparinux at admission. Patients who survived to discharge were included in the survival group. Patient severity was adjusted using multivariable logistic regression and PSM with the following covariates: age, sex, CCI, level of consciousness, use of mechanical ventilation, use of disseminated intravascular coagulation, admission to intensive care unit (ICU), history of diabetes, use of noradrenaline, diagnosis of acute renal failure, and diagnosis of cerebral infarction.

**Statistical Analysis**

We performed severity adjustment between patients with STIJV who received anticoagulation treatment and those who did not using a multivariate logistic regression analysis. The defined covariates were included in a generalized linear model. We categorized the population into two groups in a 70/30 ratio, with 70% defining the parameters of the regression model and the remaining data assessing its performance. We assessed the model accuracy using the area under the receiver operating characteristic curve and conducted the Hosmer-Lemeshow test to evaluate its goodness of fit of the constructed model.

To ensure the robustness of our results, we performed PSM under the following conditions: 1:1 K-nearest neighbor matching without replacement, matching caliper set at 0.2 times the standard deviation of the logit-transformed propensity score. Luo et al previously reported on the details on the PSM method.[19] Additionally, we performed instrumental variable estimation to further evaluate the robustness of the results, using institution identification numbers as the instrument. The Durbin-Wu-Hausman test was subsequently applied to assess the endogeneity of this variable. We applied the chi-square test to compare outcomes between the PSM groups. Statistical analyses were conducted using R software v4.4.2 (The R Foundation for Statistical Computing, Vienna, Austria).

## RESULTS

The patient selection process is shown in Figure 1. Among the 523 patients diagnosed with STIJV during the study period, 180 met the inclusion criteria. A total of 156 patients were included in the analysis. We excluded 24 patients due to missing values (n = 16), age < 16 years (n = 4), pregnancy (n = 1), and discharge within two days of admission (n = 3).

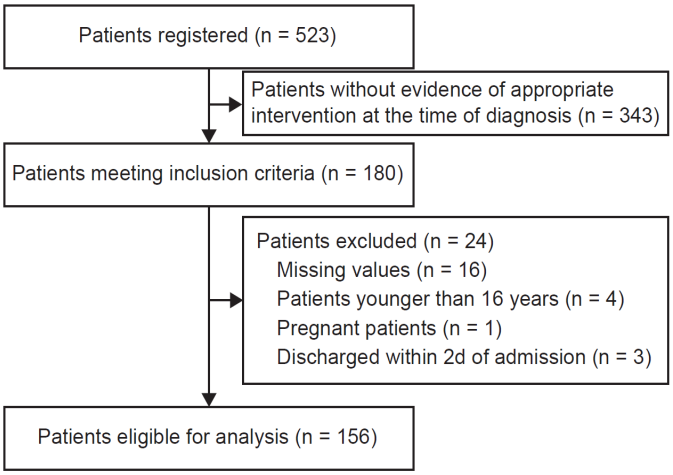


**Figure 1.** Flowchart depicting patient selection in a study of anticoagulation in patients with septic internal jugular thrombophlebitis.

Hospitalized patients diagnosed with STIJV between April 1, 2014–March 31, 2022 were registered in this study based on data extracted from the Japanese DPC system. The anticoagulants administered to the treated group were as follows: unfractionated heparin (n = 66, 42.3%); warfarin (n = 31, 19.9%); apixaban (n = 19, 12.2%); edoxaban (n = 5, 3.2%); rivaroxaban (n = 5; 3.2%); dalteparin (n = 2, 1.3%); and fondaparinux (n = 2, 1.3%). The patient demographics are presented in Table 1, showing that patients treated with anticoagulants had higher scores on the CCI (median of 0 vs 1 in patients not treated with anticoagulants), a higher rate of coma (2% vs 0% in patients not treated with anticoagulants), mechanical ventilation (2% vs 0% in patients not treated with anticoagulants), and administration of noradrenaline (12.8% vs 1.4% in patients not treated with anticoagulants).

Patients treated with anticoagulants received the following agents: unfractionated heparin (n = 66, 42.3%); warfarin (n = 31, 19.9%); apixaban (n = 19, 12.2%); edoxaban (n = 5, 3.2%); rivaroxaban (n = 5, 3.2%); dalteparin (n = 2, 1.3%); and fondaparinux (n = 2, 1.3%).

The performance of the established generalized linear model was robust, with an area under the receiver operating characteristic curve of 0.92 (Supplementary Figure 1) and well calibrated; Hosmer-Lemeshow goodness of fit, $P$ =.89 (Supplementary Figure 2). The results of the main analysis are shown in Figure 2. Using this model, the adjusted odds ratio (AOR) for in-hospital mortality was estimated to be 0.858 (95% CI, 0.126-5.826, $P$ = .88). Similarly, the AOR for 90-day mortality was 0.991 (95% CI, 0.932-1.055, $P$ = .79), indicating that anticoagulation treatment neither significantly improved nor worsened the survival rates.

We estimated AORs for in-hospital mortality and 90-day

**Table 1.** Characteristics of patients and hospitals investigated in a study of anticoagulation in patients with septic internal jugular thrombophlebitis.

| Patient or hospital characteristic | Patient not treated with anticoagulants | Patient treated with anticoagulants | SMD |
|---|---|---|---|
| Number of participants, n | 70 | 86 | |
| Age (years), median [25th-75th percentiles] | 68.50 [45.75, 79.00] | 61.50 [38.25, 77.75] | 0.149 |
| Sex, female, n (%) | 34 (48.6) | 35 (40.7) | 0.159 |
| Charlson Comorbidity Index, median [25th-75th percentiles] | 0 [0, 1] | 1 [0, 2] | 0.388 |
| Consciousness, alert, n (%) | 55 (78.6) | 70 (81.4) | 0.071 |
| Consciousness, coma, n (%) | 0 (0.0) | 2 (2.3) | 0.218 |
| Mechanical ventilation use, n (%) | 0 (0.0) | 2 (2.3) | 0.218 |
| Disseminated intravascular coagulation, n (%) | 5 (7.1) | 7 (8.1) | 0.038 |
| Admission to ICU, n (%) | 5 (7.1) | 15 (17.4) | 0.318 |
| History of diabetes, n (%) | 5 (7.1) | 14 (16.3) | 0.287 |
| Use of noradrenaline, n (%) | 1 (1.4) | 11 (12.8) | 0.453 |
| Diagnosis of acute renal failure, n (%) | 7 (10.0) | 8 (9.3) | 0.024 |
| Diagnosis of cerebral infarction, n (%) | 2 (2.9) | 4 (4.7) | 0.094 |

*ICU,* intensive care unit; *SMD,* standardized mean difference.

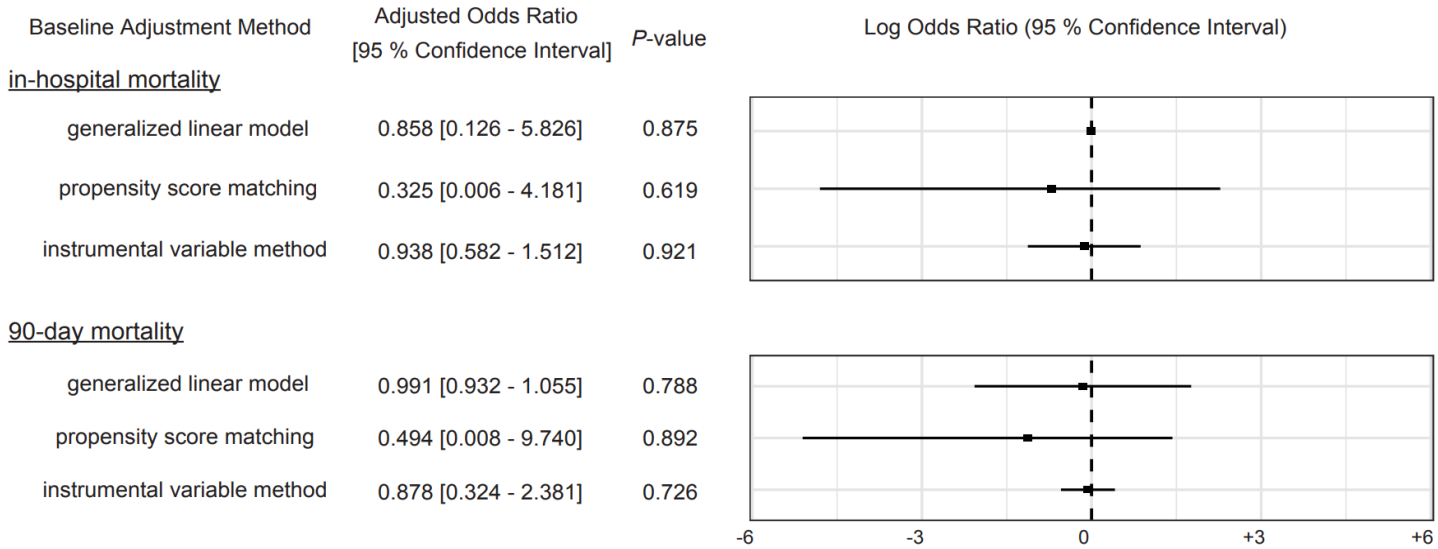


**Figure 2.** Forest plot comparing in-hospital mortality and 90-day mortality between patients treated with anticoagulants and those not treated with anticoagulants in a study of anticoagulation in patients with septic internal jugular thrombophlebitis.

mortality between patients treated with anticoagulants and those not treated with anticoagulants using a generalized linear model and propensity score matching, respectively. Baseline characteristics after 1:1 PSM are presented in Table 2. Following PSM, the estimated OR for in-hospital mortality was 0.325 (95% CI, 0.006-4.181, $P$ = .62). Similarly, the AOR for 90-day mortality was 0.494 (95% CI, 0.008-9.740, $P$ = .62), consistent with the results of the main analysis. The result of Durbin-Wu-Hausman test was $P$ =.328e-12, indicating endogeneity of the instrumental variable we enveloped. The estimated OR for in-hospital mortality was 0.938 (95% CI, 0.582-1.512, $P$ = .92), and the AOR for 90-day mortality was 0.878 (95% CI, 0.324-2.381, $P$ = .73), which further supports the robustness of the study.

In the group treated with anticoagulants, one patient (1.7%) experienced gastrointestinal bleeding during hospitalization; however, the patient survived without requiring additional intervention. Figure 3 illustrates the duration of hospitalization for both groups, showing longer LOS among patients receiving anticoagulants in both analyses. Subcategorical analysis, estimating the treatment effects of unfractionated heparin and the direct Xa inhibitor, is shown in Figure 4. The estimated OR

**Table 2.** Patient and hospital characteristics after propensity score matching in a study of anticoagulation in patients with septic internal jugular thrombophlebitis.

| Patient or hospital characteristic | Patient not treated with anticoagulants | Patient treated with anticoagulants | SMD |
|---|---|---|---|
| Number of participants, N | 59 | 59 | |
| Age (years), median [25th-75th percentiles] | 65 [36.5, 78] | 62 [38, 78.5] | 0.023 |
| Sex, female, n (%) | 25 (42.4) | 24 (40.7) | 0.034 |
| Charlson Comorbidity Index, median [25th-75th percentiles] | 0 [0,1] | 0 [0,1] | 0.038 |
| Consciousness, alert, n (%) | 51 (86.4) | 48 (81.4) | 0.139 |
| Consciousness, coma, n (%) | 0 (0.0) | 0 (0.0) | <0.001 |
| Mechanical ventilation use, n (%) | 0 (0.0) | 0 (0.0) | <0.001 |
| Disseminated intravascular coagulation, n (%) | 4 (6.8) | 4 (6.8) | <0.001 |
| Admission to ICU, n (%) | 5 (8.5) | 4 (6.8) | 0.064 |
| History of diabetes, n (%) | 5 (8.5) | 3 (5.1) | 0.135 |
| Use of noradrenaline, n (%) | 1 (1.7) | 1 (1.7) | <0.001 |
| Diagnosis of acute renal failure, n (%) | 5 (8.5) | 4 (6.8) | 0.064 |
| Diagnosis of cerebral infarction, n (%) | 0 (0.0) | 0 (0.0) | <0.001 |

We performed propensity score analysis under the following conditions: 1:1 K-nearest neighbour matching without replacement, matching caliper set at 0.2 times the standard deviation of the logit-transformed propensity score.
*ICU,* intensive care unit; *SMD,* standardized mean difference.

for in-hospital mortality was 2.361 (95% CI, 0.320-17.394, $P$ = .40) in the patient treated with unfractionated heparin and 0.444 (95% CI, 0.032-6.229, $P$ = .55) in the patient treated with direct Xa inhibitor compared with the patient who received none of the anticoagulants.

We estimated differences in the length of hospitalization between patients treated with anticoagulants and those not treated with anticoagulants using a generalized linear model and PSM, respectively.

## DISCUSSION

In this largest study of STIVJ to date, no survival benefit from anticoagulation therapy was found in patients with STIJV; however, an association between anticoagulation therapy and prolonged hospitalization was noted. Clinicians often face major challenges when treating patients with Lemierre syndrome, or STIJV, owing to limited information. Whether anticoagulation treatment should be initiated in these patients has been debated; however, no systematic study of STIJV has been performed due to the rarity of this condition. To the best of our knowledge, this is the first study to assess the effectiveness of anticoagulants in this specific patient group.

This study showed no survival benefit from anticoagulation therapy in patients with STIJV. However, it showed an association between anticoagulation therapy and prolonged hospitalization. Clinicians often face major

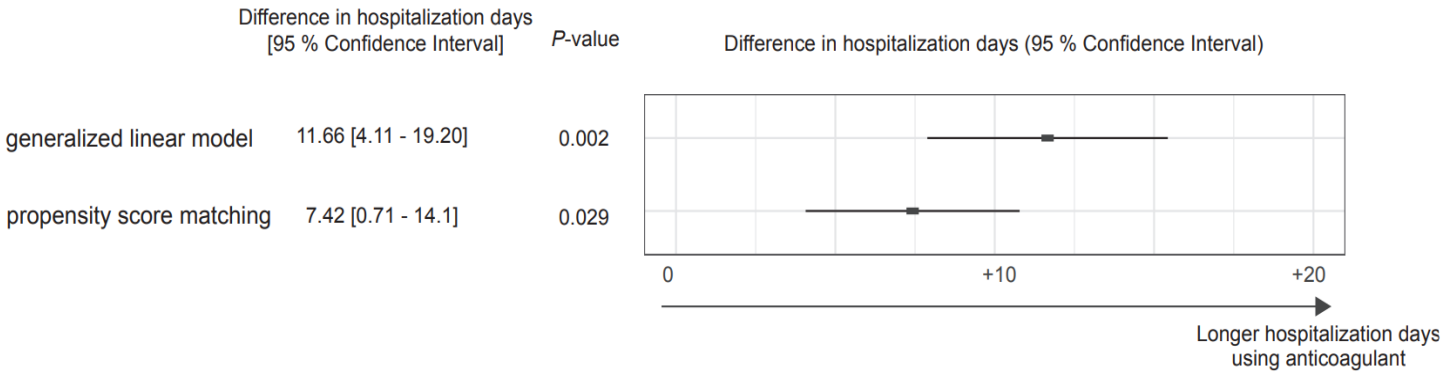


**Figure 3.** Forest plot comparing the length of hospitalization between patients treated with anticoagulants and those not treated with anticoagulants in a study of anticoagulation in patients with septic internal jugular thrombophlebitis.

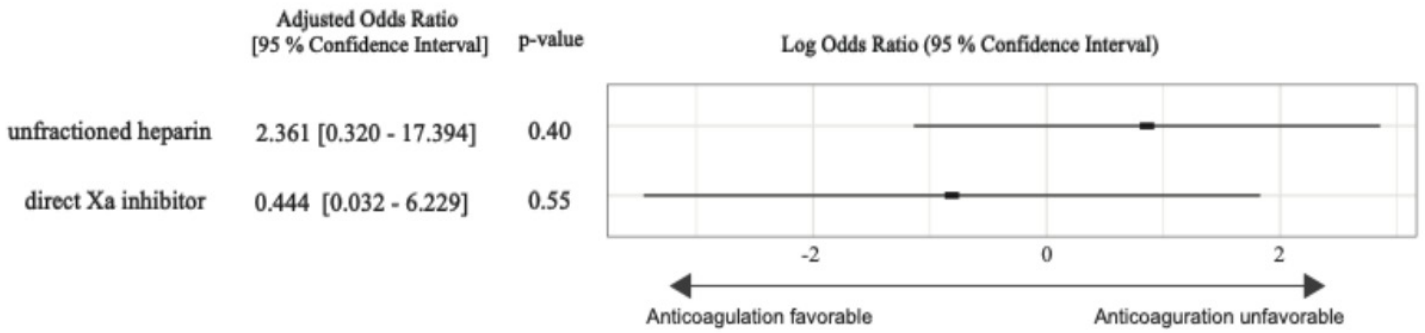


**Figure 4.** Forest plot comparing in-hospital mortality between patients treated with unfractionated heparin or the direct Xa inhibitor and patients not treated with any anticoagulants in a study of anticoagulation in patients with septic internal jugular thrombophlebitis. Analysis was performed using a generalized linear model.

challenges when treating patients with Lemierre syndrome owing to limited information. Whether anticoagulation treatment should be initiated in these patients has been debated; however, to the best of our knowledge, this is the first study to assess the effectiveness of anticoagulants in this specific patient group.

Several studies have investigated this condition under the term Lemierre syndrome or disease. However, we focused on patients with STIJV. This approach was chosen because the concept of Lemierre syndrome is abstract; the definition of study populations has varied widely across previous studies. Notably, some studies included patients wherein *F necrophorum* was detected, regardless of clinical presentation.[7,20] By contrast, our study included patients with STIJV, irrespective of the pathogen. This inclusion criterion was justified, as clinical decisions were often made before the availability of bacteriological results.

Successful cases have been reported both with[21-25] and without anticoagulation therapy.[26-30] A study analyzing 712 cases of Lemierre syndrome suggested that anticoagulation therapy may represent a favorable prognostic factor.[9] However, this analysis was based on reported cases, introducing potential publication bias and issues of pseudo-correlation, as the study period spanned 17 years, during which the use of anticoagulation therapy became more common.[5,9,12-14] Despite differences in study populations, our findings align with those of a previous study showing no significant differences in outcomes between patients with jugular vein thrombosis who received therapeutic, prophylactic, or no anticoagulation therapy.[7]

In the current study, we applied three complementary adjustment methods to mitigate differences in baseline characteristics. The model demonstrated excellent predictive accuracy (AUROC = 0.92) and confirmed population balance between the anticoagulant-treated and untreated groups after PSM, thereby addressing indication bias. Furthermore, the consistency of the instrumental variable estimation results with those from the other analyses suggests that residual confounding is unlikely to have substantially affected the findings.

Using the PSM analysis, only one patient (1.7%) who received anticoagulation therapy experienced gastrointestinal bleeding during hospitalization. This finding aligns with previous findings indicating that anticoagulation therapy is relatively safe, without major bleeding complications attributed to it.[21-24] However, the prolonged hospitalization observed in patients receiving anticoagulation therapy necessitates further investigation. This may reflect the challenges physicians face in dose adjustment or a preference for keeping patients hospitalized until thrombosis resolves.

Although the subgroup analysis comparing unfractionated heparin and direct Xa inhibitors showed no apparent difference in in-hospital mortality between the two anticoagulants. The estimated OR for in-hospital mortality was 0.444 for direct Xa inhibitors, compared with 2.361 for unfractionated heparin. This finding may suggest the potential superiority of direct Xa inhibitors. A larger scale study is warranted to confirm this observation.

Lemierre syndrome is more common in men than in women, primarily affecting younger patients.[31-33] This tendency was also observed in our study; however, the median age in our cohort was 65 years of age (IQR 39-79 years). This trend may be attributed to Japan's aging population and the fact that antibiotics are administered more frequently to younger individuals than older adults, as indicated by surveillance data in Japan.[34]

## LIMITATIONS

This study has some limitations. First, bacteriological results confirming the pathogen were not available, preventing further detailed analyses. Second, to address immortal time bias, we excluded patients who stayed for < 2 days from the analysis. However, only three patients were excluded, which was unlikely to have affected the results of the study. Third, to confirm the robustness of the results, we used instrumental variable estimation. Although endogeneity of the instrument was confirmed, the extent to which the findings are fully

reliable remains uncertain.

Finally, owing to the unique characteristics of our dataset, we did not evaluate long-term outcomes such as local thrombosis progression, which are common measures of treatment effects in other studies. Despite these limitations, this is the only study to thoroughly assess the effect of anticoagulation treatment in patients with STIJV while carefully addressing indication bias.

## CONCLUSION

This is the largest and first study to assess the effectiveness of anticoagulants in patients with septic thrombophlebitis of the internal jugular vein. Early initiation of anticoagulation therapy was not statistically associated with survival benefit. When comparing unfractionated heparin with direct Xa inhibitors, the findings suggest a potential superiority of direct Xa inhibitors. Larger scale studies, particularly those assessing the clinical benefits of direct Xa inhibitors, are warranted to strengthen the evidence base for this rare condition.

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*Conflicts of Interest*: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. No author has professional or financial relationships with any companies that are relevant to this study. There are no conflicts of interest or sources of funding to declare.

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# Comparison of Perspectives on Cannabis Use Between Emergency Department Patients Who Are Users and Non-users

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**Introduction:** Many states have legalized the use of cannabis for medical or recreational purposes. Cannabis is commonly used both recreationally and medicinally, with therapeutic applications for conditions including chronic pain, seizure disorders, multiple sclerosis, anxiety, and depression. The purpose of this study was to compare emergency department (ED) patient knowledge of the short- and long-term effects of cannabis between users and non-users, and to understand perspectives and knowledge of cannabis use, to assist in development of public health interventions.

**Methods:** We conducted this prospective survey study at Penn State Health – Milton S. Hershey Medical Center. Inclusion criteria included adult ED patients, ≥ 18 years of age, who had used cannabis in the most recent 30 days, between May to August 2024. The control group consisted of adult ED patients, ≥ 18 years of age, who had not used cannabis in the most recent 30 days. We conducted thematic analysis to identify subjects' knowledge of positive and negative effects of cannabis use.

**Results:** Of 258 eligible subjects, 169 consented to participate (65.5%). Most identified as female (54.4%) and White (68.1%), with a mean age of 40 years. Most participants reported cannabis use in their lifetime (75.7%). Participants reported a myriad of reasons for using cannabis, including to treat anxiety (N = 67; 40%); pain (N = 65; 38%); recreational use (N = 62; 37%); sleep (N = 48; 28%); and depression (N = 34; 20%). Commonly perceived positive effects of cannabis use included relaxation (18%), pain relief (16%), and improved mental health symptoms (13%). Commonly perceived negative effects of cannabis use included cognitive impairment (11%), addictive potential (7%), pulmonary effects (8%), and worsened mental health symptoms (6%). Cannabis users were less likely to correctly identify negative short-term and long-term consequences of cannabis use, compared to non-users. Cannabis users scored mean 2.51/5 (95% CI 2.11-2.92) for correctness of negative short-term effects, compared to 3.28/5 (95% CI 2.96-3.6) for non-users ($P$ = .004). Cannabis users scored mean 1.78/5 (95% CI 1.44-2.12) for correctness of negative long-term effects, compared to 2.38/5 (95% CI 2-2.76) for non-users ($P$ = .002).

**Conclusion:** Among ED patients who reported using cannabis, reasons cited for its use included recreation, anxiety, pain, depression, and sleep. Emergency department patients had significant knowledge gaps regarding the effects of cannabis use, and these knowledge gaps were higher among cannabis users. Cannabis users were less likely to correctly identify negative short-term and long-term consequences of cannabis use, compared to non-users. [West J Emerg Med. 2025;26(6)1598–1604.]

## INTRODUCTION

Cannabis is a drug derived from the cannabis plant, with delta-9-tetrahydrocannabinol (THC) being its primary psychoactive component, which produces its effects in humans and animals. As one of the most widely used substances globally, approximately 45% of United States residents have tried cannabis at least once in their lifetime.[1] In the 1990s, Simons et al categorized five motives for cannabis use: enhancement; conformity; mind expansion; coping; and social motives.[2] Cannabis is commonly used both recreationally and medicinally, with therapeutic applications for conditions including chronic pain, seizure disorders, multiple sclerosis, anxiety, and depression. In chronic pain users, cannabis has been shown to reduce pain, improve sleep, and reduce anxiety and depression.[3]

The literature is mixed on the effects of cannabis. Short-term effects of cannabis can include attention impairment, increased impulsivity, and impairments in working memory and decision-making, with these effects being more common in irregular users. Chronic, frequent users often experience long-term effects such as a slower processing speed, impaired decision-making, and impaired attention when abstinent from cannabis. Long-term effects include airway inflammation, cardiovascular effects, including tachycardia and increasing the risk of myocardial infarction.[4,5] With the growing legalization of cannabis, its usage is increasing.[6,7] Despite the common perception that there are no risks with cannabis, approximately 10% of users will develop dependence.[8]

There has also been a growing rate of cannabis-related emergency department (ED) visits over the last two decades. In addition to psychiatric complaints, the most common reasons for this population to visit the ED are intoxication and gastrointestinal (GI) symptoms. Cannabinoid hyperemesis syndrome (CHS) is a disorder characterized by cyclic nausea and vomiting with daily cannabis use. Habboushe et al found that 32.9% of near-daily or daily users who came to the ED for a non-GI complaint also had symptoms of CHS.[9]Although more prevalent, GI and psychiatric complaints are less likely to result in hospital admission. Patients with more rare complaints, including dermatologic, respiratory, trauma, and cardiovascular, are more likely to be admitted.[10]

Previous studies have explored perceptions of cannabis and its effects. Fennell et al found that patients who use cannabis for chronic pain perceive their use as having low risks and moderate benefits. Those who did perceive risks were more likely to have poorer mental health and more problems with cannabis.[11] Marco et al found significant discordance between patient and physician perspectives on the clinical effects of cannabis.[1]

Our goal in this study was to explore ED patient knowledge of the short- and long-term effects of cannabis use among cannabis users and non-users. By understanding both the knowledge and perspectives of those who use cannabis, we aimed to compare ED patient understanding of the short- and long-term effects of cannabis between users and non-users, and to build on these perspectives to assist in development of public health interventions.

*Population Health Research Capsule*

What do we already know about this issue?
*Previous studies have explored perceptions of cannabis and its effects. There is significant discordance between patient and physician perspectives on its clinical effects.*

What was the research question?
*We compared emergency department (ED) patient knowledge of the short- and long-term effects of cannabis between users and non-users.*

What was the major finding of the study?
*Cannabis users scored mean 2.51/5 (95% CI 2.11-2.92) for correctness of negative short-term effects, compared to 3.28/5 (95% CI 2.96-3.6) for non-users (P = .004).*

How does this improve population health?
*The significant knowledge gaps regarding effects of cannabis use represents an opportunity for patient education.*

## METHODS

This cross-sectional survey study was approved by the Penn State University Institutional Review Board (STUDY00024608). Eligible subjects were recruited as a convenience sample when a research assistant (RA) was available, which included all days of the week, and hours between 8 AM–12 AM. Inclusion criteria included adult patients in the Milton S. Hershey Medical Center ED, ≥ 18 years of age, who had used cannabis in the most recent 30 day between May–August 2024; for purposes of this study, they were categorized as cannabis users. Adult ED patients ≥ 18 years of age who had not used cannabis in the most recent 30 days comprised the control group entitled non-users (terminology cited in previous published literature).[12-13] Subjects were excluded if they did not speak English, were prisoners, or were in distress, as defined by requiring resuscitation or unable to participate. Written informed consent was obtained. A total of six trained RAs administered the survey verbally without prompts and recorded subject responses.

The survey was developed by researchers, based on a

previously published study instrument,[14] and it was pilot-tested among a focus group of ED patients for clarity. Data collected included the study participants' demographic information, personal cannabis use habits, and their awareness of the legality of cannabis use and their reported understanding of positive and negative short-term and long-term effects of cannabis. Open-ended questions allowed participants to describe positive and negative effects of cannabis in their own words to avoid interpretation bias. (Appendix A).

We conducted thematic analysis using MAXQDA v24.6.0 (VERBI Software GmbH, Berlin, Germany) to systematically identify and analyze themes from participants' responses to open-ended questions regarding cannabis use.[15] The process followed a rigorous approach to ensure reliability and validity, as described below. The codebook was developed through inductive coding (Appendix B). Two coders applied the codes to a 20% validation dataset to establish interrater reliability (IRR); the Cohen kappa (κ) was then calculated. Discrepancies in coding were flagged by the software and reviewed by a third coder, who adjudicated disagreements to achieve consensus. After coding, we analyzed themes using MAXQDA's visualization and reporting tools. Frequencies and co-occurrences of codes were examined to identify dominant patterns.

Following thematic analysis, we coded responses for accuracy. Correct responses were defined a priori, based on three authoritative sources (Table 1).[16-18] Three reviewers—one EM faculty, one pharmacology faculty, and one EM resident who were blinded to the study hypothesis and to the cannabis use of the participant—scored correct responses using a modified Likert scale of 0-5 (0 = completely incorrect; 5 = completely correct), to allow partial credit for variable understanding of the effects of cannabis. We used parametric statistics (the Student *t*-test) to compare groups by their Likert scale responses due to relatively large sample size, where the differences between results of parametric and non-parametric comparisons are largely inconsequential. A statistician analyzed data using SAS software v9.4 (SAS Institute Inc, Cary, NC). Descriptive data were expressed using frequency and percent. Comparison between groups was performed using the Fisher exact test.

## RESULTS

### Characteristics of Study Participants

Of 258 eligible subjects, 169 consented to participate (65.5%). Most identified as female (54.4%) and White (68.1%), with a mean age of 40 years. Demographic data is described in Table 2. Patients were interviewed each day of the week, with Thursday being the most common (20.7%). Most participants (82.9%) arrived via walk-in, and all were triaged as either an Emergency Severity Index (ESI) level 2, 3, or 4.

### Cannabis and Other Substance-use Habits

Most participants reported cannabis use in their lifetime (75.7%). The average number of days of cannabis use in the prior month across all participants was 11.6, with a wide variation in number of individual uses in the past month, 0 (minimum) – 1,500 (maximum). Participants who reported cannabis use had used it for mean nine years and first used cannabis at mean age 20. Participants reported a myriad of reasons for using cannabis, including to treat anxiety (N = 67; 40% pain (N = 65; 38%); recreational use (N = 62; 37%); sleep (N = 48; 28%); and depression (N = 34; 20%). Thirty percent of participants reported current possession of a medical cannabis prescription. Over 95% of participants reported no recreational drug use outside cannabis. Alcohol use was reported by 51.2% of participants, citing either drinking alcohol daily or socially.

### Participant Knowledge of State Cannabis Legislation

Of the participants, 163 resided in Pennsylvania, where the study was conducted, while six participants resided out of

**Table 1.** Short- and long-term effects of cannabis use.[16,17,18]

| Clinical Category | Short-term effects of cannabis use | Long-term effects of cannabis use |
|---|---|---|
| Mental Health | Euphoria, relaxation, sedation, hallucinations | Anxiety, depression, suicidal thoughts, sleep disorder, psychosis, delirium, schizophrenia, risk of substance use disorder |
| Gastrointestinal | Increased appetite, dry mouth | Cannabinoid hyperemesis syndrome |
| Neurologic | Impaired short-term memory, impaired concentration, impaired psychomotor coordination, slurred speech | Impaired cognition, reduced frequency of seizures |
| Cardiovascular | Tachycardia, hypertension, arrhythmia | Increased risk of stroke, heart disease, and other vascular diseases Pediatrics: impaired attention, memory, and learning |
| Other | Impaired driving skills (including slowed reaction time and ability to make decisions, impairing coordination, and distorting perception), impaired time perception | Reduction of chronic pain, reduction of musculoskeletal pain, low birth weight, NICU admission |

*NICU,* neonatal intensive care unit.

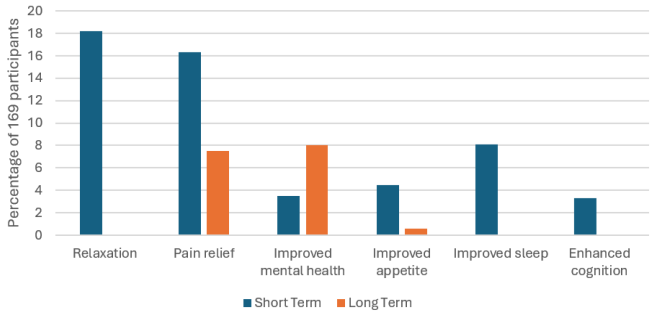


**Figure 1.** Positive effects of cannabis as reported by 169 participants.

**Table 2.** Demographic Information of 169 participants in study of the effects of cannabis use.

| | n (%) | Users | Non-users |
|---|---|---|---|
| Sex | | | |
| Male | 77 (45.6) | 45 (61.6%) | 40 (41.7%) |
| Female | 92 (54.4) | 28 (38.3%) | 56 (58.3%) |
| Race/Ethnicity | | | |
| Black | 16 (9.5) | 13 (13.6%) | 4 (5%) |
| Asian | 2 (1.2) | 2 (2%) | 0 |
| Hispanic | 20 (11.8) | 11 (11.4%) | 9 (12.3%) |
| Multiracial | 16 (9.5) | 11 (11.4%) | 5 (6.8%) |
| White | 115 (68.1) | 59 (61.5%) | 55 (75.3%) |
| Age *M* (SD) | 40.4 (14.6) | 38 | 44 |

state. Most participants (N = 147; 87%) correctly answered questions about legality of cannabis in their home state.

**Knowledge of Effects of Cannabis**

We analyzed five open-ended questions focusing on the short- and long-term consequences of cannabis use, both positive and negative. Responses were collected from 169 participants, yielding a total of 676 individual responses across all questions. Participants were able to identify multiple positive and negative short- and long-term effects. The IRR was found to be acceptable with a κ value of 0.87 (Table 3).

**Consequences of Short-term Cannabis Use**

*Positive Consequences*

Among participants, 97.0% identified at least one short-term positive effect of cannabis use. The most commonly mentioned benefits included relaxation and calming effects (18.2%), pain relief (16.3%), and improved mental health symptoms (12.7%). Additionally, cannabis was noted for increasing appetite (8.1%), aiding in sleep (8.1%), and enhancing mental focus and cognition (3.3%).

*Negative Consequences*

Short-term negative effects were reported by 91.1% of participants. These included cognitive impairments such as brain fog (10.7%), physical effects like cotton mouth or lung irritation (7.8%), and worsened mental health symptoms (5.5%). Participants also highlighted concerns about diminished reaction time and driving impairment (4.3%).

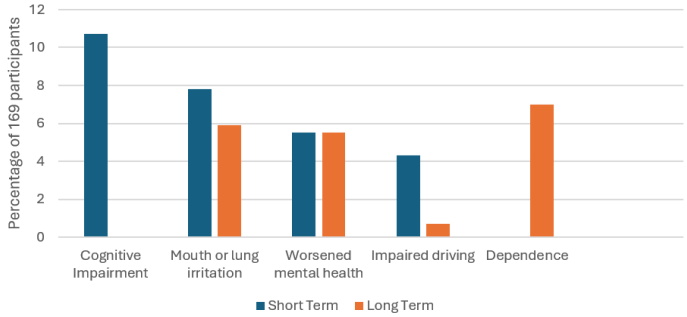


**Figure 2.** Negative effects of cannabis as reported by 169 participants.

**Long-term Consequences**

*Positive Consequences*

With regard to long-term cannabis use, 90.5% of participants described positive outcomes. Key benefits included chronic pain relief (7.5%), improved mental health symptoms (8.0%), and therapeutic uses for conditions such as cancer (1.8%). Other benefits, such as increased appetite and weight gain, were noted less frequently (0.6%).

*Negative Consequences*

Long-term negative consequences were reported by 84.6% of respondents. Dependency or addictive potential was highlighted by 7.0%, with negative pulmonary effects (5.9%) and worsened mental health symptoms (5.5%) also commonly mentioned. Concerns regarding cost (0.7%) and driving impairment (0.7%) were noted less often but remain relevant.

*Differences Between Cannabis Users and Non-Users*

At the time of interview, 74 participants were classified as current cannabis users and 86 as non-users. Nine participants were not classified as either user or non-users. Those classified as cannabis non-users (μ = 43.6 years of age) were significantly older than cannabis users (μ = 36.5 years of age, $P = .03$), although their sex and ethnicity were not significantly different. Cannabis users were more likely to answer correctly about the legality of cannabis for recreational use in the state where they lived (94.19%, $\chi^2 = 0.0190$, $P = .02$). There was no significant difference between cannabis users' and non-users' answers regarding the legality of cannabis use for medical purposes in the state where they lived ($\chi^2 = 0.1718$, $P = .25$).

**Table 3.** Results of thematic analysis of open-ended questions regarding positive and negative short- and long-term effects of cannabis use among 169 participants.

| | Frequency | Percentage |
|---|---|---|
| Positive Short-term | 656 | 97.0 |
| Relaxation/Calms mood | 123 | 18.2 |
| Pain relief | 110 | 16.3 |
| Increases appetite | 55 | 8.1 |
| Helps with sleep | 55 | 8.1 |
| Improves mental health | 54 | 8 |
| Improves cognition | 22 | 3.3 |
| Fun/Social | 11 | 1.6 |
| Negative Short-term | 616 | 91.1 |
| Lazy, sleepy, brain fog | 72 | 10.1 |
| Physical body effects | 53 | 7.8 |
| Worsens mental health | 37 | 5.5 |
| Diminished reaction/driving | 29 | 4.3 |
| Increased appetite | 29 | 4.3 |
| Addictive potential | 19 | 2.8 |
| Cost | 5 | 0.7 |
| Positive Long-term | 612 | 90.5 |
| Mental health | 86 | 12.7 |
| Pain | 51 | 7.5 |
| Addiction | 12 | 1.8 |
| Cancer | 12 | 1.8 |
| Appetite | 12 | 1.8 |
| Negative Long-term | 572 | 84.6 |
| Negative brain effects | 53 | 7.8 |
| Addictive effect | 47 | 7.0 |
| Negative lung effects | 40 | 5.9 |
| Impaired driving | 5 | 0.7 |
| Increased appetite | 4 | 0.6 |

*Cannabis Users' and Non-Users' Perceptions of the Effects of Cannabis*

Participant answers to open-ended questions about the positive and negative short- and long-term effects of cannabis use were evaluated by three blinded scorers. The IRR ranged from moderate to excellent agreement (K = 0.56-0.83). Cannabis users and non-users displayed statistically significant differences in the correctness of their responses about the negative short- and long-term effects of cannabis use, with non-users rated as more correct in their responses (Figure 3 and Figure 4). Cannabis users scored mean 2.51/5 (95% CI 2.11-2.92) for correctness of negative short-term effects, while non-users scored a mean 3.28/5 (95% CI 2.96-3.6; *t*-test $P$ = .004). Cannabis users scored a mean 1.78/5 (95% CI 1.44-2.12) for correctness of negative long- term effects, while non-users scored a mean 2.38/5 (95% CI 2-2.76; *t*-test $P$ = .002). There were no differences between groups in correctness of perception about positive effects, either short- or long-term.

## DISCUSSION

In this study, cannabis non-users reported higher numbers of negative short- and long-term effects compared to cannabis users. Most participants (83%) of correctly stated that recreational cannabis is illegal in the state of Pennsylvania.

Effects of cannabis on cognitive and physiologic function have been previously reported. Cannabis use is associated with impaired neurophysiological function regarding memory, learning, attention, coordination, emotions, and reaction time.[19,20] Chronic cannabis use at a young age (< 18 years) has been found to disrupt normal brain development. Acute cannabis intoxication has the potential to impact working and episodic memory, behavioral disinhibition, and impulsivity; in the *Coronary Artery Risk Development in Young Adults* study, chronic exposure to cannabis was associated with worse verbal memory.[21] Additionally, approximately 30% of cannabis users will develop cannabis use disorder. With an increasing incidence of mental health illnesses in the US, close attention is being paid to a connection with cannabis usage.

Cannabis use is thought to be a preventable risk factor for the development of psychosis. In one investigation, daily cannabis use was associated with at 3.2 times greater odds of developing a psychotic disorder.[22] Among many studies, long-term heavy cannabis use was associated with underachievement and impaired motivation. Interestingly, one study found an association between suicidality trends from 2008–2019 and cannabis use, although the researchers identified potential overlapping risk factors and cited the need for further research.[23] Cannabis use is associated with motor vehicle crashes, malignancy, negative cardiovascular outcomes, and ED visits. Regular smoking of cannabis is associated with airway inflammation similar to cigarette

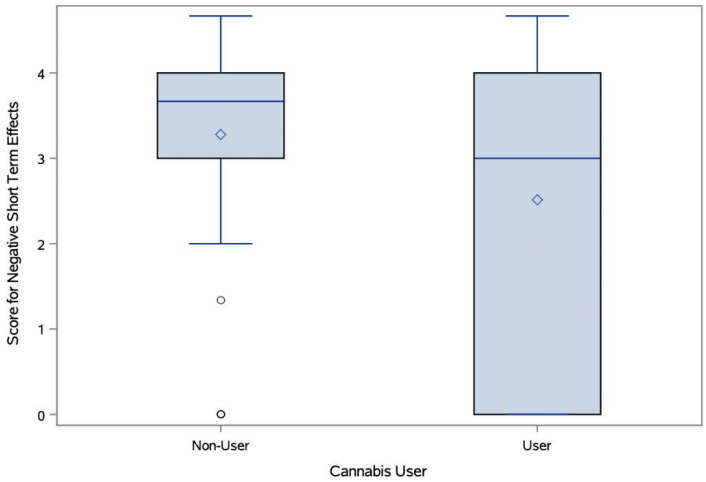


**Figure 3.** Negative short-term effects response scores by cannabis users compared to non-users.

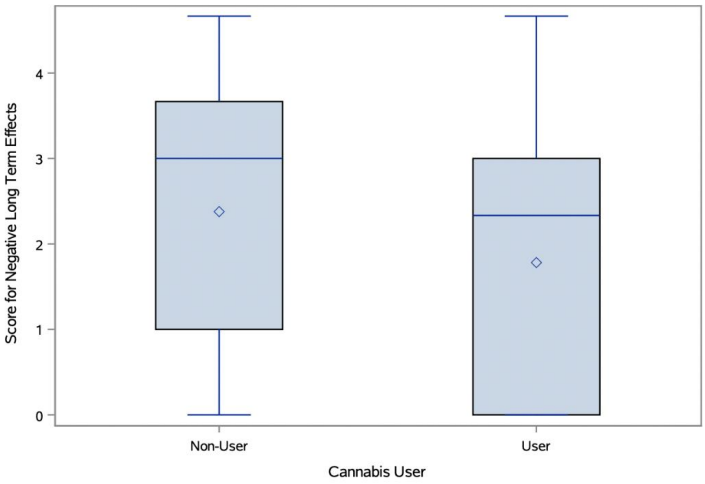


**Figure 4.** Negative long-term effects response scores by cannabis users compared to non-users.

smoking. Although no link has been established between cannabis use and cancer, research is ongoing. Cannabinoid hyperemesis syndrome is associated with weekly use of cannabis. Characterized by several cyclic vomiting episodes accompanied by abdominal pain, CHS may be due to derangements in the body's intrinsic control of nausea and vomiting from chronic overstimulation of endocannabinoid receptors. Further complications of this syndrome include acid/base abnormalities and aspiration pneumonitis.[24]

A recent study cited significant adverse health effects associated with legalization of recreational cannabis use, including psychosis, suicide, other substance use, increases in the number of fatal motor vehicle collisions, and others.[25] Another study made conclusions regarding heart disease, vascular accidents, and cannabis use. Cannabis is now emerging as a predictor or potential risk factor for heart failure and cerebrovascular accidents.[26] Jeffers et al recently published a study controlling for tobacco smoking when studying cannabis use and cardiovascular outcomes. Using a behavioral risk factor surveillance survey from 27 states in the US, the group suggested in their cross-sectional study that cannabis use is associated with higher risk of myocardial infarction and stroke.[27]

Visits to the ED involving cannabis use have increased 12-17% per annum over the past few decades.[28] The US Centers for Disease Control and Prevention (CDC) used national surveillance program data to study cannabis-related ED visits during the COVID-19 pandemic in 2020-2022 for people < 25 years of age. This analysis found that the largest increase in cannabis-related ED visits was in children ≤ 10 years of age from pre-pandemic to pandemic times.[29]

We found significant knowledge gaps among ED patients regarding cannabis use. Many patients, particularly cannabis users, are unaware of negative effects of cannabis use. As more US residents use cannabis as a recreational activity and as a medical therapy, informing and educating the public about the risks regarding cannabis, similar to alcohol and tobacco use prevention campaigns, is crucial. Future directions include public health measures to identify and correct knowledge gaps regarding safety of cannabis use and potential negative effects of cannabis use. Future research should also identify and quantify negative physiologic and cognitive effects to better inform safe medical use or avoidance of cannabis use.

## LIMITATIONS

Among the limitations of this study was its small sample size of 169 participants. Additionally, while the population demographics did match typical Pennsylvania demographics, this is specific to the state and may not be generalizable to the entire country. Further, the survey instrument was original and has not been validated. It should be noted that the number of eligible subjects was based on RA recall and that data were collected based on RA availability. Finally, because data were largely self-reported by participants, this could have led to potential bias, inaccuracy, or survey fatigue.

## CONCLUSION

Among ED patients who used cannabis, reasons cited for cannabis use included recreation, anxiety, pain, depression, and sleep. The study participants had significant knowledge gaps regarding effects of cannabis use, and these knowledge gaps were higher among cannabis users. Cannabis users were less likely to correctly identify negative short-term and long-term consequences of cannabis use, compared to non-users.

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# Development of a Low-Barrier, Reimbursable Take-Home Naloxone Program at a Regional Health System

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**Introduction:** Take-home naloxone (THN) programs in emergency departments (ED) can reduce opioid overdose deaths by providing naloxone directly to at-risk patients before discharge. However, sustainable models that integrate reimbursement and workflow alignment remain limited.

**Methods:** A reimbursable ED-led THN program was developed across a large regional health system. The program used electronic health record (EHR)–integrated ordering, on-site kit dispensing, and third-party insurance billing when available. Kits were stocked in automated medication dispensing systems and supplemented by city-provided stock for uninsured patients. Pilot outcomes included kits dispensed and reimbursement rates across eight participating EDs.

**Results:** A total of 2,520 naloxone kits were dispensed across eight EDs between January 2019–December 2024, with a total of 6,551 encounters with decision support prompting naloxone ordering (31.6% of eligible). The proportion of kits reimbursed by insurance rose from 46% in 2019 to 95% by 2025. In total, 89.9% of kits were reimbursed either by insurance or public supply (the rest paid by the hospital system). Kit distribution grew from 99 in 2019 to 702 in 2024, reflecting expanded site participation, improved workflows, and greater staff engagement.

**Conclusion:** A reimbursable ED-led naloxone program can increase access to life-saving medication for patients at risk of opioid overdose. Integrating take-home naloxone distribution into EHR workflows, leveraging insurance billing, and partnering with public health agencies offers a sustainable, low-barrier model that other health systems can adopt. [West J Emerg Med. 2025;26(6)1605–1610.]

## INTRODUCTION

Opioid overdose remains a leading cause of preventable death in the United States, further exacerbated by an increasingly complicated and adulterated illicit drug supply.[1] Hospital emergency departments (ED) are critical touchpoints for overdose prevention efforts. Being treated at an ED for a non-fatal overdose is a significant predictor of a subsequent fatal overdose, underscoring the need to reach an incredibly vulnerable population of people who use drugs.[2] Traditionally, patients at risk for opioid overdose might receive a naloxone

prescription in the ED to fill at a pharmacy later or may be told how to acquire naloxone on their own in the community. This approach often falls short with one nationwide analysis finding that only about 7% of ED visits for opioid overdose result in a naloxone prescription being issued, and an even smaller fraction are actually filled at an outside pharmacy.[3] Stigma from requesting this medication in a public setting is likely a contributing factor in this challenge.[4,5]

In practice, studies report that only approximately 1 in 5 ED naloxone prescriptions are picked up by patients.[6] The result is that many high-risk individuals leave the hospital without this critical tool. By contrast, take-home naloxone (THN) programs that dispense naloxone kits directly to patients before discharge can dramatically improve access and uptake. By reducing barriers to getting the medicine into the hands of patients, one program was able to offer naloxone to nearly 50% of eligible overdose patients when kits were given in the ED instead of relying on outpatient prescriptions.[7] Similarly, a recent multiphase study observed steep improvements in dispensing of naloxone when clinicians hand out kits and even more when all ED staff (nurses, pharmacists, etc) participated.[8] These data confirm that low-threshold THN models—where naloxone is provided immediately and without out of pocket expense, without extra steps for the patient—can greatly expand access in the ED setting.

Another crucial consideration in hospital naloxone programs is sustainability and cost.[9] Naloxone medications (especially intranasal formulations) have a significant unit cost, and hospitals must account for staff time to provide overdose education. Traditional insurance reimbursement mechanisms pose challenges: Most insurers will not reimburse a medication dispensed directly by the ED or inpatient unit (since those are billed under facility fees rather than outpatient pharmacy claims). Thus, if an ED simply hands out a kit from floor stock, the hospital may bear the cost unless alternative billing arrangements are in place.

Our health system implemented a THN program leveraging several of the following best practices: integrating distribution into the electronic health record (EHR) for billing when possible; providing kits free of charge at bedside; engaging multidisciplinary staff in the workflow; and using public partnerships for uninsured patients. We describe the development and pilot outcomes of this low-barrier, reimbursable naloxone distribution program in a large regional health system. The primary outcome was the number of naloxone kits dispensed from the EDs. We also discuss how our approach aligns with emerging evidence and share insights to inform similar efforts in other hospitals.

*Population Health Research Capsule*

What do we already know about this issue?
*Naloxone is a lifesaving medication that can be vital for those who use opioids. Dispensing naloxone after overdose is fundamental harm reduction.*

What was the research question?
*What evidence-based, practical steps can increase access and provision of naloxone from the emergency departments (ED) of a hospital system?*

What was the major finding of the study?
*2,520 naloxone kits were dispensed from eight EDs, from 6,551 eligible encounters (31.6%). The proportion of kits reimbursed by insurance rose from 46% in 2019 to 95% by 2025, with 89.9% overall reimbursed by insurance or public supply.*

How does this improve population health?
*Naloxone from the ED makes communities more resilient to the overdose crisis. By destigmatizing and normalizing harm reduction, health-positive care is possible.*

## METHODS

### Study Design and Setting

This study was an implementation science manuscript combined with a retrospective observational pilot study conducted from January 2019–December 2024 in Philadelphia, PA. The study took place across EDs within Jefferson Health, a large regional health system. Initially, four hospitals participated, with four additional hospitals added progressively over the study period, totaling eight dispensing sites by the study's conclusion.

### Participants

Participants included ED patients identified as at risk for opioid overdose based on predefined criteria, such as presentation for opioid overdose or opioid-related care. Patient selection occurred via automated prompts integrated within the EHR, as well as clinical discretion. We included all eligible patient encounters within participating EDs during the implementation period.

### Intervention

A multidisciplinary team of pharmacists, physicians, and nurses at Jefferson Health designed and implemented a THN program. The core intervention involved placing an order for naloxone kits via the EHR (Epic Systems Corporation, Madison, WI, and Cerner Millenium, Oracle Health, Kansas City, MO), which was automatically routed to the hospital

outpatient pharmacy for third-party insurance billing when possible and then dispensed through an automated medication storing/dispensing system (AMDS). Each kit contained two doses of 4 mg of intranasal naloxone as well as graphic and written instructions on use. Additionally, each kit had a sticker-based pharmacy prescription label (see Appendix 1), which was filled out and signed by a clinician or pharmacist to maintain regulatory requirements on medication provision in the ED.

In the hospitals using EPIC EHR, patients with a chief complaint of overdose who had opioid use disorder in their problem list or received an *International Classification of Diseases, 10th Rev*, diagnosis involving F11 codes also received active clinical decision support via a "best practice advisory," which fires in the disposition navigator, encouraging THN ordering. Naloxone nasal spray kits (two 4 mg Narcan nasal sprays per kit) were pre-stocked in AMDS within the EDs. Clinicians or pharmacists dispensed kits directly from these systems by labeling kits appropriately and handing them to nurses, who then provided the kits to patients at discharge along with brief overdose response education. This included instructions on how to identify an overdose, how to use the naloxone and its mechanism, and how to get additional community-based naloxone.

For insured patients whose claims were accepted, kits were billed as standard outpatient prescriptions; no co-pays were required. In the event a co-pay was required by the insurer, or the patient was uninsured, kits were provided free through a replenishment agreement with the Philadelphia Department of Public Health. The acquisition cost for naloxone kits ranged from free when provided by the city to a maximum of $36.81 per dispensed item if the hospital system paid for the item. Reimbursement was defined as being able to wholly cover the minimum costs of acquiring, storing, and dispensing the medication (approximately $40.00). Members of the outpatient pharmacy staff monitored an EHR naloxone-distribution report for doses dispensed. Staff would submit claims to insurers for reimbursable doses and document the date/time dispensed for city reporting purposes.

### Staff Training and Program Implementation

Staff received ongoing education through in-service training sessions, printed workflow guides, and EHR quick-reference sheets to facilitate consistent program adoption. Hospital-based peer specialists—those with lived experience who help engage and advocate for recovery—and social workers also played an active role in workflow dissemination to front-line caregivers. Implementation data collection included numbers of kits dispensed and insurance reimbursement rates, covering January 2019–December 2024.

### Outcomes and Variables

The primary outcome measured was the number of naloxone kits dispensed at discharge. Secondary outcomes included reimbursement rates, differentiated by insurance coverage or public health-provided supplies. Exposure to the intervention was defined by participation in the ED-led naloxone-dispensing protocol. Selection biases were minimized given the data was acquired and maintained through an automated electronic pharmacy database. Chart abstractors were not blinded to the study hypothesis.

### Statistical Analysis

Quantitative data, including dispensed naloxone kits and reimbursement rates, were analyzed descriptively. We summarized continuous data as totals and percentages, and trends annually and monthly. Analyses were performed using Microsoft Excel (Microsoft Corporation, Redmond, WA), focusing exclusively on descriptive statistics without hypothesis testing or adjustment for confounders. No formal sample-size calculation was conducted due to the pilot nature of this observational implementation study.

### Ethical Considerations/Funding

The institutional review board reviewed the study protocol and deemed it exempt based on its retrospective and de-identified nature. The study reporting follows the STROBE (Strengthening the reporting of observational studies in epidemiology) guidelines for observational studies.[10] The only external funding for this work was through the Philadelphia Department of Health, which provided dose-for-dose replenishment for any kits that could not be reimbursed through public or private insurers.

## RESULTS

This study was conducted from January 1, 2019–December 31, 2024. Across the entire study period, 2,520 naloxone kits were dispensed systemwide. The EDs that use the Epic EHR (all except the Einstein campuses) recorded a total of 6,551 patients for whom the best practice advisory fired, dispensing 2,073 naloxone kits (31.6%).

Naloxone distribution increased over time, from 99 kits in 2019 to 702 kits in 2024. This growth coincided with the introduction of EHR-integrated workflows, expansion to new campuses, and enhanced staff engagement. Figure 1 shows the continued rise in monthly dispensing through 2024. The most substantial contributions came from Jefferson Torresdale/Frankford (n=1,166 kits), Thomas Jefferson University Hospital (n=491), and Methodist Hospital (n=418). Newer participating hospitals, Einstein Philadelphia and Einstein Montgomery, dispensed 370 and 77 kits, respectively, despite joining the program mid-course.

Table 1 summarizes naloxone dispensing and reimbursement data by year and site. Across the program, 1,147 kits (43.9%) were reimbursed through third-party insurers (primarily Medicaid), and 1,178 kits (45.1%) were covered through a replacement agreement with the Philadelphia Department of Public Health. The rest were paid by the hospital system as part of operating costs. In total,

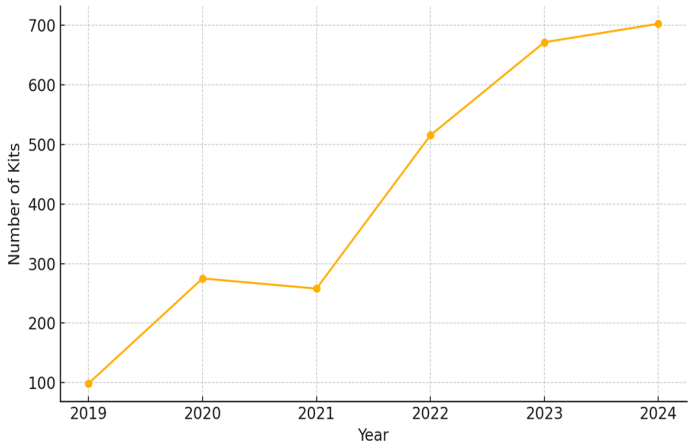


**Figure 1.** Annual number of take-home naloxone kits dispensed from emergency departments, 2019–2024.

2,265 of the 2,520 dispensed kits (89.9%) were reimbursed by either mechanism. No patients were charged directly for naloxone at any point, indicating strong fidelity to the program's low-barrier and no-cost design. The total cost savings, compared to the hospital system paying for every dispensed dose, was approximately $90,000.

Reimbursement performance improved over time. In 2019, only 46.5% of distributed kits were reimbursed. This increased to 100% by 2021, dipping only briefly during the onboarding of new hospitals to the program, and then exceeded 90% throughout 2023 and 2024.

## DISCUSSION

### Interpretation/Summary of Findings

The implementation of an ED-led take-home naloxone program was associated with increases in naloxone distribution, improved reimbursement over time, and broad uptake across a diverse group of hospitals. The intervention was built iteratively across the system and achieved sustainable fidelity through a focus on evidence-based insight and incremental improvement. This pilot demonstrates the feasibility and scalability of a hospital-based, reimbursable THN program. By integrating naloxone distribution into the existing ED workflow and EHR system, we were able to use third-party insurance billing when available and minimize additional steps for staff. The provision of free kits via the Philadelphia Department of Health ensured equitable access when insurance did not cover the cost. We observed year-over-year growth in naloxone dispensing across our EDs, which suggests increasing staff buy-in and patient acceptance over time.

### Comparison to Previous Studies

Notably, our experience aligns with broader evidence that bringing naloxone directly to the bedside improves access and can lead to overdose reversals in the community. Prior studies confirm that patients are far more likely to receive and use naloxone when it is dispensed on-site in the ED, rather than simply prescribed.[7,11,12] Many patients, however, still did not receive this intervention. This gap underscores the need for equity-focused ED protocols to ensure vulnerable groups are not overlooked in naloxone provision.[13] National data shows that THN is under-prescribed in EDs across the country, with even lower rates among women, older or younger patients, non-English speakers, and certain racial/ethnic groups.[14,15] Such disparities highlight areas for opportunity for improvement in equitable naloxone distribution from the ED.

### Strength and Clinical Interpretation

Our THN initiative adds to the growing evidence that health system-based programs can successfully reduce barriers and reach vulnerable patients who might otherwise not obtain naloxone. We demonstrated a model in which clinical workflows and billing mechanisms were leveraged to sustain the program, supplemented by public health partnerships.

### Clinical and Research Implication

Geographic barriers contributing to naloxone access

**Table 1.** Naloxone kit distribution totals and reimbursement outcomes by hospital site from 2019 –2024.

| Year/Month | TJU-CC | MHD | JNE | JHN | EinsteinP | EinsteinM | Abington | Lansdale |
|---|---|---|---|---|---|---|---|---|
| 2019 Summary | 35 | 36 | 28 | 0 | -- | -- | -- | -- |
| 2020 Summary | 80 | 52 | 142 | 1 | -- | -- | -- | -- |
| 2021 Summary | 71 | 68 | 119 | 0 | -- | -- | -- | -- |
| 2022 Summary | 121 | 82 | 189 | 1 | 58 | 14 | 36 | 14 |
| 2023 Summary | 88 | 83 | 309 | 0 | 140 | 30 | 16 | 5 |
| 2024 Summary | 92 | 90 | 352 | 0 | 120 | 28 | 14 | 6 |
| Total | 491 | 418 | 1,166 | 2 | 370 | 77 | 67 | 21 |

*TJU-CC,* Thomas Jefferson University Hospital; *MHD*, Jefferson Methodist Hospital; *JNE*, Jefferson Torresdale and Frankford Hospitals; *EinsteinP*, Jefferson Einstein Philadelphia Hospital; *EinsteinM*, Jefferson Einstein Montgomery Hospital; *Abington*, Jefferson Abington Hospital; *Lansdale*, Jefferson Lansdale Hospital

**Table 1.** Continued.

| Year/Month | Total # Dispensed | 3rd Party Reimbursement | Replacement Dose Provided by City | Total Reimbursed (%) |
|---|---|---|---|---|
| 2019 Summary | 99 | 33 | 13 | 46 (49) |
| 2020 Summary | 275 | 100 | 145 | 245 (89) |
| 2021 Summary | 258 | 149 | 109 | 258 (100) |
| 2022 Summary | 515 | 169 | 229 | 398 (77) |
| 2023 Summary | 671 | 314 | 306 | 620 (92) |
| 2024 Summary | 702 | 283 | 385 | 668 (95) |
| Total | 2,520 | 1,078 | 1,187 | 2,265 (90) |

inequity also exist; a spatial study noted that underserved areas are often at highest risk of having an overdose occur.[16] This is of concern as those experiencing homelessness are at greater risk for both fatal and non-fatal overdoses.[17,18] An ED- based program, by directly handing out kits, could help circumvent these "naloxone deserts" and reach patients who might otherwise have no access. Multiple studies reiterate that ED access is a strong first step in providing this community service.[19-20] Further addressing these issues in our THN naloxone program, for example, through stigma-reduction training and involving people with lived experience in program design, was essential to help ensure we reached as many individuals as possible. Future studies should continue to assess patient and clinician barriers to THN dispensing to vulnerable patients.

Additional clinical opportunities include providing THN to at-risk patients upon discharge from inpatient units, to individuals who are prescribed opioids but do not have an opioid use disorder, and exploring providing additional harm reduction supplies (eg, fentanyl test strips) at discharge. By making THN a routine part of emergency care, hospitals can play a crucial role in preventing overdose deaths and connecting high-risk patients to further services, ultimately contributing to a broader culture of harm reduction in healthcare.

## LIMITATIONS

This study was conducted as a pilot-program evaluation at a single regional health system, which limits generalizability. Our data reviewers were not blinded to our hypotheses. Our outcome data are primarily process-oriented (number of kits dispensed and reimbursement rates); we were not able to directly track demographics, the use of distributed naloxone kits, or the downstream impact on overdose events and patient behavior after ED discharge. Follow-up with patients was not performed. Additionally, while we infer that greater naloxone dispensing likely prevented some overdoses, we cannot definitively attribute any changes in overdose outcomes to our program alone. Another limitation is that our program's success was facilitated by unique resources such as an internal outpatient pharmacy and a city-supplied naloxone stock, which may not be available in all hospital settings.

Finally, cultural change among staff, while anecdotally observed, was not formally measured. Resistance or stigma in other settings could pose barriers that were addressed in our system via strong leadership support. Despite these limitations, we believe our findings demonstrate practical strategies that can be adapted elsewhere, and they highlight the need for further study (ideally multicenter and with patient follow-up) to fully quantify the benefits of ED THN distribution programs.

## CONCLUSION

Hospital-based and ED-based take-home naloxone distribution programs have emerged as a crucial component of the overdose response, offering a "low-barrier" safety net to individuals at high risk for opioid overdose. Our experience and the recent literature show that these programs are feasible to implement and can greatly increase the reach of naloxone into the community. Key elements for success include making naloxone readily accessible at patient discharge (preferably at no out-of-pocket cost), embedding the process into standard clinical workflows (with EHR support and multidisciplinary staff involvement), securing sustainable funding or reimbursement, and educating staff to foster a supportive, harm reduction-oriented culture. Continued innovation will be important to determine which workflow refinements or educational approaches yield the highest uptake, and how these programs can best link patients to long-term recovery resources. Future work should also evaluate longer term patient outcomes from such programs, including overdose mortality rates, subsequent treatment engagement, and cost effectiveness.

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# Intersectional Analysis of Suicide-related Emergency Department Visits in Youth in California, 2018–2021

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**Introduction:** The COVID-19 pandemic and related anti-Asian political rhetoric had a detrimental impact on the mental health of Asian American and Pacific Islander (AAPI) youth in the United States. Our objective was to quantify trends in suicide-related emergency department (ED) encounters among AAPI youth before and during the COVID-19 pandemic, using an intersectional lens of race and sex and to contextualize these trends on a timeline of political and social events (such as anti-Asian hate crimes) occurring during the same period in California.

**Methods:** Using data from the California State Emergency Department Database (SEDD) from 2018–2021, we evaluated changes in quarterly proportions of suicide-related ED encounters by age, race, and sex subgroups by comparing mean percentage change in proportions before and during the pandemic among patients 8-21 years of age. We evaluated changes in quarterly proportions of suicide-related ED encounters by age, race, and sex subgroups by comparing mean percentage changes as they related to events around the pandemic and spikes in anti-Asian hate crimes. To compare relative disparities during the periods, we used stratified adjusted mixed multilevel logistic regression, with White males as the reference group.

**Results:** The overall increase in suicide-related ED visits for all youth during this period was 49.5% (95% CI 46.7-52.2%), representing 2,637 more suicide-related ED visits in 2021 than 2018. The graphical observational analysis of changes in quarterly proportions of suicide-related ED visits showed some temporal correlation between spikes in rates among AAPI and American Indian and Alaska Native (AI/AN) females and specific events, such as anti-Asian hate crimes and school closings. The largest percentage increase was seen among females of all races, and in particular, AI/AN females (+58.1%, representing 471 more suicide-related ED visits in 2021 than 2018) and AAPI females (+57.5%, representing 1,545 more suicide-related ED visits in 2021 than 2018). During the pandemic, the adjusted odds of a suicide-related ED visit among AAPI females 13-17 years of age compared to White males was 2.01 (95% CI, 1.91-2.13). A total of 131 in-ED deaths occurred during the study period, with no significant year-to-year variation in the number of deaths.

**Conclusion:** Suicide-related ED visits increased for all youth during COVID-19, with the sharpest rise among AAPI and AI/AN females. Asian American and Pacific Islander females 8-12 and 13-17 years of age showed especially large increases. While causality cannot be inferred, patterns aligned with pandemic disruptions and anti-Asian hate crimes. Findings highlight the value of intersectional analysis to identify disproportionately impacted subgroups and inform future, culturally responsive suicide prevention efforts. [West J Emerg Med. 2025;26(6)1611–1621.]

## INTRODUCTION

The COVID-19 pandemic and related anti-Asian political rhetoric had a markedly detrimental impact on the mental health of people who identify as Asian American and Pacific Islander (AAPI) in the United States.[1-4] The rate of hate crimes against AAPI in the US increased considerably during the pandemic as compared to pre-pandemic years[5]; one national survey found that 60.7% of Asian Americans experienced at least one incident of verbal or physical discrimination between 2020-2021, and that being Asian American, female, and younger were some of the factors associated with increased discrimination.[6-7] According to a national poll conducted in April 2020, approximately 30% of all respondents witnessed an Asian person being "verbally blamed" for the pandemic.[8]

In parallel, emergency department (ED) visit rates for self-harm in adolescents and young adults exceeded that of middle-aged adults by approximately three-fold in 2020, and ED encounters for suicidal ideation and attempts among young people increased five-fold between 2011–2021.[9-10] These and other troubling indicators led the American Academy of Pediatrics to declare a national emergency in child and adolescent mental health in 2021, noting the disproportionate impact of the pandemic on ethnically and racially minoritized youth.[11] Adolescent females, in particular, have seen increases in rates of depression, anxiety, and suicidal thoughts and behaviors both before and during the pandemic.[10,12-15] For this reason, we used an intersectional lens in this analysis—an important tool in highlighting experiences and needs unique to those belonging to multiple marginalized groups, such as ethnoracially minoritized females.[14,16,17]

Among AAPI adults, racial discrimination has been associated with post-traumatic stress disorder, suicidal ideation, and all-cause mortality.[2,3,18] In a survey study of 1,697 AAPI university students in the US, discrimination related to COVID-19 was associated with higher odds of self-injury and suicidal ideation.[19] Despite this, little attention has been paid specifically to how the pandemic may have impacted the mental health of AAPI children and adolescents. To address these troubling trends, it is critical to understand the full impact of the COVID-19 pandemic on the mental health of all young people, especially subgroups such as young male and female AAPI in the US, who have previously not been considered high risk for suicidal thoughts and behaviors and yet have been deeply impacted by targeted, politically charged racism.[7,20,21]

In this work, we sought to quantify trends in suicide-related emergency department (ED) encounters among male and female young people from various racial and ethnic groups during the period of the COVID-19 pandemic. Our study is among the first to use a large, statewide ED dataset to conduct an intersectional analysis of suicide-related ED visits by race and sex, with a specific focus on AAPI youth. Most prior studies report aggregated racial groups or do not disaggregate trends by age-sex-race subgroups. Our stratified, longitudinal approach can identify disproportionately affected populations that may be obscured in more aggregated analyses. To this end, we used ED data from California, the state with the largest AAPI population in the US.[22] We used data from before COVID-19 (2018 and 2019) and during COVID-19 (2020 and 2021) to understand trends in suicide-related ED visits as they relate to historic events during this time, specifically quarantines, mandated statewide school closures, and marked increases in hate crimes against AAPI individuals in California that occurred in the spring and summer of 2020.[23]

*Population Health Research Capsule*

What do we already know about this issue?
*Youth mental health worsened during COVID-19, with rising emergency department visits for suicidal thoughts and behaviors and widening disparities across minoritized populations.*

What was the research question?
*How did suicide-related ED visits among Asian and other minoritized youth change during COVID-19 across race and sex groups?*

What was the major finding of the study?
*Asian American and Pacific Islander (AAPI) girls had 2.01 times higher odds of suicide-related ED visits during COVID-19 than White boys (95% CI, 1.91-2.13, P < 001).*

How does this improve population health?
*Spotlighting disparities identified youth subgroups at highest suicide risk during COVID-19 to inform targeted, culturally responsive prevention strategies.*

## METHODS

### Data Source and Sample

The ED visit data was derived from the Agency for Healthcare Research and Quality (AHRQ) Healthcare Cost and Utilization Project (HCUP) California State Emergency Department Database (SEDD) from 2018–2021. The SEDD is a complete registry of ED encounters that do not result in an admission and includes diagnoses and procedures as well as patient demographics (eg, age, race, ethnicity, sex), insurance information, and total amounts billed. For this study, we identified ED visits for patients 8-21 years of age. Detailed information on the SEDD is available on the HCUP website.[24]

This study was determined to be exempt from full institutional review board (IRB) review, by the institution's School of Medicine IRB.

**Case Definitions**

We classified age groups as 8-12, 13-17, and 18-21 years of age. The lower bound of eight years was chosen due to small numbers of suicide-related ED events among younger children in the data, making stratified analyses infeasible. We classified race and ethnicity according to the groupings within the SEDD, which included: "White," "Black," "Hispanic," "Asian or Pacific Islander" (identified here using the acronym AAPI), "Native American," and "other." For purposes of the analysis, we did not examine the grouping of "other," as we did not have details as to who may have been included in this group. The SEDD classifies sex only as "male" or "female"; accordingly, these groupings were used in this analysis, and the term "sex" is used throughout, noting that we do not actually have information about biological sex or gender identity.

We generated intersectional subgroups by combining sex and racial/ethnic group (ie, AAPI female, AAPI male, White female, White male, etc). Two proxies for socioeconomic status were used: 1) primary insurance, classified as "private," "public," or "none/other"; and 2) median income per patient's ZIP Code. We used *International Classification of Diseases, 10th. Modification* (*ICD-10*) diagnosis codes to identify suicide-related encounters. We chose to use a broad classification to encompass all potential suicide-related billing diagnoses including suicidal ideation (*ICD-10* code: R45851), suicide attempt ,and/or intentional self-harm with suicidal intent (*ICD-10* codes: T36-T65, X71-X83, T1491, T71112A-T71232S, X710XXA-X838XXS, Z915).[9,24]

**Data Analysis**

***Graphical Analysis***

We conducted an observational, descriptive analysis of temporally aligned trends in suicide-related ED encounters and key political and social events during the years of the COVID-19 pandemic. The percentage of all ED encounters with diagnosis codes for suicidal ideation, suicidal behavior, and/or self-harm with suicidal intent were calculated by race/sex subgroup as well as age subgroup. We used interclass correlation coefficients (ICC) to determine whether denominators (all ED visits) differed by subgroup from quarter to quarter and year to year, to ensure that trends in the proportion of suicide-related encounters were not biased due to changing denominators of ED visits from year to year. We compared characteristics of patients with and without suicide-related ED visits using chi-squared tests for categorical variables and Welch two-sample *t*-tests for continuous variables. Graphical representations of trends in quarterly proportions of suicide-related encounters were generated by race and age group, including markers for dates of specific policy changes in California, including quarantine, reported increases in racially motivated hate crimes, school closures, and vaccine availability for adolescents.

***Analysis of Percentage Change***

We compared the mean quarterly change by race and sex subgroups before and during the pandemic using Welch two-sample *t*-tests. The period before the COVID-19 pandemic was classified as Q1 of 2018 through and including Q1 of 2020, and the period during the COVID-19 pandemic was classified as Q2 of 2020 through and including Q4 of 2021.[25] We performed stratified analysis by sex and racial/ethnic subgroup as well as age groups.

***Relative Disparities Regression Analysis***

We used a series of unadjusted and adjusted mixed multilevel logistic regression models, stratified by pre- and during-COVID-19 periods, to understand differences in the relationship between suicide-related ED visits between sex and race subgroups. We used the White male subgroup as the reference category for three reasons: 1) this subgroup's historical prominence in suicide research and prevention frameworks; 2) consistently elevated suicide death rates relative to other groups; and 3) lower exposure to racism-related stressors during the pandemic.[26] This framing allows clearer contrast with subgroups that may have been experiencing disproportionate increases. As a result, the odds ratios indicated the odds of a suicide-related ED encounter for AAPI females, AAPI males, White females, etc, as compared to White males separately before and during the pandemic. Adjusted models included insurance type and household income quartile; hospital was treated as a nested level to account for potential clustering by hospital. Non-overlapping confidence intervals for the pre-during time periods indicated a significant change in odds between the periods, relative to White males. All statistical tests were two sided, with a $P$ value $\leq .05$ considered significant. We performed all statistical analyses using R software, v4.3.2 (The R foundation for Statistical Computing, Vienna, Austria) and RStudio software, v2023.12.0 (Posit PBC, Boston, MA).

## RESULTS

***Overall Trends in the Total Study Sample, 2019–2022***

The proportion of ED visits that were suicide-related in this population ranged from 3.3% in 2019 to 4.7% in 2021 (Table 1). The median age across all years was 16 (interquartile range 14,19), and the age category 13-17 years of age had the highest number of suicide-related ED visits as compared to all other age groups (50.0%, n = 116,754; Table 1). There were more suicide-related ED visits by females than males (60.9% vs 39.1%), and suicide-related ED visits were the most common within the Hispanic subgroup and White subgroup during the study period, although it should be noted that these groups had the highest number of ED visits overall (Table 1). When stratified by race and sex, the highest proportion of suicide-

**Table 1.** Characteristics of the study population by suicide-related and non-suicide-related visits.

| Characteristics | All ED Visits N | Suicide-related ED Visit [1] n (%) | Non-Suicide-related ED Visit [1] n (%) |
|---|---|---|---|
| N | 6,050,870 | 233,448% | 5,817,422% |
| Age | 16.0 (12.0, 19.0) | 16.0 (14.0, 19.0) | 16.0 (12.0, 19.0) |
| Age (Categorical) | | | |
| 8-12 years | 1,626,796 (26.9) | 31,614 (13.5) | 1,595,182 (27.4) |
| 13-17 years | 1,991,371 (32.9) | 116,754 (50.0) | 1,874,617 (32.2) |
| 18-21 years | 2,432,703 (40.2) | 85,080 (36.4) | 2,347,623 (40.4) |
| Sex | | | |
| Female | 3,270,817 (54.1) | 142,076 (60.9) | 3,128,741 (53.8) |
| Male | 2,780,053 (45.9) | 91,372 (39.1) | 2,688,681 (46.2) |
| Race | | | |
| AAPI | 298,190 (4.9) | 13,731 (5.9) | 284,459 (4.9) |
| AI/AN | 22,213 (0.4) | 1,068 (0.5) | 21,145 (0.4) |
| Black | 607,471 (10.0) | 21,789 (9.3) | 585,682 (10.1) |
| Hispanic | 3,482,055 (57.5) | 104,837 (44.9) | 3,377,218 (58.1) |
| White | 1,640,941 (27.1) | 92,023 (39.4) | 1,548,918 (26.6) |
| Insurance | | | |
| Medicare | 84,611 (1.4) | 3,530 (1.5) | 81,081 (1.4) |
| Medicaid | 3,562,367 (58.9) | 114,508 (49.1) | 3,447,859 (59.3) |
| Private Insurance | 1,855,930 (30.7) | 96,587 (41.4) | 1,759,343 (30.2) |
| Self-Pay/ Other/ None/ Unknown | 547,962 (9.1) | 18,823 (8.0) | 529,139 (9.1) |
| Race/Sex | | | |
| AAPI, male | 149,067 (2.5) | 4,964 (2.1) | 144,103 (2.5) |
| AAPI, female | 149,123 (2.5) | 8,767 (3.8) | 140,356 (2.4) |
| AI/AN, male | 9,803 (0.2) | 415 (0.2) | 9,388 (0.2) |
| AI/AN, female | 12,410 (0.2) | 653 (0.3) | 11,757 (0.2) |
| Black, male | 262,297 (4.3) | 8,350 (3.6) | 253,947 (4.4) |
| Black, female | 345,174 (5.7) | 13,439 (5.8) | 331,735 (5.7) |
| Hispanic, male | 1,608,210 (26.6) | 41,969 (18.0) | 1,566,241 (26.9) |
| Hispanic, female | 1,873,845 (31.0) | 62,868 (26.9) | 1,810,977 (31.1) |
| White, male | 750,676 (12.4) | 35,674 (15.3) | 715,002 (12.3) |
| White, female | 890,265 (14.7) | 56,349 (24.1) | 833,916 (14.3) |
| Median Household Income Quartile | | | |
| Q1 | 2,176,204 (36.0) | 65,107 (27.9) | 2,111,097 (36.3) |
| Q2 | 1,735,094 (28.7) | 64,882 (27.8) | 1,670,212 (28.7) |
| Q3 | 1,262,816 (20.9) | 57,189 (24.5) | 1,205,627 (20.7) |
| Q4 | 876,756 (14.5) | 46,270 (19.8) | 830,486 (14.3) |
| Year | | | |
| 2018 | 1,763,631 (29.1) | 59,646 (25.6) | 1,703,985 (29.3) |
| 2019 | 1,761,692 (29.1) | 58,698 (25.1) | 1,702,994 (29.3) |
| 2020 | 1,192,620 (19.7) | 52,821 (22.6) | 1,139,799 (19.6) |
| 2021 | 1,332,927 (22.0) | 62,283 (26.7) | 1,270,644 (21.8) |

[1]*P*-value not shown. All differences were significant at the $P < .001$ level. Pearson chi-squared test was used for categorical variables, and Welch two-sample *t*-test for continuous variables.
*ED,* emergency department; *AAPI,* Asian American Pacific Islander; *AI/AN,* American Indian and Alaska Native.

related ED visits overall were among White females (6.3%), Asian females (5.3%), and White males (4.8%) (Table 1). The highest proportion of suicide-related ED visits was among patients with either private insurance (5.2%) or Medicare (4.2%), or as the expected primary payor (Table 1). The ICC analysis indicated that the overall number of ED visits by race/ethnic and sex subgroup did not change significantly from year to year and, thus, was not the underlying reason for trends in the proportion of suicide-related ED encounters.

### *Graphical Analysis*

In the graphical analysis of quarterly trends in the proportion of suicide-related ED visits during the study period, there was a notable increase in all subgroup rates in the second quarter of 2020, coinciding with the beginning of the COVID-19 pandemic. Before the second quarter of 2020, AAPI, American Indian and Alaska Native (AI/AN), and White females had the highest proportions of suicide-related ED visits, and by the end of 2020, ED visits among these groups peaked at 10%, increasing the gap between the three groups and the other subgroups (Figure 1). While all subgroup rates increased during the COVID-19 pandemic period, the highest proportions of suicide-related ED visits were among AAPI and White females. When compared to a contextual overlay of social and political events at that time, the rates track with statewide school closures and mask mandates, as well as anti-Asian hate crimes in California, which increased by 162% in 2020 as compared to the average number of hate crimes over the previous four years.[23] The proportions leveled off closer to 7% in late 2021, which corresponds with the time when vaccines became available for adolescents and schools reopened (Figure 2).

### *Analysis of Percentage Change*

The overall increase in suicide-related ED visits for all youth during this period was 49.5% (95% CI, 46.7-52.2%), representing 2,637 more suicide-related ED visits in 2021 than 2018. Among all ages, the largest increases in mean quarterly percentage of suicide-related ED visits were seen among females and ranged from an increase of 52.6% among White females to a 58.1% increase among AI/AN females, with AAPI females demonstrating the second highest increase of 57.5% (Table 2). Comparatively, the increases in mean quarterly percentage of suicide-related ED visits among males ranged from an increase of 25.5% among White males to a 43.1% increase among AI/AN males, with AAPI males having the second lowest increase of 28.8%. There is notable variation by age, among youth 8-12 years of age. Black females saw an increase of 103.2%, representing a more than double increase between the two time periods, while AAPI females saw an increase of 91.6%, which was the second-largest increase in this age group. Among youth 13-17 years of age, the greatest increase was seen among AI/AN males (90.6%), but the second through sixth largest increases were all among females, with the second largest increase among AAPI females (77.6%). Among youth 18-21 years of age, the increases were not as dramatic, with most in the 20% range, although AI/AN females saw an increase of 62.1% (Table 2).

### *Relative Disparities Regression Analysis*

In the adjusted analysis, most male racial and ethnic subgroups of youth were as likely or less likely than White males to have a suicide-related ED encounter, both before and during the pandemic (Table 3). White, AAPI and AI/AN females generally had increased odds of an ED encounter both before and during the pandemic and, with the exception of AI/AN females, the confidence intervals for the pre- and during periods did not overlap, indicating a significantly increased difference in odds of a suicide-related ED encounter during the pandemic. The most pronounced odds of suicide-related

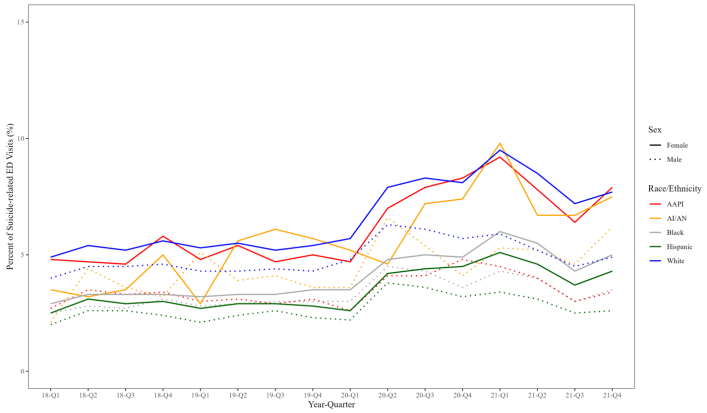


**Figure 1.** Quarterly trends in suicide-related emergency department visits by race and sex, 8-21 years of age, 2018-2021. *ED,* emergency department; *AAPI,* Asian American Pacific Islander; *AI/AN,* American Indian and Alaska Native.

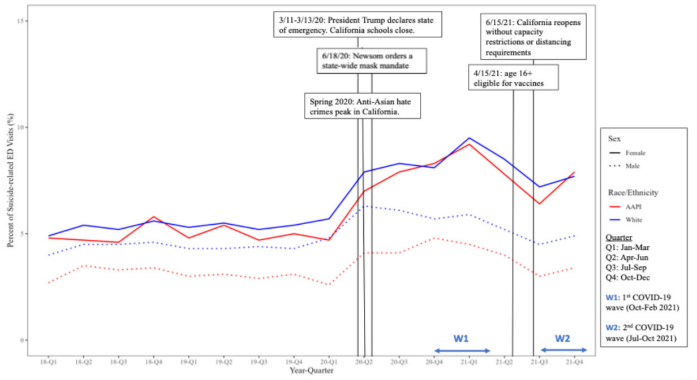


**Figure 2.** COVID-19-related annotated quarterly trends in suicide-related emergency department visits in California among AAPI and White males and females, 8-21 years of age, 2018-2021. *ED,* emergency department; *AAPI,* Asian American Pacific Islander.

**Table 2.** Mean quarterly percentage of suicide-related emergency department encounters by race/ethnicity and age group before and during the COVID-19 pandemic (2018-2021, N = 6,050,870).

| | Pre-COVID-19 | | During COVID-19 | | | |
|---|---|---|---|---|---|---|
| | Mean | 95% CI | Mean | 95% CI | % Change | P-value[1] |
| All Ages (8-21) | | | | | | |
| AAPI, male | 3.09 | 2.85, 3.33 | 3.98 | 3.40, 4.56 | 28.80 | .008 |
| AAPI, female | 4.94 | 4.64, 5.24 | 7.78 | 6.95, 8.61 | 57.49 | < .001 |
| AI/AN, male | 3.74 | 3.10, 4.37 | 5.35 | 4.58, 6.12 | 43.05 | .002 |
| AI/AN, female | 4.51 | 3.56, 5.47 | 7.13 | 5.70, 8.56 | 58.09 | .004 |
| Black, male | 2.87 | 2.73, 3.00 | 3.89 | 3.38, 4.40 | 35.54 | .002 |
| Black, female | 3.30 | 3.17, 3.42 | 5.06 | 4.55, 5.58 | 53.33 | < .001 |
| Hispanic, male | 2.37 | 2.20, 2.53 | 3.19 | 2.75, 3.63 | 34.60 | .003 |
| Hispanic, female | 2.83 | 2.68, 2.97 | 4.41 | 4.02, 4.80 | 55.83 | < .001 |
| White, male | 4.40 | 4.22, 4.57 | 5.52 | 4.90, 6.15 | 25.45 | .004 |
| White, female | 5.36 | 5.16, 5.56 | 8.18 | 7.51, 8.85 | 52.61 | < .001 |
| Ages 8-12 | | | | | | |
| AAPI, male | 1.24 | 1.00, 1.47 | 1.43 | 0.89, 1.98 | 15.32 | .44 |
| AAPI, female | 2.03 | 1.80, 2.27 | 3.89 | 2.99, 4.78 | 91.63 | .002 |
| AI/AN, male | 2.28 | 1.31, 3.25 | 2.54 | 1.27, 3.81 | 11.40 | .71 |
| AI/AN, female | 3.10 | 0.90, 5.29 | 4.15 | 2.39, 5.91 | 33.87 | .39 |
| Black, male | 1.69 | 1.49, 1.90 | 2.57 | 2.00, 3.14 | 52.07 | .008 |
| Black, female | 1.86 | 1.67, 2.05 | 3.78 | 2.98, 4.57 | 103.23 | < .001 |
| Hispanic, male | 1.24 | 1.00, 1.47 | 1.53 | 1.31, 1.76 | 23.39 | .05 |
| Hispanic, female | 1.59 | 1.43, 1.76 | 2.85 | 2.45, 3.26 | 79.25 | < .001 |
| White, male | 2.18 | 1.93, 2.43 | 2.70 | 2.34, 3.06 | 23.85 | .02 |
| White, female | 2.64 | 2.38, 2.90 | 4.94 | 4.41, 5.47 | 87.12 | < .001 |
| Ages 13-17 | | | | | | |
| AAPI, male | 4.08 | 3.66, 4.51 | 5.51 | 4.25, 6.78 | 35.05 | .03 |
| AAPI, female | 7.55 | 6.93, 8.18 | 13.41 | 11.49, 15.34 | 77.62 | < .001 |
| AI/AN, male | 4.37 | 3.59, 5.14 | 8.33 | 7.22, 9.45 | 90.62 | < .001 |
| AI/AN, female | 7.50 | 5.95, 9.04 | 11.21 | 9.10, 13.33 | 49.47 | .005 |
| Black, male | 3.48 | 3.22, 3.73 | 4.85 | 4.02, 5.68 | 39.37 | .006 |
| Black, female | 5.65 | 5.33, 5.97 | 9.23 | 8.12, 10.35 | 63.36 | < .001 |
| Hispanic, male | 3.02 | 2.91, 3.13 | 3.96 | 3.29, 4.62 | 31.13 | .01 |
| Hispanic, female | 4.62 | 4.41, 4.84 | 7.75 | 6.87, 8.64 | 67.75 | < .001 |
| White, male | 5.64 | 5.31, 5.98 | 7.14 | 6.11, 8.17 | 26.60 | .01 |
| White, female | 8.77 | 8.29, 9.26 | 14.23 | 12.75, 15.71 | 62.26 | < .001 |
| Ages 18-21 | | | | | | |
| AAPI, male | 3.99 | 3.75, 4.24 | 4.46 | 3.81, 5.11 | 11.78 | .14 |
| AAPI, female | 4.68 | 4.39, 4.98 | 5.62 | 5.34, 5.91 | 20.09 | < .001 |
| AI/AN, male | 4.34 | 3.47, 5.20 | 4.51 | 2.74, 6.27 | 3.92 | .84 |
| AI/AN, female | 3.09 | 2.10, 4.09 | 5.01 | 3.64, 6.38 | 62.14 | .02 |
| Black, male | 3.33 | 3.10, 3.55 | 3.99 | 3.64, 4.35 | 19.82 | .003 |
| Black, female | 2.63 | 2.49, 2.77 | 3.51 | 3.20, 3.83 | 33.46 | < .001 |
| Hispanic, male | 2.99 | 2.85, 3.14 | 3.64 | 3.26, 4.02 | 21.74 | .005 |
| Hispanic, female | 2.19 | 2.06, 2.32 | 2.75 | 2.60, 2.90 | 25.57 | < .001 |
| White, male | 5.01 | 4.73, 5.29 | 5.84 | 5.32, 6.35 | 16.57 | .007 |
| White, female | 4.16 | 4.00, 4.33 | 5.18 | 4.74, 5.63 | 24.52 | < .001 |

*CI,* confidence interval; *AAPI,* Asian American Pacific Islander; *AI/AN,* American Indian and Alaska Native.

**Table 3.** Odds of suicide-related emergency department encounter by race/ethnicity and age group before and during the COVID-19 pandemic (2018-2021, N = 6,050,870).
*Mixed multilevel logistic regression analysis, hospital as nested level*

| | Pre-COVID-19 (2018-2019) | | During COVID-19 (2020-2021) | |
|---|---|---|---|---|
| | OR (95% CI) | aOR† (95% CI) | OR (95% CI) | aOR† (95% CI) |
| All Ages (8-21) | | | | |
| White, male | Reference | Reference | Reference | Reference |
| White, female | 1.24 (1.22-1.26)** | 1.23 (1.21-1.25)** | 1.56 (1.52-1.59)** | 1.56 (1.52-1.59)** |
| AAPI, male | 0.69 (0.66-0.72)** | 0.71 (0.68-0.74)** | 0.69 (0.66-0.72)** | 0.70 (0.67-0.74)** |
| AAPI, female | 1.12 (1.08-1.15)** | 1.13 (1.09-1.16)** | 1.43 (1.38-1.48)** | 1.46 (1.41-1.52)** |
| AI/AN, male | 0.94 (0.82-1.07) | 0.98 (0.86-1.12) | 1.05 (0.90-1.22) | 1.15 (0.98-1.34) |
| AI/AN, female | 1.13 (1.01-1.25)* | 1.19 (1.07-1.32)* | 1.43 (1.26-1.62)** | 1.49 (1.31-1.69)** |
| Black, male | 0.68 (0.66-0.70)** | 0.77 (0.75-0.80)** | 0.70 (0.67-0.73)** | 0.80 (0.77-0.84)** |
| Black, female | 0.79 (0.77-0.81)** | 0.90 (0.88-0.93)** | 0.95 (0.92-0.98)** | 1.11 (1.07-1.15)** |
| Hispanic, male | 0.58 (0.57-0.59)** | 0.68 (0.66-0.69)** | 0.60 (0.58-0.61)** | 0.69 (0.67-0.70)** |
| Hispanic, female | 0.70 (0.69-0.71)** | 0.80 (0.78-0.81)** | 0.86 (0.84-0.88)** | 0.98 (0.95-1.00)* |
| Ages 8-12 | | | | |
| White, male | Reference | Reference | Reference | Reference |
| White, female | 1.22 (1.16-1.29)** | 1.24 (1.18-1.30)** | 1.92 (1.80-2.04)** | 1.94 (1.82-2.06)** |
| AAPI, male | 0.57 (0.51-0.63)** | 0.57 (0.51-0.64)** | 0.56 (0.48-0.65)** | 0.56 (0.48-0.65)** |
| AAPI, female | 0.97 (0.88-1.06) | 0.97 (0.88-1.07) | 1.46 (1.31-1.64)** | 1.47 (1.31-1.64)** |
| AI/AN, male | 1.05 (0.77-1.44) | 1.09 (0.80-1.49) | 1.13 (0.74-1.72) | 1.20 (0.79-1.82) |
| AI/AN, female | 1.17 (0.87-1.57) | 1.24 (0.93-1.67) | 1.68 (1.16-2.44)* | 1.80 (1.24-2.61)* |
| Black, male | 0.79 (0.73-0.86)** | 0.86 (0.80-0.93)** | 0.91 (0.82-1.00) | 0.99 (0.89-1.1) |
| Black, female | 0.89 (0.82-0.96)* | 0.97 (0.90-1.05) | 1.41 (1.29-1.55)** | 1.54 (1.41-1.69)** |
| Hispanic, male | 0.57 (0.55-0.60)** | 0.63 (0.60-0.67)** | 0.60 (0.56-0.64)** | 0.66 (0.61-0.70)** |
| Hispanic, female | 0.75 (0.72-0.79)** | 0.83 (0.79-0.87)** | 1.13 (1.06-1.20)** | 1.24 (1.16-1.32)** |
| Ages 13-17 | | | | |
| White, male | Reference | - | Reference | - |
| White, female | 1.62 (1.58-1.67)** | 1.65 (1.60-1.69)** | 2.21 (2.15-2.29)** | 2.25 (2.18-2.32)** |
| AAPI, male | 0.73 (0.69-0.78)** | 0.74 (0.70-0.79)** | 0.74 (0.69-0.80)** | 0.74 (0.69-0.80)** |
| AAPI, female | 1.40 (1.33-1.46)** | 1.43 (1.36-1.50)** | 2.02 (1.91-2.13)** | 2.05 (1.94-2.17)** |
| AI/AN, male | 0.87 (0.71-1.07) | 0.94 (0.77-1.16) | 1.32 (1.06-1.65)* | 1.43 (1.15-1.79)* |
| AI/AN, female | 1.62 (1.40-1.87)** | 1.76 (1.53-2.04)** | 1.77 (1.50-2.10)** | 1.91 (1.61-2.27)** |
| Black, male | 0.64 (0.61-0.68)** | 0.73 (0.69-0.77)** | 0.64 (0.60-0.68)** | 0.74 (0.69-0.78)** |
| Black, female | 1.08 (1.03-1.12)** | 1.25 (1.2-01.30)** | 1.34 (1.28-1.40)** | 1.56 (1.49-1.64)** |
| Hispanic, male | 0.58 (0.57-0.60)** | 0.68 (0.66-0.70)** | 0.56 (0.54-0.58)** | 0.66 (0.64-0.69)** |
| Hispanic, female | 0.92 (0.89-0.94)** | 1.07 (1.05-1.11)** | 1.19 (1.16-1.23)** | 1.41 (1.36-1.45)** |

*Indicates significance at the $P < .05$ level.
**Indicates significance at the $P < .001$ level.
†Adjusted for insurance type and median household income quartiles
*OR,* odds ratio; *aOR,* adjusted odds ratio; *AAPI,* Asian American Pacific Islander; *AI/AN,* American Indian and Alaska Native.

ED encounters occurred among youth 13-17 years of age during the pandemic, as AAPI and White females were more than twice as likely to have an ED encounter for a suicide-related cause as White males (AAPI females, OR 2.01, 95% CI, 1.91-2.13; White females, OR 2.21, 95% CI, 2.15-2.29).

## DISCUSSION

In 2020, a study by Lo et al used the AHRQ Nationwide Emergency Department Sample (NEDS) and methods similar to those in this work to determine that between 2007–2016 there was a five-fold increase in the proportion of suicide-

**Table 3.** Continued.

| | Pre-COVID-19 (2018-2019) | | During COVID-19 (2020-2021) | |
|---|---|---|---|---|
| | OR (95% CI) | aOR† (95% CI) | OR (95% CI) | aOR† (95% CI) |
| Ages 18-21 | | | | |
| White, male | Reference | - | Reference | - |
| White, female | 0.84 (0.81-0.86)** | 0.85 (0.83-0.88)** | 0.89 (0.86-0.92)** | 0.90 (0.87-0.93)** |
| AAPI, male | 0.76 (0.71-0.80)** | 0.76 (0.71-0.81)** | 0.73 (0.68-0.79)** | 0.73 (0.68-0.79)** |
| AAPI, female | 0.89 (0.85-0.94)** | 0.90 (0.86-0.95)** | 0.95 (0.89-1.01) | 0.96 (0.91-1.03) |
| AI/AN, male | 0.94 (0.77-1.15) | 0.98 (0.80-1.20) | 0.81 (0.62-1.05) | 0.87 (0.67-1.13) |
| AI/AN, female | 0.64 (0.52-0.77)** | 0.69 (0.57-0.84)** | 0.92 (0.74-1.14) | 1.00 (0.80-1.24) |
| Black, male | 0.68 (0.64-0.71)** | 0.75 (0.72-0.79)** | 0.70 (0.66-0.74)** | 0.77 (0.72-0.81)** |
| Black, female | 0.54 (0.51-0.56)** | 0.61 (0.58-0.64)** | 0.61 (0.58-0.64)** | 0.68 (0.65-0.72)** |
| Hispanic, male | 0.63 (0.61-0.65)** | 0.71 (0.69-0.73)** | 0.65 (0.63-0.68)** | 0.72 (0.70-0.75)** |
| Hispanic, female | 0.46 (0.45-0.48)** | 0.53 (0.51-0.54)** | 0.49 (0.48-0.51)** | 0.55 (0.53-0.57)** |

*Indicates significance at the $P < .05$ level.
**Indicates significance at the $P < .001$ level.
†Adjusted for insurance type and median household income quartiles
*OR,* odds ratio; *aOR,* adjusted odds ratio; *AAPI,* Asian American Pacific Islander; *AI/AN,* American Indian and Alaska Native.

related ED visits among young people.[27] The trends we found raise similar concern about accelerating rates of suicide-related ED visits among adolescents in California over a short time frame. The lack of available longitudinal race data in the NEDS made it impossible to explore racial differences in suicide-related ED visit trends, an important step in fully understanding the landscape of suicide prevention needs. In this study, we used the SEDD dataset to explore racial differences in suicide-related ED visits.

Although suicide-related ED visit proportions increased for all racial/ethnic subgroups during COVID-19, we found that AAPI and AI/AN females had the greatest percentage increase across all ages combined. The mean percentage of suicide-related ED visit rates for AAPI females almost doubled for those 8- 12 years of age during the pandemic, and the greatest increase was seen among youth 13-17 years of age. This is consistent with previous research findings that young AAPI females suffered disproportionately from racism during the period of the COVID-19 pandemic.[7] The proportions of suicide-related ED encounters among AAPI females tracked closely not only with COVID-19-related school closures and isolation orders but also with the uptick in anti-Asian hate crimes in California in 2020 (Figure 2).[23]

It is clear from the graphical analysis presented in Figure 1 that the mental health of all youth was negatively impacted during the COVID-19 pandemic, regardless of sex and race or ethnicity. Our analysis focused on the outcome of suicide-related ED encounters, as opposed to death by suicide to more broadly capture mental health indicators specific to females, a group generally less likely to die by suicide than males, but more likely to suffer from depression and anxiety.[29-31] We additionally found that after adjusting for insurance type and median household income quartiles, the odds of having suicide-related ED encounters increased during the pandemic universally among females as compared to those before the pandemic. This is consistent with previous findings that females from all racial/ethnic groups may have experienced a greater overall negative emotional impact as a result of the pandemic than male peers,[7,15,32-35] as well as increased suicide-related ED visits during the pandemic.[36] While the acute phase of the pandemic has ended, the mental health effects on youth, particularly among marginalized groups, are ongoing. Suicide-related ED visits remain elevated, and our findings highlight youth populations (eg, AAPI females, AI/AN youth) who may have been under-recognized.

## LIMITATIONS

It is important to acknowledge the limitations associated with using clinical data, such as the SEDD, for this type of research. The SEDD only includes patients discharged from the ED, excluding those admitted to the hospital who may have more serious presentations of suicide risk. We found that while AAPI and AI/AN males had the lowest proportions of suicide-related ED visits (2.1% and 0.2%, respectively), these two groups had the highest mortality rates after presentation to the ED (14.1 and 24.3 per 100,000, respectively; Supplemental Table 1). That said, mortality data from the SEDD should be interpreted with caution, as these data would only have captured the subset of patients who were admitted to the ED alive but died subsequently.[24] Neither do the SEDD's data elements include suicide risk screening information (such as the ASK [ask suicide-screening questions] tool), leaving opportunities for missing individuals who may have screened positive for suicide risk but did not

have an *ICD-10* code related to suicide risk.[24] Finally, *ICD-10* codes for intentional self-harm may include some accidental self-harm events, particularly among younger children, potentially inflating suicide-related visit estimates.[37,38]

The SEDD only collects sex and gender data as "male" or "female," which did not allow for the exploration of suicide-related ED encounters among transgender and non-gender conforming youth in this analysis; this is an important area for future research. Similar to many other large datasets, the SEDD's categories of race and ethnicity do not allow for a more granular focus on the many heterogenous groups that make up each of the racial subgroups used in this analysis. The grouping AAPI, in particular, represents a wide array of cultural backgrounds, languages, immigration histories, generational statuses, and belief systems, and this certainly represents an area for further study.[6] It should be noted that causal inferences cannot be drawn from our graphical analysis of temporal associations between social and political events during the pandemic and suicide-related ED encounters. However, the temporal alignment between public events (eg, spike in anti-Asian hate crimes) and ED visit trends offers a hypothesis-generating basis for future studies that incorporate direct measures of discrimination and longitudinal mental health outcomes.

We believe the strengths associated with using SEDD data in this work far outweigh these limitations. The SEDD is a large, longitudinal data source containing detailed information on patient demographics, diagnosis codes and disposition, and has very few missing data.[24] The California SEDD, in particular, represents a large, diverse patient population, providing enough statistical power for our disaggregated analysis. While this paper primarily focuses on the AAPI population, it is worth stressing the need for more research into the mental health of young females in general and specific minority groups such as Black females 8-12 years of age, among whom the proportion of suicide-related ED encounters more than doubled (103%) during the COVID-19 pandemic. Similar to the AAPI population during the pandemic, Black Americans faced increased stress during the pandemic related to concurrent events, such as media attention surrounding Black Lives Matter and police violence against unarmed Black citizens.[39-42]

## CONCLUSION

Broadly speaking, a more complete understanding of the intersectional epidemiology of suicide risk is an important step toward preventing suicide-related ED encounters and addressing the national youth mental health crisis. The 2024 National Strategy for Suicide Prevention[43] provides an actionable framework for policymakers to enact a wide range of upstream and downstream, evidence-based suicide-prevention solutions, from large-scale efforts like infrastructure building and prioritizing equity to more specific efforts such as increasing mental health services capacity, lethal means reduction, and crisis care accessibility. Legislators should support continued funding of the 988 platform and related communication programs, and health systems should ensure that systems are in place to identify, support, and appropriately follow up with patients at risk for suicide. Our findings support the prioritization of intensive, multifaceted, culturally sensitive approaches to suicide prevention research and mental health programming to ensure that all young people with mental health needs are identified and provided with the best possible care.

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# Sociodemographic and Health Behaviour of Frequent, Avoidable Emergency Department Users in Ontario, Canada: A Population-based Descriptive Study

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**Introduction:** Frequent users are a small but important group of patients in the emergency department (ED). This group is often the target of interventions that redirect visits to other areas of the healthcare system under the premise that some of these visits could be best managed elsewhere. Most existing interventions do not consider sociodemographic factors when targeting specific populations, while larger scale policy initiatives often do not reach those who would most benefit from alternative points of healthcare access. In this study we use population-level survey data linked to health administrative data to describe frequent ED users and those whose visits are potentially avoidable and could benefit from additional points of healthcare access.

**Methods:** This was a population-based cohort study of responses from 18-74 year-old Ontario residents to the Canadian Community Health Survey from 2001–2014, which we linked to administrative health data for one-year following survey completion. We categorized participants according to the frequency of their ED use in the year following survey date and whether any of their visits were potentially avoidable. Associations between category of ED use and various sociodemographic, health, and behavioural factors were examined with multinomial logistic regression.

**Results:** A total of 181,369 eligible respondents were included in this study. Of these, 1,460 (0.8%) were frequent users (four or more visits) with one or more potentially avoidable visits in the year following survey date. Compared to non-ED users, frequent users with avoidable visits were associated with the lowest quintile of household income (aOR: 1.91, 95% CI: 1.37, 2.65), rural-dwelling (aOR: 1.44, 95% CI: 1.18, 1.77), and the highest quintile of material resource deprived neighbourhoods (aOR: 2.23, 95% CI: 1.47, 3.36). They were more likely to have poor self-reported physical (17.2% vs 9.0%) and mental health (4.1% vs 2.7%) compared to total cohort, and more likely to have comorbidities (63.3% vs 48.7%), but less likely to access a usual provider of care for their healthcare needs (33.3% vs 28.2% without a usual provider of care).

**Conclusion:** This study provides a novel description of frequent ED users for whom some of their visits were potentially avoidable. As efforts are made to redesign access to primary and community care, and with increasing emphasis on virtual care and other initiatives to reduce avoidable ED use, the healthcare system should ensure that these interventions are responsive to the needs of the people at higher likelihood of needing them. [West J Emerg Med. 2025;26(6)1622–1639.]

## INTRODUCTION

Frequent users represent a small but important group of patients in the emergency department (ED). Although no standard definition exists, they are often defined as those with four or more visits within a year.[1,2] These individuals represent less than 5% of visitors but account for up to 30% of all ED visits.[1–6] Frequent users have been the focus of many initiatives to reduce frequent ED use in favour of other options for care, both in the form of large-scale policy (eg, telehealth, ED dis-incentive programs) and smaller scale interventions (eg, case management programs, individual care plans), which have had mixed results in curtailing frequent ED usage.[5–9] A recent mapping review by Memedovich et al identified 58 studies from 2013–2023 that aimed to address frequent users in an ED setting.[7] Most existing programs were created for specific conditions or for populations such as older adults, but the authors identified that very few of the studies considered mental health conditions or sociodemographic characteristics, such as income and racial or indigenous identity.[7]

In Canada, there has been an increase in health system strategies, including team-based primary care and digital health solutions such as virtual care and telehealth, which offer differing approaches to providing alternative points of care for patients who may not require management in the ED setting. In Ontario, patients receiving primary care delivered by a team-based model had lower rates of ED use compared to patients participating in nonteam practice.[10] However, these team-based models are not universally available— particularly for patients living in more rural or remote regions who may be in greater need of healthcare.[10,11] Virtual care in various forms proliferated throughout the COVID-19 pandemic as a means to reduce in-person healthcare use, including ED visits. However, when delivered by clinicians without an ongoing relationship with the patient (ie, emergency or walk-in services), virtual care was not found to necessarily keep patients from visiting the ED.[12,13] It is also not clear whether virtual care is reaching those most in need or even the most appropriate care modality for many conditions. Virtual care evaluations in both Ontario and British Columbia revealed that services were primarily accessed by individuals who already had primary care access, were educated and middle-aged, and lived closer to urban centres.[12,14,15]

As health systems across many jurisdictions continue to move towards team-based primary care models, and as virtual care and other digital health solutions proliferate, it is important to understand the patient populations who could most benefit from alternative access points to healthcare. Given the heterogeneous nature of frequent or avoidable ED users, these health-seeking behaviours may not have a singular root cause but may be made up of multifaceted, upstream factors including perceived urgency of the acute health issue, beliefs, and timeliness of other forms of healthcare.[1,2,16,17] To design policy and interventions in the most effective way and target those with the greatest need, we need a comprehensive understanding of the social determinants of frequent ED use and of the frequent ED users for whom their visits may be amenable to other areas of care, as well as those who will continue to rely on the ED as their primary point of healthcare access.[17]

*Population Health Research Capsule*

What do we already know about this issue?
*Frequent users of the emergency department are a diverse group, and existing ED diversion initiatives often do not consider social factors in their implementation.*

What was the research question?
*We sought to describe the sociodemographic and behavioural characteristics of frequent, avoidable ED users.*

What was the major finding of the study?
*Frequent ED use in the year prior was strongly associated with frequent, avoidable ED use (OR 82.13, 95% CI 61.60-109.50).*

How does this improve population health?
*Social factors must be considered in population-level ED diversion programs to provide contextually appropriate in-ED programs to manage frequent ED users.*

Existing studies describing individuals who use the ED frequently or for potentially avoidable reasons have typically relied on either electronic health record data or large-scale administrative data studies that lack the social, demographic and broader determinants of health data available in more detailed health surveys.[16–19] In this study we used a population-representative survey of community-dwelling Canadian adults linked to future healthcare-use data to provide a more detailed characterization of frequent ED users and those whose visits are potentially avoidable. This was accomplished through the application of the Andersen-Newman Behavioural Model (ANBM)[20–22] for healthcare use and the categorization of sociodemographic, health behaviour, health status, and geographic variables with known or theoretical associations with frequent or avoidable ED use into predisposing, enabling, or need factors based on their theorized mechanism of action on ED use. We hypothesized that frequent, avoidable ED use would be associated with each of predisposing, enabling, and need factors.

## METHODS

### Data Sources

Ontario respondents to the Canadian Community Health Survey (CCHS) between 2001–2014 were linked to

population-based health administrative data. The CCHS is a cross-sectional survey administered annually or bi-annually by Statistics Canada, which through the use of multistage sampling consisting of stratified cluster sampling and random digit dialing and the application of sampling weights, is considered representative of community-dwelling Canadians over 12 years of age.[23] The CCHS methodology has been described in detail elsewhere.[23] Participants may consent to the linkage of their survey response with administrative health data. For this study, respondents were only included if they were between the ages of 18- 74 years at the time of interview, and respondents were excluded if they had previously completed the survey during the study period. The CCHS contains data on household income, demographics, health behaviours (e.g., alcohol consumption, physical activity), and health status (e.g., self-perceived physical health, mental health).[24]

The CCHS has been used extensively in previous studies of health system use or performance.[25,26] These datasets were linked using unique encoded identifiers and analyzed at ICES (formerly the Institute for Clinical Evaluative Sciences, which is now identified solely by the initialism ICES). Data on most publicly funded healthcare use in the province are housed in ICES' various databases, given universal healthcare coverage.[27] The Ntional Ambulatory Care Reporting System (NACRS) database contains mandatory reporting of all hospital-based and community-based ED and ambulatory care visits for individuals with an Ontario Health Insurance Plan number.

The NACRS dataset provided information regarding each individual visit before and in the year following the CCHS interview, including date and time, length of stay, presenting complaint (Canadian Emergency Department Information System [CEDIS]),[28] discharge diagnosis (*International Classification of Diseases* Revisions 9 or 10 codes), mode of arrival, and acuity.[29] The Ontario Marginalization Index contains dissemination-area and census-tract level measurements including types of residential density and family structure characteristics (households and dwellings), access to basic material needs (material resources), and ratio of seniors and children to working age population (age and labour force).[30] We calculated Johns Hopkins ACG® System Aggregated Diagnosis Groups (ADG) using a two-year lookback to reflect five clinical dimensions: duration of the condition; severity of the condition; diagnostic certainty; etiology of the condition; and specialty care involvement.[31,32]

Visits to the ED were categorized as avoidable based on two definitions previously used in Canadian administrative data research[33]: ambulatory care sensitive conditions (ACSC)[34] and sentinel nonurgent conditions (SNC).[35] The ACSC are typically chronic conditions (e.g., asthma, congestive heart failure) for which effective ongoing care could reduce the risk of acute illness. They are commonly used for regular health system monitoring in Canada,[33,34] while SNCs are low-acuity conditions (e.g., upper respiratory tract infections) that could be managed in alternative, primary care settings.[33,35] These two definitions were chosen to reflect different pathways through which avoidable ED visits can occur, while also being more specific than broad definitions based solely on acuity.[33] Complete criteria for both definitions are presented in Supplemental File 1. Respondents were categorized based on frequency of ED usage one-year following CCHS interview (four or more visits, one to three visits, zero visits) and whether any of their visits were potentially avoidable (one or more vs no avoidable visits), resulting in five categories of ED usage. Categories of ED use were as follows: frequent ED use (≥ 4 visits) with at least one avoidable visit; frequent ED use without avoidable visits; infrequent ED use (1-3 visits) with at least one avoidable visit; infrequent ED use without avoidable visits; and no ED utilization.

Covariate selection was guided by previous literature on frequent ED use, avoidable ED use, or health services utilization and categorized according to the ANBM.[20–22] The ANBM had been used previously to describe non-emergent ED use in non-Canadian settings.[36] Covariates were categorized as either predisposing factors, enabling factors, or need factors influencing frequent, avoidable ED use. Predisposing factors were variables inherent to the individual, predominately sociodemographic variables such as age, sex, or ethnicity. Enabling factors were variables which may influence an individual's ability to access healthcare or the way in which they access healthcare such as having a regular family doctor. Need factors were variables associated with acute or ongoing medical need, such as self-reported health or comorbidities.[20–22] A complete list of covariates included in this study is included in Supplemental File 2.

**Statistical Analyses**

Covariates with missing data were imputed using 10-times multiple imputation. Variables with greater than 5% missingness included first language (27.7%), life satisfaction (15.6%), self-reported mental health (15.5%), and income (5.9%), the former three of which were not asked in one or more cycles of the CCHS (2001 for life satisfaction and self-reported mental health, 2011/12 and 2013/14 for first language). We fit logistic regression models for categorical variables and used predictive mean matching for continuous variables containing all other covariates included in this analysis to inform imputation. Distributions of data were examined before and after imputation to ensure consistency. All analyses were performed using the 10-times imputed data.

We calculated descriptive statistics in the form of weighted frequency distributions for all covariates, both across the total cohort and stratified by category of ED use and weighted using CCHS sampling weights. To assess associations between individual covariates and ED use, we performed multinomial logistic regression models using category of ED utilization as the nominal outcome with 'no ED utilization' as the reference outcome. We assessed relationships between covariates and the outcome through

unadjusted models, age-adjusted models, and models adjusting for demographics, behavioural factors, comorbidities, and past healthcare use (a *fully-adjusted* model). Multicollinearity was assessed using variance inflation factors. We performed both multiple imputation and all statistical analyses using SAS v9.3 (SAS Institute, Cary, NC).

**Ethics Approval**

This study received research ethics approval from the University of Toronto Research Ethics Board (Human Protocol Number: 44462).

**RESULTS**

After exclusions, a total of 181,369 (77.5%) individuals who consented to linkage were included in this study. When applying the criteria for ED utilization, we identified 1,460 participants (0.8%) as having four or more ED visits within the following year (frequent) with one or more visits being considered avoidable. A further 3,062 participants (1.7%) were categorized as frequent users but with no identified avoidable visits, while 5,245 participants (2.9%) had fewer than four visits but with one or more avoidable, and 35,313 (19.5%) with one to three ED visits and no identified avoidable visits in the year following survey completion. All other CCHS participants had no ED visits within Ontario in the year following survey completion. The complete weighted distribution of all covariates in the cohort and stratified by ED use category is in Table 1, and weighted multinomial logistic regression is in Table 2.

**Predisposing Factors**

There was a higher proportion of older individuals (61-74 years of age) in the frequent, avoidable ED user group than in the overall CCHS population. In the fully adjusted model, female sex was associated with both frequent, avoidable ED use (adjusted odds ratio [AOR] 1.35, 95% CI 1.09-1.66) and infrequent, avoidable ED use (AOR 1.50, 95% CI 1.35-1.66) compared to male sex. Frequent, avoidable ED users were both less likely to have a post-secondary education (AOR 0.57, 95% CI 0.45, 0.72) and more likely to be in the lowest quintile of household income (AOR 1.91, 95% CI 1.37-2.65) compared to those who did not have an ED visit within the year following survey completion. Frequent, avoidable users were less likely to be married or in a common-law relationship than infrequent or non-ED users. Individuals in the frequent, avoidable ED user group reported higher levels of life stress and lower levels of overall life satisfaction than other groups; however, after adjustment both factors were also not statistically significant.

**Enabling Factors**

Neighbourhood-level material resource deprivation (the inability of individuals and communities to attain their basic material needs)[30] was more common amongst individuals

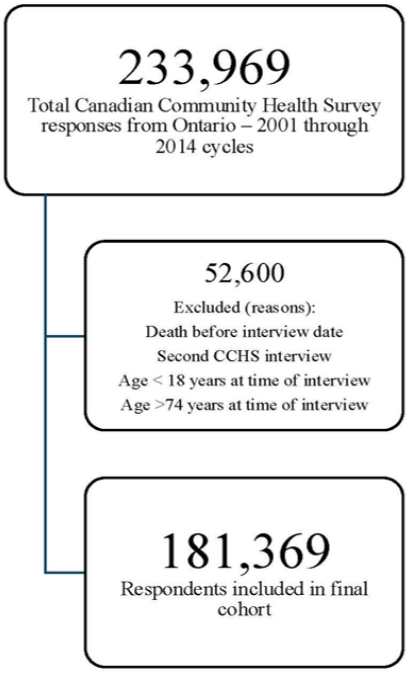


**Figure 1.** Flow diagram of inclusion into final cohort from all 2001-2014 Canadian Community Health Survey respondents in a study of frequent emergency department users.
*CCHS,* Canadian Community Health Survey.

with frequent, avoidable ED use, with 30.4% living in the highest quintile of most-deprived neighbourhoods compared to 18.4% of individuals with no ED use. Neighbourhood-level household and dwelling stability was similarly associated with ED use, as individuals living in the most residentially stable neighbourhoods were least represented amongst the frequent, avoidable ED users (8.0%) compared to 21.3% of individuals with no ED use living within the same neighbourhood quintile. Neighbourhood-level proportion of population outside working age (age and labour force) was also associated with frequent ED utilization, as 35.0% of frequent, avoidable ED users resided in neighbourhoods in the highest quintile of dependency. All neighbourhood-level marginalization metrics were associated with each level of ED use; however, effect sizes on unadjusted, age-adjusted, and fully adjusted models are highest in the frequent, avoidable ED-user and frequent ED-user categories.

Frequent, avoidable ED use was more likely to be by White (91.3%) and Canadian born (83.7%) individuals than their non-avoidable frequent and infrequent counterparts. This association remained with adjustment for other covariates, as both visible minorities and immigrants who had been in Canada for longer than 10 years were at reduced likelihood of being in the avoidable ED use categories compared to White or Canadian-born individuals.

All ED use categories had a similar proportion of individuals who reported a connection to a regular family doctor in the CCHS survey. However, after adjusting for other

**Table 1.** The weighted distribution of predisposing, enabling, and need factors, across ED usage categories, for adult Ontarians from the 2001-2014 Canadian Community Health Survey cohorts.

| Characteristic | Total | Frequent (≥ 4 visit), avoidable ED user | Frequent (≥ 4 visit), non-avoidable ED user | Infrequent (1-3 visit), avoidable ED user | Infrequent (1-3 visit), non-avoidable ED user | No ED usage |
|---|---|---|---|---|---|---|
| | N = 181,369 | n = 1,460 | n = 3,062 | n = 5,245 | n = 35,313 | n = 136,289 |
| Predisposing Factors | | | | | | |
| Age group | | | | | | |
| 18 - 30 | 26.9 | 27.3 | 29.9 | 26.7 | 27.1 | 23.6 |
| 31 - 40 | 17.7 | 14.6 | 15.3 | 18.9 | 19.3 | 20.2 |
| 41 - 50 | 18.2 | 13.1 | 19.2 | 16.6 | 19.9 | 22.3 |
| 51 - 60 | 17.4 | 18.2 | 16.0 | 17.8 | 16.6 | 18.3 |
| 61 - 74 | 19.8 | 26.8 | 19.6 | 20.0 | 17.1 | 15.5 |
| Sex (male) | 44.4 | 37.2 | 47.0 | 38.5 | 49.6 | 49.7 |
| Education level | | | | | | |
| Less than secondary | 19.5 | 30.0 | 22.9 | 17.5 | 15.8 | 11.3 |
| Secondary graduate | 20.5 | 19.4 | 21.9 | 20.5 | 21.0 | 19.8 |
| Some post-secondary | 8.4 | 9.3 | 8.2 | 8.0 | 8.7 | 7.8 |
| Post-secondary certificate | 51.6 | 41.3 | 47.0 | 53.9 | 54.5 | 61.2 |
| Household income | | | | | | |
| Q1 (lowest) | 20.7 | 31.1 | 25.8 | 15.6 | 17.3 | 13.6 |
| Q2 | 16.9 | 17.4 | 19.0 | 16.4 | 16.4 | 15.3 |
| Q3 | 20.1 | 21.2 | 19.3 | 21.8 | 19.2 | 18.9 |
| Q4 | 21.8 | 18.0 | 19.6 | 23.6 | 23.3 | 24.7 |
| Q5 (highest) | 20.5 | 12.2 | 16.4 | 22.6 | 23.7 | 27.6 |
| Marital status | | | | | | |
| Married or common law | 59.4 | 54.8 | 53.4 | 61.5 | 61.7 | 65.5 |
| Other | 40.6 | 45.2 | 46.6 | 38.5 | 38.3 | 34.5 |
| Cigarette-smoking status | | | | | | |
| Non-smoker | 46.4 | 40.1 | 39.1 | 45.5 | 49.8 | 57.2 |
| Heavy smoker (≥ 1 pack/day) | 5.9 | 6.3 | 8.5 | 5.7 | 5.6 | 3.3 |
| Light smoker (< 1 pack/day) | 24.3 | 28.8 | 30.3 | 22.5 | 22.1 | 17.9 |
| Former smoker | 23.5 | 24.8 | 22.1 | 26.3 | 22.5 | 21.6 |
| Alcohol consumption (prior year) | | | | | | |
| Non-drinker | 64.1 | 75.0 | 67.1 | 63.5 | 58.7 | 56.1 |
| Light or moderate drinker | 27.3 | 17.3 | 23.9 | 27.9 | 31.6 | 35.9 |
| Heavy drinker | 8.6 | 7.7 | 9.0 | 8.6 | 9.7 | 8.0 |

*ED,* emergency department.

**Table 1.** Continued.

| Characteristic | Total | Frequent (≥ 4 visit), avoidable ED user | Frequent (≥ 4 visit), non-avoidable ED user | Infrequent (1-3 visit), avoidable ED user | Infrequent (1-3 visit), non-avoidable ED user | No ED usage |
|---|---|---|---|---|---|---|
| | N = 181,369 | n = 1,460 | n = 3,062 | n = 5,245 | n = 35,313 | n = 136,289 |
| Physical activity | | | | | | |
| Very active | 25.0 | 22.4 | 24.6 | 25.3 | 26.6 | 26.1 |
| Moderately active | 23.5 | 25.9 | 18.2 | 24.3 | 23.7 | 25.1 |
| Inactive | 51.5 | 51.7 | 57.1 | 50.4 | 49.7 | 48.8 |
| Life stress | | | | | | |
| Low (a bit, not very, none) | 71.0 | 67.5 | 65.9 | 73.2 | 72.3 | 76.3 |
| High (quite a bit, extreme) | 29.0 | 32.5 | 34.1 | 26.8 | 27.7 | 23.7 |
| Life satisfaction | | | | | | |
| Very high | 33.5 | 31.9 | 26.3 | 37.6 | 34.7 | 37.2 |
| High | 48.7 | 44.4 | 49.0 | 49.1 | 49.5 | 51.5 |
| Neutral | 12.5 | 15.0 | 16.2 | 10.4 | 11.6 | 9.0 |
| Low | 4.0 | 6.6 | 6.4 | 2.3 | 3.1 | 1.8 |
| Very low | 1.3 | 2.0 | 2.1 | 0.7 | 1.1 | 0.5 |
| Body Mass Index | | | | | | |
| Underweight, <18.5 | 6.3 | 8.2 | 7.6 | 5.5 | 5.6 | 4.7 |
| Normal weight, 18.5-24.9 | 32.8 | 26.0 | 34.1 | 31.6 | 34.2 | 38.3 |
| Overweight, | | | | | | |
| 25- 29.9 | 31.6 | 29.3 | 27.2 | 31.9 | 33.9 | 35.4 |
| Obese, > 30 | 29.3 | 36.5 | 31.1 | 31.0 | 26.2 | 21.6 |
| Enabling Factors | | | | | | |
| Neighbourhood-level material resources | | | | | | |
| Q1 (least deprived) | 14.9 | 10.5 | 11.2 | 13.5 | 17.6 | 21.5 |
| Q2 | 18.6 | 15.9 | 16.7 | 20.0 | 19.3 | 21.4 |
| Q3 | 19.3 | 17.6 | 18.7 | 20.9 | 19.8 | 19.8 |
| Q4 | 22.3 | 25.6 | 24.3 | 22.4 | 20.3 | 19.0 |
| Q5 (most deprived) | 24.9 | 30.4 | 29.2 | 23.2 | 23.1 | 18.4 |
| Neighbourhood-level household and dwelling | | | | | | |
| Q1 (least unstable) | 14.7 | 8.0 | 13.6 | 13.6 | 17.1 | 21.3 |
| Q2 | 19.0 | 17.0 | 18.1 | 20.5 | 19.2 | 20.2 |
| Q3 | 20.9 | 23.6 | 19.2 | 23.5 | 19.9 | 18.5 |
| Q4 | 22.7 | 28.7 | 22.1 | 22.4 | 21.1 | 19.4 |
| Q5 (most unstable) | 22.6 | 22.7 | 27.0 | 20.0 | 22.6 | 20.6 |
| Neighbourhood-level age and labour force | | | | | | |
| Q1 (least dependency) | 17.3 | 11.5 | 17.4 | 14.7 | 19.8 | 23.1 |

*ED,* emergency department.

**Table 1.** Continued.

| Characteristic | Total | Frequent (≥ 4 visit), avoidable ED user | Frequent (≥ 4 visit), non-avoidable ED user | Infrequent (1-3 visit), avoidable ED user | Infrequent (1-3 visit), non-avoidable ED user | No ED usage |
|---|---|---|---|---|---|---|
| | N = 181,369 | n = 1,460 | n = 3,062 | n = 5,245 | n = 35,313 | n = 136,289 |
| Q2 | 19.1 | 15.1 | 18.6 | 18.0 | 21.6 | 22.3 |
| Q3 | 18.4 | 14.6 | 18.3 | 19.7 | 19.3 | 19.9 |
| Q4 | 21.1 | 23.8 | 21.5 | 23.1 | 19.4 | 18.0 |
| Q5 (most dependency) | 24.1 | 35.0 | 24.4 | 24.5 | 19.9 | 16.7 |
| Racial or ethnic origin | | | | | | |
| Visible minority | 15.4 | 8.7 | 16.2 | 10.0 | 18.0 | 24.4 |
| White | 84.6 | 91.3 | 83.8 | 90.0 | 82.0 | 75.6 |
| First language | | | | | | |
| Other | 26.4 | 23.4 | 26.3 | 21.0 | 27.8 | 33.5 |
| English | 73.6 | 76.6 | 73.7 | 79.0 | 72.2 | 66.5 |
| Immigration status | | | | | | |
| Canadian-born | 75.9 | 83.7 | 75.3 | 81.7 | 72.9 | 65.9 |
| Immigrant, < 10 years | 5.1 | 3.1 | 3.7 | 3.7 | 6.1 | 9.0 |
| Immigrant, ≥ 10 years | 19.0 | 13.3 | 21.0 | 14.6 | 21.1 | 25.1 |
| Worked in the past year (yes) | 69.7 | 57.5 | 63.9 | 71.9 | 75.8 | 79.1 |
| Current student (yes) | 89.4 | 91.3 | 90.5 | 88.8 | 88.5 | 88.2 |
| Urban/rural dwelling | | | | | | |
| Urban | 80.2 | 76.9 | 79.9 | 74.8 | 82.9 | 86.5 |
| Rural | 19.8 | 23.1 | 20.1 | 25.2 | 17.1 | 13.5 |
| Sense of community belonging | | | | | | |
| Strong/very strong | 63.6 | 64.5 | 62.1 | 64.9 | 62.3 | 64.2 |
| Weak/very weak | 36.4 | 35.5 | 37.9 | 35.1 | 37.7 | 35.8 |
| Has a regular doctor (yes) | 90.2 | 89.1 | 90.1 | 90.2 | 91.0 | 90.4 |
| Mental health consultation in the past year (yes) | 18.9 | 28.4 | 24.4 | 16.8 | 15.1 | 9.7 |
| Usual provider of care (UPC) | | | | | | |
| <3 visits in the past 18 months | 9.8 | 4.8 | 6.2 | 12.0 | 11.7 | 14.3 |
| No UPC | 28.2 | 33.3 | 34.7 | 24.7 | 26.6 | 21.7 |
| UPC (specialist or generalist) | 62.0 | 61.9 | 59.1 | 63.3 | 61.7 | 64.0 |

*ED,* emergency department.

**Table 1.** Continued.

| Characteristic | Total | Frequent (≥ 4 visit), avoidable ED user | Frequent (≥ 4 visit), non-avoidable ED user | Infrequent (1-3 visit), avoidable ED user | Infrequent (1-3 visit), non-avoidable ED user | No ED usage |
|---|---|---|---|---|---|---|
| | N = 181,369 | n = 1,460 | n = 3,062 | n = 5,245 | n = 35,313 | n = 136,289 |
| Continuity of care | | | | | | |
| < 3 visits in the past 18 months | 9.8 | 4.8 | 6.2 | 12.0 | 11.7 | 14.3 |
| < 50% continuity of care | 28.2 | 33.3 | 34.7 | 24.7 | 26.6 | 21.7 |
| 50-75% continuity of care | 43.0 | 43.9 | 42.2 | 42.7 | 42.8 | 43.3 |
| > 75% continuity of care | 19.0 | 18.0 | 16.9 | 20.6 | 18.9 | 20.7 |
| Need Factors | | | | | | |
| Has a chronic disease (one or more) | 48.7 | 63.3 | 53.9 | 51.1 | 41.3 | 33.8 |
| Self-perceived general health | | | | | | |
| Poor | 9.0 | 17.2 | 14.3 | 6.2 | 5.4 | 2.1 |
| Fair | 13.5 | 20.4 | 17.4 | 11.7 | 11.1 | 7.1 |
| Good (excellent/ very good) | 77.4 | 62.4 | 68.3 | 82.1 | 83.5 | 90.8 |
| Self-reported mental health | | | | | | |
| Poor | 2.7 | 4.1 | 4.8 | 1.7 | 2.1 | 1.0 |
| Fair | 8.1 | 11.3 | 12.0 | 6.5 | 6.5 | 4.2 |
| Good | 24.5 | 29.1 | 27.5 | 22.8 | 22.7 | 20.2 |
| Very good | 32.3 | 28.6 | 27.8 | 34.2 | 34.6 | 36.3 |
| Excellent | 32.4 | 26.9 | 27.8 | 34.8 | 34.0 | 38.3 |
| Prior-year ED visits | | | | | | |
| No visits | 53.9 | 23.4 | 38.4 | 55.2 | 67.3 | 85.2 |
| 1-3 visits | 34.1 | 43.7 | 43.0 | 39.7 | 29.8 | 14.2 |
| ≥ 4 visits | 12.0 | 32.8 | 18.7 | 5.1 | 2.9 | 0.6 |
| ADG quartile | | | | | | |
| Q1 (lowest) | 21.8 | 16.5 | 17.6 | 25.6 | 23.7 | 25.5 |
| Q2 | 21.6 | 14.0 | 16.9 | 22.4 | 24.2 | 30.4 |
| Q3 | 22.8 | 17.7 | 21.3 | 24.5 | 24.9 | 25.7 |
| Q4 (highest) | 33.8 | 51.8 | 44.2 | 27.5 | 27.2 | 18.4 |

*ADG,* Aggregated Diagnosis Group; *ED,* emergency department.

covariates, having a regular family doctor was associated with a reduced likelihood of frequent, avoidable ED usage (AOR 0.73, 95% CI 0.56- 0.95) and infrequent, avoidable ED usage (AOR 0.82, 95% CI 0.69-0.97). In both the frequent ED use categories, a greater proportion of participants were identified as having more than three ambulatory care healthcare encounters without a usual provider of care (UPC) in the 18 months prior to survey completion (33.7% and 34.7%, respectively) compared to their infrequent ED user counterparts.

**Need Factors**

Individuals in the frequent, avoidable ED-use category reported or were associated with poor health through several metrics: 17.2% of participants in the frequent, avoidable ED-

**Table 2.** Weighted unadjusted, age-adjusted, and adjusted odds ratios and 95% confidence intervals according to multinomial logistic regression analysis.

| | Frequent (≥ 4 visit), avoidable ED user | | | Frequent (≥ 4 visit), non-avoidable ED user | | | Infrequent (1-3 visit), avoidable ED user | | | Infrequent (1–3 visit), non-avoidable ED user | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Unadjusted | Age-adjusted | Adjusted | Unadjusted | Age-adjusted | Adjusted | Unadjusted | Age-adjusted | Adjusted | Unadjusted | Age-adjusted | Adjusted |
| Age group | | | | | | | | | | | | |
| 18-30 | 1.00 (Ref) | - | 1.00 (Ref) | 1.00 (Ref) | - | 1.00 (Ref) | 1.00 (Ref) | - | 1.00 (Ref) | 1.00 (Ref) | - | 1.00 (Ref) |
| 31-40 | 0.63 (0.48, 0.82) | - | 0.63 (0.46, 0.85) | 0.60 (0.50, 0.73) | - | 0.58 (0.47, 0.72) | 0.82 (0.71, 0.95) | - | 0.85 (0.73, 0.99) | 0.83 (0.78, 0.89) | - | 0.83 (0.77, 0.89) |
| 41-50 | 0.51 (0.37, 0.69) | - | 0.44 (0.31, 0.61) | 0.68 (0.55, 0.85) | - | 0.55 (0.42, 0.71) | 0.66 (0.57, 0.77) | - | 0.62 (0.53, 0.74) | 0.78 (0.73, 0.83) | - | 0.72 (0.67, 0.78) |
| 51-60 | 0.86 (0.62, 1.20) | - | 0.52 (0.36, 0.74) | 0.69 (0.57, 0.84) | - | 0.40 (0.31, 0.52) | 0.86 (0.74, 1.00) | - | 0.65 (0.55, 0.77) | 0.79 (0.74, 0.84) | - | 0.64 (0.59, 0.69) |
| 61-74 | 1.50 (1.19, 1.89) | - | 0.66 (0.46, 0.93) | 1.00 (0.83, 1.20) | - | 0.44 (0.32, 0.60) | 1.14 (1.00, 1.29) | - | 0.69 (0.58, 0.83) | 0.96 (0.90, 1.02) | - | 0.70 (0.64, 0.76) |
| Sex | | | | | | | | | | | | |
| Female (vs male) | 1.66 (1.36, 2.03) | 1.66 (1.35, 2.03) | 1.35 (1.09, 1.66) | 1.11 (0.98, 1.27) | 1.11 (0.98, 1.27) | 0.93 (0.80, 1.07) | 1.58 (1.43, 1.74) | 1.58 (1.43, 1.74) | 1.50 (1.35, 1.66) | 1.00 (0.96, 1.05) | 1.00 (0.96, 1.05) | 0.96 (0.92, 1.01) |
| Education level | | | | | | | | | | | | |
| Less than secondary | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) |
| Secondary graduate | 0.37 (0.28, 0.48) | 0.39 (0.30, 0.51) | 0.62 (0.47, 0.81) | 0.55 (0.45, 0.66) | 0.53 (0.44, 0.65) | 0.83 (0.67, 1.02) | 0.67 (0.57, 0.78) | 0.67 (0.58, 0.78) | 0.82 (0.69, 0.97) | 0.76 (0.71, 0.82) | 0.74 (0.69, 0.80) | 0.87 (0.81, 0.94) |
| Some post-secondary | 0.45 (0.31, 0.67) | 0.49 (0.33, 0.73) | 0.78 (0.53, 1.14) | 0.52 (0.40, 0.68) | 0.50 (0.38, 0.65) | 0.78 (0.59, 1.03) | 0.66 (0.54, 0.81) | 0.66 (0.54, 0.81) | 0.82 (0.67, 1.01) | 0.80 (0.73, 0.88) | 0.77 (0.70, 0.85) | 0.91 (0.82, 1.01) |
| Post-secondary certificate | 0.25 (0.20, 0.32) | 0.26 (0.21, 0.33) | 0.57 (0.45, 0.72) | 0.38 (0.32, 0.45) | 0.37 (0.31, 0.44) | 0.75 (0.62, 0.90) | 0.57 (0.50, 0.65) | 0.57 (0.50, 0.65) | 0.83 (0.71, 0.97) | 0.64 (0.60, 0.68) | 0.63 (0.59, 0.67) | 0.81 (0.76, 0.87) |
| Household income | | | | | | | | | | | | |
| Q1 (lowest) | 5.17 (3.89, 6.86) | 5.18 (3.90, 6.87) | 1.91 (1.37, 2.65) | 3.21 (2.58, 3.99) | 3.20 (2.58, 3.99) | 1.31 (0.99, 1.72) | 1.40 (1.20, 1.64) | 1.40 (1.20, 1.64) | 1.06 (0.88, 1.29) | 1.48 (1.38, 1.60) | 1.48 (1.37, 1.60) | 1.21 (1.11, 1.33) |
| Q2 | 2.56 (1.89, 3.48) | 2.54 (1.87, 3.45) | 1.39 (0.99, 1.93) | 2.09 (1.67, 2.63) | 2.09 (1.67, 2.63) | 1.25 (0.96, 1.61) | 1.31 (1.11, 1.54) | 1.31 (1.11, 1.54) | 1.08 (0.91, 1.30) | 1.25 (1.16, 1.34) | 1.25 (1.16, 1.35) | 1.12 (1.03, 1.21) |
| Q3 | 2.53 (1.80, 3.55) | 2.52 (1.79, 3.53) | 1.50 (1.08, 2.09) | 1.72 (1.37, 2.16) | 1.72 (1.37, 2.16) | 1.14 (0.89, 1.47) | 1.40 (1.21, 1.63) | 1.40 (1.21, 1.63) | 1.18 (1.00, 1.39) | 1.18 (1.11, 1.26) | 1.18 (1.11, 1.26) | 1.08 (1.01, 1.16) |
| Q4 | 1.64 (1.21, 2.24) | 1.64 (1.21, 2.24) | 1.24 (0.90, 1.71) | 1.34 (1.08, 1.65) | 1.34 (1.08, 1.65) | 1.07 (0.85, 1.33) | 1.16 (1.01, 1.33) | 1.16 (1.01, 1.33) | 1.04 (0.91, 1.20) | 1.10 (1.03, 1.17) | 1.10 (1.03, 1.17) | 1.04 (0.97, 1.11) |

Reference group = Individuals with no ED use in the year following CCHS interview (No ED usage).
Age-adjusted = multivariable multinomial logistic regression model adjusting for age, in years, as a continuous variable.
Adjusted = multivariable multinomial logistic regression model including all covariates listed in Table 2.
*ED,* emergency department.

**Table 2.** Continued.

| | Frequent (≥ 4 visit), avoidable ED user | | | Frequent (≥ 4 visit), non-avoidable ED user | | | Infrequent (1-3 visit), avoidable ED user | | | Infrequent (1–3 visit), non-avoidable ED user | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Unadjusted | Age-adjusted | Adjusted | Unadjusted | Age-adjusted | Adjusted | Unadjusted | Age-adjusted | Adjusted | Unadjusted | Age-adjusted | Adjusted |
| Q5 (highest) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) |
| Age group | | | | | | | | | | | | |
| Other vs married/ common law | 1.56 (1.30, 1.89) | 1.83 (1.50, 2.24) | 1.08 (0.86, 1.36) | 1.66 (1.45, 1.89) | 1.75 (1.53, 2.01) | 1.13 (0.96, 1.33) | 1.19 (1.08, 1.31) | 1.23 (1.11, 1.37) | 1.03 (0.92, 1.15) | 1.18 (1.13, 1.23) | 1.18 (1.12, 1.23) | 0.97 (0.92, 1.03) |
| Cigarette smoking status | | | | | | | | | | | | |
| Non-smoker | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) |
| Current smoker | 2.37 (1.89, 2.96) | 2.38 (1.90, 2.97) | 1.32 (1.00, 1.72) | 2.68 (2.29, 3.13) | 2.68 (2.29, 3.13) | 1.71 (1.45, 2.01) | 1.68 (1.49, 1.88) | 1.68 (1.49, 1.88) | 1.29 (1.15, 1.46) | 1.50 (1.42, 1.58) | 1.50 (1.42, 1.58) | 1.20 (1.14, 1.27) |
| Former smoker | 1.64 (1.31, 2.06) | 1.50 (1.19, 1.89) | 1.08 (0.85, 1.38) | 1.50 (1.26, 1.78) | 1.51 (1.26, 1.81) | 1.24 (1.02, 1.51) | 1.53 (1.37, 1.72) | 1.54 (1.36, 1.74) | 1.26 (1.11, 1.43) | 1.20 (1.13, 1.26) | 1.23 (1.16, 1.30) | 1.07 (1.01, 1.13) |
| Alcohol consumption (prior year) | | | | | | | | | | | | |
| Non-drinker | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) |
| Light or moderate drinker | 0.36 (0.30, 0.44) | 0.35 (0.29, 0.43) | 0.59 (0.48, 0.73) | 0.56 (0.48, 0.65) | 0.56 (0.48, 0.65) | 0.81 (0.69, 0.95) | 0.69 (0.62, 0.76) | 0.68 (0.61, 0.76) | 0.78 (0.70, 0.87) | 0.84 (0.80, 0.88) | 0.84 (0.80, 0.88) | 0.92 (0.87, 0.97) |
| Heavy drinker | 0.73 (0.53, 1.00) | 0.77 (0.56, 1.05) | 0.81 (0.58, 1.13) | 0.94 (0.76, 1.17) | 0.95 (0.76, 1.18) | 0.85 (0.68, 1.07) | 0.96 (0.81, 1.13) | 0.97 (0.82, 1.14) | 0.89 (0.75, 1.05) | 1.17 (1.09, 1.26) | 1.16 (1.08, 1.25) | 1.04 (0.96, 1.13) |
| Physical activity | | | | | | | | | | | | |
| Very active | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) |
| Moderately active | 1.20 (0.90, 1.60) | 1.17 (0.87, 1.56) | 1.11 (0.85, 1.45) | 0.77 (0.65, 0.92) | 0.77 (0.65, 0.92) | 0.77 (0.64, 0.92) | 1.00 (0.88, 1.14) | 1.00 (0.87, 1.14) | 1.00 (0.87, 1.14) | 0.93 (0.87, 0.99) | 0.93 (0.88, 0.99) | 0.94 (0.88, 1.00) |
| Inactive | 1.23 (0.99, 1.53) | 1.19 (0.96, 1.48) | 0.79 (0.63, 1.01) | 1.24 (1.06, 1.44) | 1.24 (1.07, 1.44) | 0.94 (0.79, 1.11) | 1.06 (0.95, 1.19) | 1.06 (0.94, 1.19) | 0.98 (0.87, 1.10) | 1.00 (0.95, 1.05) | 1.01 (0.95, 1.06) | 0.92 (0.87, 0.97) |
| Life stress | | | | | | | | | | | | |
| High (quite a bit, extreme) vs low | 1.55 (1.28, 1.88) | 1.58 (1.30, 1.92) | 1.06 (0.85, 1.32) | 1.66 (1.45, 1.91) | 1.66 (1.45, 1.91) | 1.14 (0.98, 1.33) | 1.18 (1.06, 1.31) | 1.18 (1.06, 1.31) | 1.08 (0.96, 1.22) | 1.23 (1.17, 1.30) | 1.23 (1.17, 1.30) | 1.10 (1.04, 1.16) |
| Life satisfaction | | | | | | | | | | | | |
| Very high | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) |
| High | 1.00 (0.80, 1.26) | 1.02 (0.81, 1.27) | 0.81 (0.64, 1.04) | 1.35 (1.14, 1.58) | 1.34 (1.14, 1.58) | 1.07 (0.90, 1.28) | 0.94 (0.85, 1.05) | 0.95 (0.85, 1.05) | 0.91 (0.81, 1.02) | 1.03 (0.98, 1.08) | 1.03 (0.98, 1.08) | 0.96 (0.91, 1.02) |

Reference group = Individuals with no ED use in the year following CCHS interview (No ED usage).
Age-adjusted = multivariable multinomial logistic regression model adjusting for age, in years, as a continuous variable.
Adjusted = multivariable multinomial logistic regression model including all covariates listed in Table 2.
*ED,* emergency department.

**Table 2.** Continued.

| | Frequent (≥ 4 visit), avoidable ED user | | | Frequent (≥ 4 visit), non-avoidable ED user | | | Infrequent (1-3 visit), avoidable ED user | | | Infrequent (1–3 visit), non-avoidable ED user | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Unadjusted | Age-adjusted | Adjusted | Unadjusted | Age-adjusted | Adjusted | Unadjusted | Age-adjusted | Adjusted | Unadjusted | Age-adjusted | Adjusted |
| Neutral | 1.94 (1.38, 2.71) | 1.93 (1.37, 2.70) | 0.80 (0.53, 1.20) | 2.55 (2.03, 3.20) | 2.55 (2.03, 3.20) | 1.10 (0.81, 1.48) | 1.14 (0.96, 1.35) | 1.14 (0.96, 1.35) | 0.84 (0.69, 1.02) | 1.38 (1.26, 1.51) | 1.38 (1.26, 1.51) | 1.02 (0.92, 1.13) |
| Low | 4.22 (2.72, 6.55) | 4.16 (2.68, 6.46) | 1.00 (0.59, 1.69) | 4.95 (3.58, 6.86) | 4.97 (3.59, 6.88) | 1.30 (0.88, 1.92) | 1.24 (0.92, 1.66) | 1.23 (0.92, 1.65) | 0.68 (0.48, 0.95) | 1.80 (1.56, 2.08) | 1.81 (1.57, 2.09) | 1.06 (0.91, 1.25) |
| Very low | 5.08 (2.62, 9.87) | 4.90 (2.53, 9.50) | 0.70 (0.31, 1.60) | 6.55 (4.06, 10.56) | 6.59 (4.09, 10.64) | 1.11 (0.62, 1.98) | 1.48 (0.93, 2.36) | 1.47 (0.92 ,2.35) | 0.61 (0.36, 1.03) | 2.69 (2.05, 3.52) | 2.72 (2.08, 3.56) | 1.33 (0.94, 1.87) |
| Body Mass Index | | | | | | | | | | | | |
| Underweight | 2.60 (1.71, 3.95) | 2.58 (1.70, 3.92) | 1.38 (0.92, 2.06) | 1.83 (1.37, 2.45) | 1.83 (1.37, 2.45) | 1.17 (0.88, 1.56) | 1.42 (1.16, 1.75) | 1.42 (1.16, 1.75) | 1.08 (0.87 ,1.34) | 1.35 (1.21, 1.50) | 1.35 (1.21, 1.51) | 1.17 (1.04, 1.31) |
| Normal weight | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) |
| Overweight | 1.22 (0.98, 1.53) | 1.17 (0.94, 1.45) | 1.27 (1.01, 1.59) | 0.86 (0.73, 1.02) | 0.87 (0.74, 1.03) | 0.90 (0.75, 1.08) | 1.09 (0.97, 1.23) | 1.10 (0.97, 1.24) | 1.11 (0.99, 1.26) | 1.07 (1.02, 1.13) | 1.09 (1.04, 1.15) | 1.08 (1.02, 1.14) |
| Obese | 2.49 (1.96, 3.17) | 2.35 (1.85, 2.99) | 1.51 (1.18, 1.94) | 1.62 (1.37, 1.92) | 1.64 (1.37, 1.97) | 1.15 (0.95, 1.40) | 1.74 (1.54, 1.96) | 1.75 (1.55, 1.97) | 1.33 (1.17, 1.52) | 1.36 (1.29, 1.44) | 1.39 (1.32, 1.48) | 1.18 (1.11, 1.25) |
| Neighbourhood-level material resources | | | | | | | | | | | | |
| Q1 (least deprived) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) |
| Q2 | 1.52 (1.00, 2.32) | 1.52 (1.00, 2.31) | 1.21 (0.79, 1.86) | 1.50 (1.17, 1.93) | 1.50 (1.17, 1.93) | 1.01 (0.79, 1.29) | 1.50 (1.27, 1.77) | 1.50 (1.27, 1.77) | 1.14 (0.94, 1.37) | 1.10 (1.03, 1.18) | 1.10 (1.03, 1.18) | 1.10 (1.02, 1.18) |
| Q3 | 1.82 (1.26, 2.64) | 1.83 (1.26, 2.65) | 1.11 (0.73, 1.69) | 1.82 (1.44, 2.29) | 1.82 (1.44, 2.29) | 1.02 (0.78, 1.33) | 1.69 (1.45, 1.97) | 1.69 (1.45, 1.97) | 1.18 (0.99, 1.41) | 1.22 (1.14, 1.31) | 1.22 (1.14, 1.31) | 1.04 (0.96, 1.12) |
| Q4 | 2.75 (1.94, 3.90) | 2.76 (1.95, 3.91) | 1.64 (1.08, 2.50) | 2.46 (1.95, 3.09) | 2.46 (1.95, 3.09) | 1.22 (0.96, 1.56) | 1.89 (1.61 ,2.21) | 1.89 (1.61, 2.21) | 1.40 (1.18, 1.67) | 1.31 (1.22, 1.40) | 1.31 (1.22, 1.40) | 1.11 (1.03, 1.19) |
| Q5 (most deprived) | 3.38 (2.42, 4.72) | 3.43 (2.45, 4.80) | 2.23 (1.47, 3.36) | 3.05 (2.44, 3.82) | 3.05 (2.45, 3.81) | 1.32 (1.04, 1.67) | 2.02 (1.72, 2.37) | 2.03 (1.72, 2.38) | 1.44 (1.21, 1.71) | 1.53 (1.43, 1.65) | 1.53 (1.43, 1.64) | 1.15 (1.06, 1.23) |
| Neighbourhood-level household and dwelling | | | | | | | | | | | | |
| Q1 (least unstable) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) |
| Q2 | 2.22 (1.52, 3.24) | 2.19 (1.50, 3.19) | 1.39 (0.93, 2.07) | 1.40 (1.10, 1.80) | 1.41 (1.10, 1.80) | 1.05 (0.81, 1.36) | 1.59 (1.35, 1.88) | 1.59 (1.34, 1.88) | 1.18 (0.99, 1.40) | 1.18 (1.10, 1.27) | 1.18 (1.10, 1.27) | 1.05 (0.97, 1.13) |
| Q3 | 3.37 (2.33, 4.86) | 3.31 (2.29, 4.78) | 1.51 (1.00, 2.27) | 1.62 (1.29, 2.05) | 1.63 (1.29, 2.06) | 0.99 (0.77, 1.28) | 1.99 (1.68, 2.35) | 1.99 (1.68, 2.35) | 1.31 (1.09, 1.58) | 1.34 (1.25, 1.44) | 1.34 (1.25, 1.44) | 1.12 (1.04, 1.21) |

Reference group = Individuals with no ED use in the year following CCHS interview (No ED usage).
Age-adjusted = multivariable multinomial logistic regression model adjusting for age, in years, as a continuous variable.
Adjusted = multivariable multinomial logistic regression model including all covariates listed in Table 2.
*ED,* emergency department.

**Table 2.** Continued.

| | Frequent (≥ 4 visit), avoidable ED user | | | Frequent (≥ 4 visit), non-avoidable ED user | | | Infrequent (1-3 visit), avoidable ED user | | | Infrequent (1–3 visit), non-avoidable ED user | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Unadjusted | Age-adjusted | Adjusted | Unadjusted | Age-adjusted | Adjusted | Unadjusted | Age-adjusted | Adjusted | Unadjusted | Age-adjusted | Adjusted |
| Q4 | 3.92 (2.71, 5.65) | 3.87 (2.68, 5.59) | 1.50 (1.02, 2.40) | 1.79 (1.42, 2.25) | 1.79 (1.42, 2.25) | 0.98 (0.76, 1.28) | 1.81 (1.53, 2.14) | 1.81 (1.53, 2.14) | 1.20 (1.00, 1.44) | 1.35 (1.26, 1.45) | 1.36 (1.26, 1.45) | 1.09 (1.01, 1.18) |
| Q5 (most unstable) | 2.91 (2.01, 4.21) | 2.90 (2.00, 4.19) | 1.05 (0.68, 1.63) | 2.05 (1.61, 2.59) | 2.05 (1.61, 2.60) | 1.02 (0.76, 1.38) | 1.52 (1.27, 1.80) | 1.51 (1.27, 1.80) | 1.10 (0.90, 1.34) | 1.36 (1.27, 1.47) | 1.36 (1.27, 1.47) | 1.11 (1.02, 1.21) |
| Neighbourhood-level age and labour force | | | | | | | | | | | | |
| Q1 (least dependency) | | | | | | | | | | | | |
| Q2 | 1.35 (0.82, 2.23) | 1.34 (0.81, 2.21) | 1.21 (0.79, 1.86) | 1.11 (0.87, 1.41) | 1.11 (0.87, 1.42) | 1.01 (0.79, 1.29) | 1.26 (1.05, 1.52) | 1.26 (1.05, 1.52) | 1.14 (0.94, 1.37) | 1.13 (1.05, 1.21) | 1.13 (1.05, 1.22) | 1.10 (1.02, 1.18) |
| Q3 | 1.48 (0.90, 2.43) | 1.45 (0.88, 2.4) | 1.11 (0.73, 1.69) | 1.22 (0.95, 1.56) | 1.23 (0.96, 1.58) | 1.02 (0.78, 1.33) | 1.55 (1.30, 1.84) | 1.55 (1.31, 1.85) | 1.18 (0.99, 1.41) | 1.13 (1.05, 1.22) | 1.14 (1.06, 1.23) | 1.04 (0.96, 1.12) |
| Q4 | 2.65 (1.63, 4.31) | 2.59 (1.59, 4.23) | 1.64 (1.08, 2.50) | 1.59 (1.27, 1.99) | 1.61 (1.28, 2.01) | 1.22 (0.96, 1.56) | 2.01 (1.70, 2.38) | 2.02 (1.71, 2.39) | 1.40 (1.18, 1.67) | 1.26 (1.17, 1.35) | 1.27 (1.19, 1.37) | 1.11 (1.03, 1.19) |
| Q5 (most dependency) | 4.20 (2.61, 6.77) | 4.05 (2.50, 6.55) | 2.23 (1.47, 3.36) | 1.94 (1.56, 2.40) | 1.97 (1.59, 2.45) | 1.32 (1.04, 1.67) | 2.29 (1.95, 2.69) | 2.31 (1.96, 2.72) | 1.44 (1.21, 1.71) | 1.39 (1.30, 1.49) | 1.42 (1.32, 1.52) | 1.15 (1.06, 1.23) |
| Racial or ethnic origin | | | | | | | | | | | | |
| Visible minority vs White | 0.30 (0.19, 0.46) | 0.31 (0.20, 0.48) | 0.58 (0.36, 0.91) | 0.60 (0.47, 0.77) | 0.59 (0.46, 0.76) | 0.88 (0.66, 1.17) | 0.34 (0.28, 0.42) | 0.34 (0.28, 0.42) | 0.57 (0.45, 0.71) | 0.68 (0.63, 0.73) | 0.67 (0.62, 0.72) | 0.82 (0.75, 0.89) |
| First language | | | | | | | | | | | | |
| Other vs English-speaking | 0.61 (0.46, 0.79) | 0.60 (0.46, 0.79) | 1.01 (0.75, 1.36) | 0.71 (0.59, 0.86) | 0.71 (0.59, 0.86) | 0.92 (0.74, 1.14) | 0.53 (0.46, 0.60) | 0.53 (0.46, 0.60) | 0.82 (0.70, 0.96) | 0.77 (0.72, 0.81) | 0.77 (0.72, 0.81) | 0.91 (0.84, 1.00) |
| Immigration status | | | | | | | | | | | | |
| Canadian-born | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) |
| Immigrant, <10 years | 0.27 (0.12, 0.60) | 0.29 (0.13, 0.65) | 1.01 (0.41, 2.49) | 0.36 (0.23, 0.57) | 0.36 (0.23, 0.57) | 0.73 (0.44, 1.21) | 0.33 (0.24, 0.48) | 0.34 (0.24, 0.49) | 0.90 (0.61, 1.31) | 0.61 (0.55, 0.69) | 0.61 (0.54, 0.68) | 0.89 (0.77, 1.02) |
| Immigrant, ≥10 years | 0.42 (0.31, 0.57) | 0.38 (0.28, 0.52) | 0.70 (0.48, 1.00) | 0.73 (0.59, 0.91) | 0.74 (0.60, 0.91) | 1.05 (0.84, 1.32) | 0.47 (0.40, 0.55) | 0.46 (0.39, 0.54) | 0.81 (0.68, 0.98) | 0.76 (0.71, 0.81) | 0.77 (0.72, 0.82) | 0.97 (0.89, 1.04) |
| Worked in the prior year | | | | | | | | | | | | |
| Did not work in the past year (vs did) | 2.79 (2.32, 3.36) | 2.91 (2.37, 3.56) | 0.91 (0.72, 1.16) | 2.14 (1.87, 2.44) | 2.48 (2.12, 2.90) | 1.10 (0.91, 1.34) | 1.48 (1.34, 1.63) | 1.55 (1.38, 1.73) | 1.02 (0.90, 1.17) | 1.21 (1.15, 1.27) | 1.29 (1.22, 1.36) | 0.93 (0.87, 0.99) |
| Current student | | | | | | | | | | | | |
| Current student (vs not) | 1.41 (1.02, 1.95) | 1.17 (0.84, 1.65) | 1.29 (0.89, 1.86) | 1.27 (1.02, 1.59) | 1.35 (1.04, 1.75) | 1.29 (0.99, 1.70) | 1.07 (0.92, 1.23) | 1.04 (0.89, 1.21) | 1.00 (0.85, 1.18) | 1.04 (0.97, 1.11) | 1.10 (1.02, 1.18) | 1.09 (1.00, 1.18) |

Reference group = Individuals with no ED use in the year following CCHS interview (No ED usage).
Age-adjusted = multivariable multinomial logistic regression model adjusting for age, in years, as a continuous variable.
Adjusted = multivariable multinomial logistic regression model including all covariates listed in Table 2.
*ED,* emergency department.

**Table 2.** Continued.

| | Frequent (≥ 4 visit), avoidable ED user | | | Frequent (≥ 4 visit), non-avoidable ED user | | | Infrequent (1-3 visit), avoidable ED user | | | Infrequent (1–3 visit), non-avoidable ED user | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Unadjusted | Age-adjusted | Adjusted | Unadjusted | Age-adjusted | Adjusted | Unadjusted | Age-adjusted | Adjusted | Unadjusted | Age-adjusted | Adjusted |
| Urban/rural dwelling | | | | | | | | | | | | |
| Rural vs Urban | 1.92 (1.61, 2.29) | 1.87 (1.56, 2.23) | 1.44 (1.18, 1.77) | 1.61 (1.40, 1.84) | 1.62 (1.41, 1.85) | 1.50 (1.29, 1.75) | 2.16 (1.95, 2.38) | 2.16 (1.95, 2.38) | 1.65 (1.48, 1.85) | 1.32 (1.26, 1.38) | 1.33 (1.27, 1.39) | 1.23 (1.17, 1.30) |
| Sense of community belonging | | | | | | | | | | | | |
| Weak/very weak vs strong/very strong | 0.99 (0.79, 1.23) | 1.02 (0.82, 1.27) | 0.85 (0.67, 1.07) | 1.09 (0.95, 1.26) | 1.09 (0.95, 1.26) | 0.86 (0.73, 1.00) | 0.97 (0.88, 1.07) | 0.97 (0.88, 1.08) | 0.97 (0.87, 1.09) | 1.08 (1.03, 1.14) | 1.08 (1.03, 1.13) | 1.02 (0.97, 1.07) |
| Has a regular doctor | | | | | | | | | | | | |
| Yes (vs no) | 0.87 (0.69, 1.09) | 0.80 (0.63, 1.02) | 0.73 (0.56, 0.95) | 0.96 (0.78, 1.18) | 0.96 (0.78, 1.18) | 0.92 (0.73, 1.16) | 0.97 (0.82, 1.15) | 0.96 (0.81, 1.14) | 0.82 (0.69, 0.97) | 1.07 (0.99, 1.16) | 1.09 (1.00, 1.18) | 1.06 (0.97, 1.15) |
| Mental health consultation in the past year | | | | | | | | | | | | |
| Yes (vs no) | 3.71 (2.99, 4.60) | 3.79 (3.06, 4.69) | 1.66 (1.29, 2.13) | 3.01 (2.57, 3.52) | 3.01 (2.57, 3.52) | 1.39 (1.16, 1.66) | 1.89 (1.65, 2.16) | 1.90 (1.65, 2.17) | 1.26 (1.08, 1.48) | 1.66 (1.57, 1.77) | 1.66 (1.56, 1.77) | 1.23 (1.15, 1.33) |
| Usual Provider of Care (UPC) | | | | | | | | | | | | |
| < 3 visits | 0.35 (0.25, 0.49) | 0.37 (0.26, 0.52) | 0.58 (0.40, 0.84) | 0.47 (0.38, 0.59) | 0.47 (0.38, 0.58) | 0.63 (0.50, 0.79) | 0.85 (0.73, 1.00) | 0.86 (0.73, 1.00) | 1.06 (0.90, 1.25) | 0.85 (0.79, 0.91) | 0.83 (0.78, 0.89) | 0.92 (0.86, 0.99) |
| ≥ 3 visits, no UPC | 1.59 (1.28, 1.98) | 1.60 (1.29, 1.99) | 1.09 (0.89, 1.33) | 1.74 (1.50, 2.01) | 1.73 (1.50, 2.01) | 1.30 (1.12, 1.52) | 1.15 (1.03, 1.28) | 1.15 (1.04, 1.29) | 1.01 (0.90, 1.13) | 1.27 (1.21, 1.34) | 1.27 (1.21, 1.34) | 1.15 (1.09, 1.21) |
| ≥ 3 visits, specialist or generalist | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) |
| Chronic diseases | | | | | | | | | | | | |
| ≥ 1 more vs none | 3.38 (2.78, 4.10) | 3.62 (2.96, 4.43) | 1.73 (1.38, 2.17) | 2.28 (2.00, 2.61) | 2.66 (2.30, 3.07) | 1.42 (1.19, 1.70) | 2.04 (1.86, 2.24) | 2.27 (2.05, 2.51) | 1.72 (1.53, 1.93) | 1.37 (1.31, 1.44) | 1.50 (1.43, 1.57) | 1.15 (1.09, 1.21) |
| Self-perceived general health | | | | | | | | | | | | |
| Poor | 11.89 (8.53, 16.59) | 12.02 (8.54, 16.91) | 2.45 (1.68, 3.58) | 9.07 (7.40, 11.11) | 10.18 (8.20, 12.64) | 2.23 (1.72, 2.89) | 3.24 (2.68, 3.91) | 3.31 (2.74, 4.00) | 1.84 (1.48, 2.29) | 2.81 (2.52, 3.12) | 2.97 (2.67, 3.31) | 1.63 (1.43, 1.85) |
| Fair | 4.19 (3.45, 5.09) | 4.22 (3.46, 5.15) | 1.45 (1.16, 1.83) | 3.27 (2.76, 3.88) | 3.54 (2.98, 4.21) | 1.34 (1.09, 1.64) | 1.83 (1.62, 2.08) | 1.86 (1.64, 2.11) | 1.18 (1.03, 1.36) | 1.70 (1.59, 1.83) | 1.77 (1.65, 1.91) | 1.22 (1.13, 1.33) |
| Good (excellent/ very good) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) |
| Self-reported mental health | | | | | | | | | | | | |
| Poor/fair vs Good/ excellent/ very good) | 2.36 (1.94, 2.86) | 2.34 (1.93, 2.83) | 1.08 (0.84, 1.39) | 2.33 (2.01, 2.70) | 2.33 (2.02, 2.70) | 1.15 (0.95, 1.40) | 1.32 (1.19, 1.46) | 1.32 (1.19, 1.46) | 1.02 (0.90, 1.15) | 1.34 (1.28, 1.41) | 1.34 (1.28, 1.41) | 1.02 (0.96, 1.08) |

Reference group = Individuals with no ED use in the year following CCHS interview (No ED usage).
Age-adjusted = multivariable multinomial logistic regression model adjusting for age, in years, as a continuous variable.
Adjusted = multivariable multinomial logistic regression model including all covariates listed in Table 2.
*ED,* emergency department.

**Table 2.** Continued.

| | Frequent (≥ 4 visit), avoidable ED user | | | Frequent (≥ 4 visit), non-avoidable ED user | | | Infrequent (1-3 visit), avoidable ED user | | | Infrequent (1–3 visit), non-avoidable ED user | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Unadjusted | Age-adjusted | Adjusted | Unadjusted | Age-adjusted | Adjusted | Unadjusted | Age-adjusted | Adjusted | Unadjusted | Age-adjusted | Adjusted |
| Prior-year ED visits | | | | | | | | | | | | |
| No ED visits | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) |
| 1-3 ED visits | 11.19 (9.11, 13.73) | 11.22 (9.14, 13.77) | 7.15 (5.83, 8.78) | 6.71 (5.77, 7.81) | 6.71 (5.77, 7.81) | 4.54 (3.88, 5.32) | 4.31 (3.91, 4.75) | 4.31 (3.91, 4.76) | 3.33 (3.01, 3.70) | 2.66 (2.53, 2.79) | 2.66 (2.53, 2.79) | 2.19 (2.08, 2.30) |
| ≥ 4 ED visits | 212.97 (162.59, 278.96) | 214.55 (163.82, 280.99) | 82.13 (61.60, 109.50) | 73.97 (60.66, 90.21) | 74.00 (60.69, 90.24) | 31.17 (25.11, 38.69) | 14.02 (11.11, 17.69) | 14.04 (11.13, 17.72) | 8.45 (6.57, 10.86) | 6.61 (5.74, 7.62) | 6.60 (5.73, 7.61) | 4.34 (3.76, 4.99) |
| ADG quartile | | | | | | | | | | | | |
| Q1 (lowest) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) | 1.00 (Ref) |
| Q2 | 0.71 (0.52, 0.97) | 0.73 (0.53, 0.99) | 1.04 (0.77, 1.43) | 0.80 (0.64, 1.01) | 0.84 (0.67, 1.06) | 1.03 (0.80, 1.31) | 0.73 (0.64, 0.84) | 0.74 (0.65, 0.85) | 0.87 (0.75, 1.00) | 0.86 (0.81, 0.91) | 0.88 (0.83, 0.93) | 0.94 (0.88, 1.00) |
| Q3 | 1.06 (0.8, 1.42) | 1.16 (0.86, 1.57) | 0.98 (0.71, 1.34) | 1.20 (0.99, 1.45) | 1.42 (1.17, 1.72) | 1.15 (0.93, 1.41) | 0.95 (0.83, 1.09) | 0.99 (0.86, 1.14) | 0.88 (0.77, 1.02) | 1.04 (0.98, 1.11) | 1.13 (1.06, 1.21) | 1.04 (0.98, 1.11) |
| Q4 (highest) | 4.35 (3.40, 5.56) | 5.10 (3.92, 6.64) | 1.70 (1.28, 2.26) | 3.47 (2.92, 4.14) | 4.700 (3.85, 5.73) | 1.82 (1.45, 2.27) | 1.49 (1.32, 1.69) | 1.60 (1.40, 1.82) | 0.94 (0.82, 1.09) | 1.59 (1.49, 1.69) | 1.83 (1.71, 1.96) | 1.28 (1.19, 1.38) |

Reference group = Individuals with no ED use in the year following CCHS interview (No ED usage).
Age-adjusted = multivariable multinomial logistic regression model adjusting for age, in years, as a continuous variable.
Adjusted = multivariable multinomial logistic regression model including all covariates listed in Table 2.
*ADG,* Aggregated Diagnosis Group; *ED,* emergency department.

user category self-reported poor general health compared to 5.4% of individuals with infrequent, non-avoidable ED use. Self-reported mental health was also more commonly poor (4.1%) or fair (11.3%) in the frequent, avoidable ED-use category compared to infrequent, non-avoidable ED users (2.1% poor and 6.5% fair, respectively). Frequent, avoidable ED use was also more likely by. individuals who had comorbidities at the time of the interview, with 63.3% of this category having one or more identified chronic conditions compared to 48.7% of the overall, weighted cohort.

Lastly, past ED use of any kind was strongly associated with the category of ED use. Nearly one-third (32.8%) of individuals in the frequent, avoidable use category were frequent users the year prior, and this association with frequent, avoidable use persisted after adjustment for other covariates (AOR 82.13, 95% CI 61.60-109.50).

## DISCUSSION

In this analysis of a population-based survey linked to administrative health data, we examined the predisposing, enabling, and need factors associated with frequent and avoidable ED users in Ontario. Our study provides a novel description of not just clinical factors, but also sociodemographic, behavioural, and geographic factors which are associated with frequent, avoidable ED use.

Based on our composite definition of avoidable[33] and commonly used benchmark for frequent use,[1] we identified a relatively small cohort of community-dwelling Ontarians (0.8%) who both make a large number of ED visits and for whom at least some of these visits may be best managed in areas of the healthcare system outside the ED. This category of ED users is generally younger, less educated, and of a lower household income quintile. They more often live rurally, and in neighbourhoods that have higher levels of material resource deprivation and lower levels of residential stability. They were also more commonly English-speaking and Canadian born, which is consistent with previous literature on Canadian immigration and ED use.[37] Intervening on this group within or outside the ED setting could improve patient care as frequent ED users have been shown to have increased likelihood of mortality

and hospital admission compared to non-frequent ED users.[38]

While this study identifies a number of predisposing and enabling factors associated with frequent, avoidable ED use, previous studies applying the ANBM or similar behavioural models have identified need as the largest driver of non-urgent or non-emergent ED presentations.[36,39] This study also demonstrated a strong association between need and frequent, avoidable ED use as self-perceived health, as well as administratively identified chronic conditions and ADG quartile were all highest in this category. However, unlike some previous studies,[36] in this study both enabling and predisposing factors demonstrated strong associations with frequent, avoidable ED use. This may be partly attributed to the consideration of frequency of ED use in addition to avoidable, non-urgent, or non-emergent ED presentations alone. Emergency department use, both frequent and potentially avoidable, is multifactorial—associated with several predisposing, enabling, and need factors—and the results of this study highlight that.

Previous studies have shown that patients seeking care in the ED for conditions perceived as non-urgent or avoidable do so for a variety of reasons ranging from primary care unavailability to perceived urgency of their medical issue, and that this group is sociodemographically heterogeneous.[40,41] Frequent, avoidable ED users in this study are also, after adjustment, less likely to self-report having a family doctor and more likely to have repeated healthcare use without that use centralized on a usual care provider. Being rostered to a primary care physician has not been shown to have a large effect on frequent or avoidable ED use based on previous studies.[42,43] However, patients with high levels of continuity of care with a primary care physician have been shown to have lower rates of emergency service ED use, which may indicate the importance of having an accessible usual care provider.[44,45]

This study highlights the role of not just having a primary care physician (via self-report response), but of having high continuity of care with a single, usual care provider which may be an indicator of having accessible care. Even amongst patients with an existing primary care connection, sociodemographic factors, geographic factors, and barriers to access may make the ED a more palatable choice when facing a medical emergency due in part to its immediate availability and access-point to specialist care and diagnostic workup.[46,47] Widespread enrollment in team-based primary care models have shown promise in reducing the impact of neighbourhood-level marginalization on low-acuity ED utilization in a Canadian setting,[48] which has been previously shown to correlate to higher rates of ED utilization in a pediatric population.[49]

Avoidable or low-acuity ED use has long been considered a metric of poor health system performance,[50] and this study further describes individuals and groups who may be falling through the gaps of primary care and could benefit most from more widespread primary care reforms.[51] However, since predisposing, enabling, and need factors beyond primary care continuity also demonstrate associations with frequent, avoidable ED use, it is likely that primary care reform alone is insufficient and that many individuals will benefit from other forms of targeted ED-based interventions or community programs.

A recent review by Jeyaraman et al described the plethora of interventions designed to manage ED flow, broadly categorizing these as within the ED and outside the ED.[52] Many of the outside-ED interventions focused on improving access to primary care and demonstrated good effectiveness; however, these largely took place in urban centres.[52] As we have seen with the roll-out of virtual urgent care programs, large-scale outside-ED interventions to provide patients with alternatives to the traditional ED have often ended up targeting those with existing access.[14,15] The characteristics of individuals characterized by frequent, avoidable ED use identified in this study differ greatly from those who have been identified as using virtual urgent care services, indicating that future similar interventions should be carefully targeted towards those with the greatest access need, specifically those living rurally, in marginalized neighbourhoods, and those with poor overall health.

Canadian recommendations for equitable and sustainable virtual urgent care include technological considerations for those living in rural areas or with limited high-speed internet access, and availability that reflects local access needs.[53] At the same time, the strong association between previous frequent ED use and current frequent, avoidable ED use indicates the need for within-ED programs such as case management for frequent users. There is a need to continue to design ED programs for frequent users but also to ensure that EDs are equipped to handle the needs of people who heavily rely on them for healthcare. However, as highlighted by the review by Memedovich et al, there is a need to integrate the broader social determinants of health along with patterns of ED use when designing and implementing ED interventions to reduce or manage frequent use, ensuring that they are adequately designed to meet the complex needs of the patients that would benefit from them.[7]

## LIMITATIONS

Firstly, while this study uses population-based administrative health data and a survey which is considered representative of community-dwelling adults, it is limited in scope by those who are not included within the sampling frame of the CCHS.[24] Of relevance is the lack of homeless representation, who are not included in the CCHS. People experiencing homelessness represent an important cohort of ED users, constituting as high as 19% of all ED visits in some settings,[54] and with a high proportion of frequent users.[55] However, the interventions and policy to improve healthcare access and reduce ED usage amongst this population is more often tied to provision of housing rather than what would be informed by the results of this study,[56] which is more

applicable to a community-dwelling population. There is a challenge of high-quality data in this population, and this should be a focus of future data collection efforts.

Secondly, the definition of "avoidable" used in this study is a composite definition based on two commonly used definitions in Canadian administrative data research.[33] This definition is not comprehensive and will not capture all ED visits that may be managed elsewhere; however, the sentinel nonurgent condition definition in particular is more specific than other primary care-sensitive definitions,[35,50] resulting in fewer avoidable categorizations and more conservative estimates. Furthermore, limitations with administrative data do not capture the nuance of patient decision-making and complex factors that go into seeking care in the ED, meaning that the visits captured in this analysis provide only a generalization of the types of visits that may be avoidable and the characteristics of patients at a population-level that make these visits, rather than an accurate count of every unique, avoidable ED visit within Ontario.

Next, survey data used in this study was from 2014 or earlier, as methodologic changes in the 2015 cycle of the CCHS led to a recommendation against pooling data from 2014 or earlier with data from 2015 to present.[57] At the time of study completion, only 2015-2016 data was available, which has been analysed in this context as a single-cycle study without linkage to administrative health data.[58] As subsequent CCHS cycles become available and linkable to administrative health data, we would recommend re-doing this analysis with data from 2015 to present. Survey data from the CCHS are entirely self-report and subject to response bias; the data are also cross-sectional and may not reflect the status of participants exactly at the time of their ED use. However, using the year immediately following CCHS interview as the window for ED use will mitigate this. Lastly, results of this study are specific to a Canadian population and health system and may not reflect all health systems. Nonetheless, there are many health systems in the world which are facing similar challenges, and these methods could still be applicable to other settings.

## CONCLUSION

This study provides a comprehensive description of frequent ED users for whom at least some of their visits could more appropriately be managed outside the ED. This is the first study to our knowledge to look at the intersection of frequent and avoidable ED use using administrative health data linked to population-representative health survey data for community-dwelling adults. Frequent, potentially avoidable ED use is associated with several predisposing, enabling, and need factors. Strongest associations were seen with female sex, low household income and education, those living rurally residing in a neighbourhood with high material deprivation and low residential stability, and poor continuity of primary care, along with poor, self-reported health and presence of one or more comorbidities. Similarly, this study also describes those characterized by frequent, avoidable ED use as having been frequent ED users in the prior year as well, indicating a need for ongoing within-ED programs to ensure EDs are well-equipped to meet the needs of these patients. As efforts are being made to redesign access to primary and community care, such as with Ontario Health Teams, and with increasing emphasis on virtual care and other initiatives to reduce avoidable ED utilization, our study shows that consideration should be made to ensure that these interventions are accessible and respond to the needs of the people at higher risk of needing them, including rural populations and those of low socioeconomic status.

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*Conflicts of Interest*: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. No author has professional or financial relationships with any companies that are relevant to this study. There are no conflicts of interest or sources of funding to declare.

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# Patterns in Duration of Emergency Department Boarding and Variation by Sociodemographic Factors

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**Introduction:** Emergency department (ED) boarding negatively affects patient outcomes, increasing length of stay, hallway care, and mortality. Prior research found disparities in capacity metrics like hallway care based on patient race and ethnicity. However, whether boarding differs by demographics is not well characterized. We examined boarding variation by sociodemographic factors in a hospital with a standardized bed-prioritization process. We hypothesized that a structured inpatient assignment method may be associated with reduced boarding inequity.

**Methods:** This single-center, retrospective, cohort study included adult patients boarding in the ED after admission to the non-intensive care inpatient medicine service between February 2020– February 2023 at an urban, academic, tertiary-care hospital with > 110,000 annual ED visits. Primary outcome was time from admission order to inpatient bed transport. Patient demographics (age, sex, race/ethnicity, language, insurance, and housing status), visit characteristics (Emergency Severity Index, time, and day), and bed request features (telemetry, sitter need, and isolation precaution) were obtained via the medical record. We assessed for bivariate relationships between boarding time and demographics with descriptive statistics and analysis of variance using adjusted and unadjusted regression analyses with generalized estimating equations to account for patient-level correlation.

**Results:** In total, 22,291 encounters were included. Average age was 64 (SD ±19) years, and 47% were female. Approximately 12% identified as Hispanic, 70% as non-Hispanic White, and 10% as non-Hispanic Black. Most (97%) boarded ≥ 120 minutes. In adjusted analyses, patients with Medicaid waited an additional 85 minutes (95% CI 49-121), and patients with Medicare waited an additional 67 minutes (95% CI 32-103) compared to those with commercial coverage (both P < .001, respectively). Non-Hispanic Black patients boarded 14 minutes longer (95% CI 22-51), and non-English primary language speakers boarded 15 minutes longer (95% CI 17-47) than non-Hispanic White patients and English primary language speakers, respectively, although these two findings were not statistically significant.

Conclusion: Among adult patients admitted to the inpatient medicine service, non-commercial insurance such as Medicaid and Medicare was significantly associated with longer ED boarding, whereas race/ethnicity and primary language were not. Further study should determine whether these findings are replicated elsewhere, how this impacts patients, and whether targeted intervention can reduce inequities. [West J Emerg Med. 2025;26(6)1640–1647.]

## INTRODUCTION

Emergency department (ED) boarding, which describes admitted patients receiving care in the ED while awaiting inpatient bed availability, increasingly strains healthcare capacity.[1–3] Its effects are felt by ED patients, hospital staff, and admitted patients alike, and the issue is steadily worsening.[4–6] Multiple studies demonstrate that ED boarding negatively affects patient outcomes.[1–3,7] Boarding has been linked to an increase in ED length of stay (LOS), hallway care, poor patient satisfaction, longer hospital stays, preventable disability, and higher in-hospital mortality.[3,8–10] It contributes to greater numbers of patients leaving the ED prior to completion of their evaluation and is tied to an increase in medical errors as well as malpractice action.[11–13] In the current environment of hospital crowding, ED boarding is often directly correlated with hallway care, leading to decreased patient privacy and at times inadequate history and physical exam.[14] Healthcare worker burnout is also associated with boarding, perpetuating the mismatch between inadequate healthcare resources and unmet patient need.[5,15] To an extent, the supply/demand imbalance in hospital resources that drives ED crowding follows established temporal patterns. Weekends are often down-staffed and can be less busy and with reduced acuity than weekdays, and certain days of the week or periods of the day (ie, late morning and afternoon hours) are often the most crowded.[16–18]

Distinct from crowding and boarding, treatment disparities based on non-clinical patient characteristics are well-described in the ED setting. Triage assessments have been found to vary by patient race and sex.[19–22] Pain medication administration has been shown to be inequitable based on patient race and ethnicity.[23,24] Non-White, Spanish-speaking, or Medicaid-covered patients are more likely to be queue-jumped and roomed to a hallway spot.[25] Several studies have found disparities in the use of hallway care based on patient race and ethnicity.[26,27] This aligns with findings from a related body of literature on demographic-based disparities in acute care and outpatient settings seen across lines of race and ethnicity, sex, age, and insurance status.[28–33] Among specific findings are race-based disparities in door-to-needle time, heart-failure cardiology care, and thrombolysis metrics among patients with ischemic stroke, sex-based gaps in acute ST-segment elevation myocardial infarction outcomes, gender discrepancies in acute pulmonary embolism testing and treatment, age-based discrimination in clinical trials and organ transplant eligibility, and increased gatekeeping behaviors and barriers to healthcare access experienced by patients with Medicaid as compared to those with commercial insurance.[28–34]

However, current data are limited and conflicting on whether ED boarding varies by patient sociodemographic characteristics. One study found that men boarded longer than women and that those ≥ 75 years of age boarded for less time than their younger counterparts, while another study corroborated this gender disparity but found prolonged boarding time was associated with older age.[35,36] To our knowledge at the time of this writing, only two studies have examined racial disparities in ED wait times for inpatient beds. One single-site study found that Black patients with high-acuity presentations boarded significantly longer than White patients, and the same racial disparity was seen with those presenting for psychiatric admission.[36] Another multisite analysis similarly found both non-intensive care unit (ICU) admissions and ICU admissions had longer waiting periods for Black patients than non-Black patients, although the study looked at among-hospital rather than within-hospital differences on adjusted analyses, and the authors were unable to include data on bed-prioritization processes or distinguish ED LOS from boarding.[37] Further study is needed to determine whether boarding patterns vary significantly based on these characteristics.

The criteria used by hospitals to determine when an admitted patient moves from the ED to the inpatient unit are not homogenous, and protocols impacting patient throughput and, thus, ED boarding duration differ by institution. Bed-assignment protocols vary considerably from those driven directly by individual staff decision-making where a flow manager works with the inpatient team to prioritize ED

*Population Health Research Capsule*

What do we already know about this issue?
*Studies show healthcare disparities across race, sex, age, and insurance. Emergency department (ED) boarding negatively affects outcomes, but whether it differs by demographics is not well characterized.*

What was the research question?
*In a hospital with a standardized bed-prioritization process, does ED boarding vary significantly by sociodemographic factors?*

What was the major finding of the study?
*Publicly insured patients boarded significantly longer: Medicaid +85 minutes (95% CI 49-121; P < .001); and Medicare +67 minutes (95% CI 32-103; P < .001), compared to private insurance.*

How does this improve population health?
*ED boarding disproportionately affects socioeconomically vulnerable populations, highlighting a need to investigate possible contributing and mitigating factors.*

patients for the next available inpatient bed, to those that are standardized or assisted by decision-technology using objective criteria such as patient age, sex, and isolation requirements.[38,39] In a hospital setting where patient throughput from ED to ready inpatient bed is largely based on a transparent algorithm considering objective, standardized criteria, we examined whether duration of ED boarding varied significantly based on patient sociodemographic factors.

## METHODS

### Study Design

This single-center, cohort analysis used retrospective chart review. The institutional review board (IRB) determined this protocol was exempt from informed consent (protocol #2023P000707).

### Study Setting and Population

The study included consecutive adult patients who boarded in the ED prior to transport to their inpatient bed after admission to the non-intensive care medicine service between January 1, 2022–December 31, 2023, at an urban, academic, tertiary hospital with approximately 110,000 annual ED visits. We focused on general medicine admissions rather than specialty service admissions such as to cardiology or oncology because admissions to other services at this institution require approval by a specialist from that service, a process we considered less generalizable to outside institutions. This hospital has approximately 1,000 beds and nearly 45,000 admissions annually.[40] At the site of this study, patient throughput from ED to ready inpatient bed is guided by an algorithm prioritizing time since bed request and matching bed availability.

Matching bed availability is according to transparent objective criteria including the floor's level of care, the floor's service (eg, medical or surgical), the patient's self-identified gender and patient's precautions (for semi-private rooms), non-cohortable infection (requires private room), and special room type (eg, negative pressure, positive pressure, lead-lined). This process is overseen by specially trained admitting staff who follow these principles. Although chiefly based on these standardized factors, opportunity for clinical judgment and discretion does remain primarily at two junctures. First, the ED resource nurse or a healthcare professional in a similar role may add priority based on a clinical need (such as for a patient with dementia and high delirium risk, or a patient with high risk for skin breakdown). Second, the clinician signing the admission order may select the need for a "Level 1" geographically-based floor team or a "Level 2" non-localized floor team, the latter of which is associated with shorter wait times due to greater supply. Level 2 beds are reserved for admissions with reduced complexity and lower monitoring frequency needs, and although guiding criteria exist for this selection between Level 1 or 2, clinician discretion remains.

Operationally at this institution, once an inpatient bed is ready and available for the admitted ED patient, two additional steps must be completed for the patient to physically be transported out of the ED. First, the ED clinical team must complete verbal pass-off to the inpatient team (separately by both clinician and nurse), after which they indicate with a button click in the electronic health record (EHR) (Epic Corporation, Verona, WI) that this pass-off has been completed. When the unit coordinator sees this indicated on their screen or is verbally notified that the pass-off is complete, they assign transport. We excluded from our investigation patients < 18 years of age, those requiring ICU admission, and interfacility transfers (which may be subject to multiple confounding effects including delays relating to imaging uploading).

### Data

We defined our primary outcome—boarding time—as the time from bed request order for admission to medicine to departure from the ED to that inpatient bed, and characterized it as a continuous variable. We obtained patient demographics (age, sex, race, ethnicity, language, insurance, and housing status), visit characteristics (Emergency Severity Index [ESI] as well as time and day), and bed request features (telemetry, sitter need, or infection control isolation precaution) via the EHR. Methods for medical record review followed standardized criterion including abstractor training, defined case-selection criteria, defined variables, use of abstraction forms, description of health record database, and IRB approval, as described by Worster et al.[41]

### Analysis

We performed a descriptive analysis of boarding time, patient demographics, visit characteristics, and bed-request features using mean (SD) or median (interquartile range [IQR]), depending on distribution for continuous variables, and *n* (proportion) for categorical variables. We assessed bivariate relationships between boarding time and patient demographics with descriptive statistics and ANOVA. We used both adjusted and unadjusted regression analyses with generalized estimating equations (GEE) to account for patient level correlation (Software R version 4.3.1); GEE is a method for modeling correlated data that produces a marginal model to generate estimates representative of the population average.[42] We chose GEE over a Cox proportional hazard model (survival analysis) to produce estimates that allowed comparison in terms of length of time in minutes rather than hazard ratios. In the adjusted models, we controlled for visit characteristics and bed request features. Specifically, the confounding factors we adjusted for included ESI, time and day, need for telemetry, sitter, and infection control isolation precautions.

We examined race/ethnicity and primary language in separate models due to the highly correlated nature of these two variables and concern that introducing collinearity into the model would reduce our ability to detect the individual

effect of each. As this is not a universal approach to addressing collinearity, we also included a GEE analysis with race/ethnicity and primary language included in the same model. We performed sensitivity analyses to evaluate the robustness of our results, including performing the regression analysis for the subgroup of patients who boarded ≥120 minutes, to align with our formal definition of a boarding patient and performing the regression analysis among the subgroup of patients with a single, bed request order. Multiple and changing bed request orders may indicate increased patient complexity or unmeasured work-flow issues that could confound findings, which prompted this second sensitivity analysis. An additional stratified analysis of insurance carrier by age group was performed post hoc.

## RESULTS

We included a total of 22,291 encounters in our analysis, with average patient age of 64 years (SD ±19), 47% of whom were female. Approximately 12% identified as Hispanic, 70% as non-Hispanic White, and 10% as non-Hispanic Black, with non-English primary language speakers comprising 15% of encounters. Most had Medicare coverage (56%), followed by Medicaid (25%), and commercial insurance (16%), and 5% had non-permanent housing status (Table 1).

Most boarding patients had a triage ESI of 2 or 3 (46% and 51%, respectively), and approximately 88% arrived to the ED during day or evening hours (7 AM - 11 PM). Monday was the highest volume day in terms of ED arrivals for admitted patients (16%), followed by the remaining weekdays (15%), and weekend days (12%). Fewer than a quarter of bed requests had an active isolation order (23%), 9% required telemetry, and only 1% required a 1:1 staff observer (Supplemental Table 1).

Most bed request orders were placed during the evening shift (3 PM - 11 PM, 49%) and the highest proportion of requests were placed on Tuesdays with the lowest proportion of requests on Saturday and Sunday (16% vs 13% and 12%). Mean ED census at the time of bed request order was 178 patients (SD 27; median 178, IQR 39) and mean daily boarder census was 40 patients (SD 12; median 39, IQR 16). The vast majority (97% of patients) boarded 120 minutes, with a mean duration of 21 hours, and 35% boarded > 24 hours. (Supplemental Table 2)

Based on GEE analysis that included race/ethnicity in the model, we found variations in duration of ED boarding based on bed request features, departmental as well as temporal factors, and patient demographics. Special bed type, which was defined as requiring either telemetry or 1:1 observer staff, increased boarding time by 50 minutes (CI 95% 11-90; P = .01). Need for active isolation precaution (such as known methicillin resistant Staphylococcus aureus colonization, or positive COVID-19 infection status) also increased boarding duration by 112 minutes (95% CI 83-141; P < .001). Lower acuity patients who had received an ESI of 3-5 in triage, boarded significantly less time than higher acuity ESI 2 patients (131 minutes less for ESI 3, 364 minutes less for ESI 4-5; 95% CI 153-08; P < .001 and 95% CI -441, -286; P < .001, respectively), and highest acuity ESI 1 patients boarded 124 minutes longer than ESI 2 patients, although this

**Table 1.** Demographics of adult emergency department patients admitted to the inpatient medicine service.

| Demographics | Encounters (N = 22,291) |
|---|---|
| Age (years) | |
| mean (SD) | 64 (19) |
| median (IQR) | 66 (28) |
| Age (years), n (%) | |
| 18-64 | 10,325 (46%) |
| > 65 | 11,966 (54%) |
| Sex, n (%) | |
| Female | 10,450 (47%) |
| Male | 11,841 (53%) |
| Race, n (%) | |
| White | 16,179 (73%) |
| Black | 2,461 (11%) |
| Asian | 839 (4%) |
| American Indian or Alaska Native, | 47 (0%) |
| Native Hawaiian or other Pacific Islander | 18 (0%) |
| More than 1 race | 138 (1%) |
| Other/unknown | 2,609 (12%) |
| Ethnicity, n (%) | |
| Hispanic | 2,593 (12%) |
| Non-Hispanic | 18,771 (84%) |
| Unavailable | 927 (4%) |
| Combined Race/Ethnicity, n (%) | |
| Hispanic | 2,593 (12%) |
| Non-Hispanic White | 15,559 (70%) |
| Non-Hispanic Black | 2,288 (10%) |
| Other | 1,851 (8%) |
| Primary Language, n (%) | |
| English | 19,002 (85%) |
| Non-English | 3,289 (15%) |
| Insurance, n (%) | |
| Commercial | 3,653 (16%) |
| Medicaid | 5,476 (25%) |
| Medicare | 12,512 (56%) |
| Other | 650 (3%) |
| Housing Status, n (%) | |
| Permanent | 21,065 (95%) |
| Non-permanent | 1,226 (5%) |

*SD,* standard deviation; *IQR,* interquartile range.

comparison did not reach statistical significance (95% CI -27, 275; P = .11).

Multiple departmental factors were significantly associated with increased ED boarding duration. For every patient increase in boarder census, wait time for inpatient bed increased by 25 minutes (95% CI 23-26; P < .001). Day of the week significantly correlated with duration of boarding with longest waiting period occurring if admission order was placed on a Sunday, followed by Saturday, and shortest duration of boarding occurring if admission order was placed on a Thursday (248 additional minutes, P < .001; 168 additional minutes P < .001, and 212 fewer minutes P < .001, respectively, as compared with Monday admission wait times).

Patient demographics were also associated with how long the patient boarded in the ED. Non-Hispanic Black-identifying patients boarded 14 minutes longer (95% CI -22, 51; P = .45) and non-English primary language speakers boarded 15 minutes longer (95% CI -17, 47; P = .37) than Non-Hispanic White-identifying patients and English primary language speakers, respectively, although these findings were not statistically significant. Patients 65 years of age waited 29 minutes longer than those 18-64 years of age, although this did not remain statistically significant on adjusted analysis (95% CI 0-58; P = .05). Patients with non-commercial insurance waited significantly longer than patients with commercial coverage in adjusted models (those with Medicaid waited an additional 85 minutes and those with Medicare waited an additional 67 minutes; 95% CI 49, 121; P < .001, and 95% CI 32-103; P < .001, respectively). Patient sex and non-permanent housing status were not associated with a significant increase in ED boarding time (Table 2).

When adjusting for race/ethnicity and primary language in separate models due to the correlated nature of these two variables, results were not significantly different. Similarly, results did not significantly differ when we adjusted for race/ethnicity and primary language in the same model (Supplemental Table 3).

Sensitivity analyses examining patients who boarded ≥ 120 minutes and patients who had a single, bed request order did not substantially affect results (Supplemental Table 4). We expected collinearity between the two groups of patients 65 years of age and patients with Medicare coverage, but we also recognized that undetected collinearity may additionally be present between the  65 age group and those with Medicaid coverage. Given this, we stratified insurance carrier by age group and did not find a significant proportion of those 65 years of age insured by Medicaid. (Supplemental Table 5).

## DISCUSSION

We found differences in duration of ED boarding based on features of the bed request order, temporal and departmental factors, and patient demographics. The variation seen with the former elements, such as longer waits for an infection control isolation bed or admission requests made on a Monday, has rational underpinnings and has been previously described.[16–18] However, the basis for disparities seen with insurance carrier is more challenging to explain. Recognizing that collinearity is present between 65 years of age and Medicare insurance, it is somewhat easier to imagine why those with Medicare had increased boarding time. One hypothesis is that the ED work-up for these often older, Medicare-insured patients is typically more extensive than that needed for the often younger, non-Medicare insured patients based on the increased comorbidities often accompanying advanced age.

At this institution, although admission order and inpatient-bed readiness are to some degree distinct and independent from completion of ED workup (ie, an inpatient bed may become ready while the patient still has ED tests in process), it is common practice for patients not to travel to their inpatient bed until tests that are potentially disposition-changing have resulted. This longer workup effect is likely compounded by a lead-time bias in decision to admit older Medicare patients, where the clarity that discharge is not advisable (and hence the bed request order) comes earlier in their ED stay as compared with younger, non-Medicare patients. On the other hand, the opportunity within this institution's admission algorithm to introduce discretion in priority based on clinical factors (such as patient dementia and increased delirium risk), would more logically seem to mitigate this trend. These hypotheses would require further investigation to explore and confirm.

The consequences of increased ED boarding duration for the Medicare-insured older adult are perhaps even more important to consider than the root causes, as the population with advanced age is at highest risk for deleterious effects and iatrogenic harm from longer boarding, including increased mortality.[43] Waiting in the ED often equates with conditions that are deliriogenic, can cause delays in home medication reconciliation, and permits circumstances where nursing-to-patient ratios are at times precarious.[3] The increased likelihood of hallway bed placement, disruption of day/night circadian rhythms, and constant ambient noise in the ED are potent agents increasing risk for delirium, which itself is tied to increased mortality.[44] Similarly, delays in medication reconciliation, which have been described in the setting of ED boarding, can contribute to significant morbidity and mortality.[45]

Why Medicaid insurance is associated with longer duration of ED boarding is unclear. Inherent in a designation as Medicaid-eligible is a scarceness in socioeconomic resources, and literature describes that this is the patient often unduly impacted by social determinants of health and marginalized from consistent and adequate healthcare.[25,29] Considering the known harms associated with ED boarding, the finding that patients with Medicaid are disproportionately affected only furthers the substantial inequity. Additional investigation is needed to determine contributors to this finding, such as

**Table 2.** Multivariable generalized estimating equation analysis showing variation in emergency department boarding by encounter and patient characteristics.

| Demographics | | Estimate (minutes) | *P*-value | 95% CI |
|---|---|---|---|---|
| Age (ref: 18-64) | >65 | 29 | .05 | [ 0, 58] |
| Sex (ref: Female) | Male | 10 | .38 | [ -12, 32] |
| Combined Race and Ethnicity (ref: Non-Hispanic White) | Hispanic | -7 | .72 | [ -43, 30] |
| | Non-Hispanic Black | 14 | .45 | [ -22, 51] |
| | Other* | -7 | .74 | [ -50, 35] |
| Insurance (ref: Commercial) | Medicaid | 85 | < .001 | [ 49, 121] |
| | Medicare | 67 | < .001 | [ 32, 103] |
| | Other | 97 | .01 | [ 21, 172] |
| Housing (ref: Permanent) | Non-Permanent | 25 | .35 | [ -27, 76] |
| Special Bed Type (ref: No) | Yes | 50 | .01 | [ 11, 90] |
| Bed Precaution (ref: No) | Yes | 17 | .81 | [-120, 155] |
| Time of Bed Request (ref: 7 AM - 3 PM) | 3 PM -11 PM | 232 | <0.001 | [ 204, 260] |
| | 11 PM - 7 AM | 177 | <0.001 | [ 145, 209] |
| Bed Request Day of Week (ref: Monday) | Tuesday | -117 | <0.001 | [-156, -78] |
| | Wednesday | -160 | <0.001 | [-199, -122] |
| | Thursday | -212 | <0.001 | [-251, -174] |
| | Friday | -155 | <0.001 | [-197, -114] |
| | Saturday | 168 | <0.001 | [ 122, 214] |
| | Sunday | 248 | <0.001 | [ 202, 294] |
| Active Isolation Precaution (ref: No) | Yes | 112 | <0.001 | [ 83, 141] |
| Acuity per Emergency Severity Index (ESI) (ref: ESI of 2) | ESI 1 | 124 | 0.11 | [ -27, 275] |
| | ESI 3 | -131 | <0.001 | [-153, -108] |
| | ESI 4-5 | -364 | <0.001 | [-441, -286] |
| | ESI unavailable | -145 | 0.03 | [-278, -11] |
| Emergency Department Census** | | 1 | 0.003 | [ 0, 2] |
| Boarder Census | | 25 | <0.001 | [ 23, 26] |

*Other insurance = Veterans Affairs, self-pay, Workers Compensation.
**For each additional patient increase in ED census, boarding time increased by one minute.
Note: Refer to Supplemental Table 3 for results of model that includes primary language.

whether the Medicaid cohort over-indexes those with greater medical complexity, creating similar workup and admission decisions as those we hypothesize are experienced by the typically older Medicare population. As barriers to access primary and preventative care exist disproportionately for those with Medicaid, we must also consider whether the opposite pattern may be at play, whereby this cohort might instead be over-represented in admission for lower acuity conditions, which could be impacted by the discretionary elements of the bed prioritization process. This requires further study.

In contrast to prior investigations, we did not find a significant difference in duration of ED boarding based on patient race and, similarly, ethnicity and primary language did not correlate with longer boarding in our study.[36,37] The reasons for this are unknown, but may be influenced by this hospital's largely transparent, objective, and standardized algorithm for patient throughput from ED to inpatient bed. Future work should examine whether the design of the patient flow algorithm plays a significant role in ED boarding duration inequities.

It may seem surprising that patients with an ESI 1 or 2, indicating higher acuity on arrival, boarded for the longest duration in the ED. However, recalling that our inclusion criteria specify patients admitted to medicine, and not to an ICU, makes this less unexpected. These were likely patients of significant medical complexity and diagnostic uncertainty where ED boarding duration was reasonably longer. Furthermore, this captured a segment of patients who may have had their disposition and bed request order change multiple times during their ED stay (eg, from initial medicine admission request, to upgrade to ICU request, to eventual de-escalation to medicine admission again after the patient stabilized during their ED boarding period). In our institution, the ED boarding clock does not "reset" with each bed request change. Results of our sensitivity analysis adjusting for number of bed request orders did not suggest this as a significant source of confounding.

## LIMITATIONS

Our study had three main limitations. First, this was a single-site, retrospective investigation, and findings may not be generalizable to other settings including community, rural, or geographically distant hospitals. Second, categorization of race/ethnicity may have resulted in misidentification of multi-race/ethnicity individuals; although registration procedure is to ask and elicit a patient's self-identified race/ethnicity, this practice is not always followed such as in the case of the unresponsive or non-verbal patient. Third, we did not adjust for chief complaint, indication for admission, or patient comorbidities; thus, it is possible that our capacity measures do not adequately capture confounding due to the COVID-19 epidemic, which occurred during the study period. It is possible that patients speaking a primary language other than English or those with non-commercial insrance may have had significantly differing distributions of diagnoses and comorbidities, which could have biased our results.

## CONCLUSION

Among adult patients admitted to medicine through the ED, we found significant differences in ED boarding times based on aspects of the bed request order, specific department-related and time-based factors, and patient demographics. Patients with non-commercial insurance boarded significantly longer in the ED before transfer to inpatient medicine beds as compared to patients with commercial insurance coverage. These differences are particularly concerning as the implications of increased boarding time likely pose the highest risk for harm to these potentially more vulnerable populations. It is possible that unmeasured confounders such as illness severity, structural bias, or deviations from protocol may have contributed to study results. Further work should investigate potential underlying administrative, clinical, and social factors behind these findings to determine whether intervention can effectively remediate these inequities.

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# Reduced Functional Bed Capacity Due to Inpatient Boarding Is Associated with Increased Rates of Left Without Being Seen in the Emergency Department

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**Introduction:** We evaluated the relationship between inpatient boarding, measured as functional bed capacity, and left-without-being-seen (LWBS) rates. Functional bed capacity is defined as the mean percentage of ED beds available for new and existing patients over a 24-hour period.

**Methods:** We performed quantile regression models examining the association between LWBS and terciles (low, medium, and high) of functional bed capacity, as well as median admit-to-departure times, controlling for other daily operational metrics. We additionally performed an encounter-level analysis to assess the relationship between functional bed capacity at the time of a patient's arrival and their likelihood of LWBS. Study sites included one academic, one community, and one pediatric ED in a single, urban medical system.

**Results:** Our study included 373,388 visits. In the adjusted regression at the daily level, low functional bed capacity was associated with an increase of 1.59% in LWBS compared to high functional bed capacity, which represented a 26.5% relative increase (about three patients) compared to median LWBS of 6.0% ($P < .001$). Larger daily census (+ 0.07% for each additional patient, $P < .001$), resulted in two additional patients LWBS for every 15-patient increase in daily census from the median. Additionally, longer length of stay of discharged patients (+ 0.05% for each minute increase, $P < .001$), resulted in two additional patients LWBS for every 20-minute increase in length of stay from the median. Weekdays relative to weekend days were associated with a 1.28% decrease in LWBS ($P < .001$) (approximately three fewer patients who left without being seen relative to the median LWBS of 6.0%). At the encounter level, functional bed capacity in the low and middle tercile was significantly associated with an increased probability of a patient LWBS (91% and 40% increases, respectively, $P < .001$). Of the patients who LWBS, 9.3% were high acuity, 59.5% medium acuity, and 31.2% low acuity.

**Conclusion:** Functional bed capacity is a new and pragmatic operational metric strongly associated with left-without-being-seen rates and provides an improved way to measure, study, and communicate the impact of inpatient boarding. We propose using functional bed capacity as a metric in future studies of ED operations. Additional studies that incorporate staffing levels to more accurately approximate functional bed capacity and better characterize its true impact on LWBS rates are needed. [West J Emerg Med. 2025;26(6)1648–1655.]

## INTRODUCTION

Emergency department (ED) boarding and crowding in the United States has reached crisis levels, resulting in significant negative effects on care quality, morbidity, mortality, patient experience, and operational efficiency.[1–7] Boarding is defined by the American College of Emergency Physicians as the practice of holding patients in the ED after they have been admitted to the hospital. Boarding occurs due to several challenges, including staffing shortages and a lack of inpatient bed availability, and it is a major driver of ED crowding.[1,8] Boarding of inpatients presents a unique challenge as these patients use limited ED beds and staff, severely limiting the ability to care for new patients who arrive. Moreover, boarding patients typically occupy more private care spaces, creating a disproportionate need to care for acute ED patients in hallways and curtained spaces.[9]

As ED crowding has worsened, so has the percentage of patients who leave without being seen (LWBS).[10] Since 2020, the volume of patients who LWBS has more than doubled, with the 95th percentile of worst-performing hospitals experiencing an increase in LWBS rates from 4.4% in January 2020 to 10.0% in December 2021. The LWBS rates are a core measure (Measure ID OP-22) tracked by the Centers for Medicare & Medicaid Services Hospital Outpatient Quality Reporting Program as a quality metric of ED throughput.[11] Similar to boarding and crowding, higher LWBS rates correlate with poor patient outcomes, as well as worse patient experience and staff satisfaction[4,12–15] and represent lost revenue; therefore, hospital leaders are increasingly interested in curbing rates of LWBS. Many strategies have been proposed to reduce ED crowding and rates of LWBS via flow improvement and decrease in length of stay (LOS). These solutions are largely aimed at improving ED efficiency and patient throughput given available resources.

We suspect that one independent driver of rising rates of LWBS is inpatient boarding within the ED. We aimed to study the impact of inpatient boarding, which is primarily a function of hospital operations rather than ED operations,[1] on the rates of LWBS across multiple EDs within an academic medical system. Emergency department boarding has previously been studied by evaluating boarding times, often measured as admission-to-departure time, or boarder burden, typically defined as the average number of boarding patients per hour.[5] These metrics are fundamentally tied to specific ED size, are not generalizable across EDs, and do not account for other factors such as staffing limitations. Moreover, they are not intuitive for hospital leaders to understand. We chose to measure boarding as a new variable termed functional bed capacity, defined as the mean percentage of ED beds available for new and existing ED patients over a 24-hour period. We hypothesized that functional bed capacity can more intuitively and accurately capture the impact of boarding and could serve as a pragmatic and more generalizable metric in the field of ED operations.

*Population Health Research Capsule*

What do we already know about this issue?
*Inpatient boarding in the emergency department has reached crisis levels and may be an independent driver of increasing rates of leaving without being seen (LWBS).*

What was the research question?
*Using a novel variable of functional bed capacity, we evaluated the association between inpatient boarding and LWBS rates.*

What was the major finding of the study?
*Low functional bed capacity is associated with an absolute increase of 1.59% in LWBS (P <.001), which is a 26.5% relative increase from the median.*

How does this improve population health?
*The association between inpatient boarding and LWBS highlights another reason to curtail inpatient boarding. Functional bed capacity is a pragmatic metric to track LWBS rates,*

## METHODS

This study was evaluated by our Institutional Review Board (IRB) and deemed exempt from IRB approval. Using a retrospective observational study design, we evaluated patient encounters between October 1, 2022–June 11, 2024 across three EDs within an academic medical system consisting of a large, academic, urban, adult ED (site A); a medium-sized, urban community ED (site B); and an academic, urban. pediatric ED (site C). We collected data from an already existing dataset of metrics without the need for individual chart review. Site A is a 706-bed tertiary care academic medical center with an annual ED patient volume of 89,406, 75 ED beds, and has Level I trauma, ST-elevation myocardial infarction (STEMI)-receiving, and comprehensive stroke center designations. Site B is a 247-bed community hospital with an annual ED patient volume of 74,239, 47 ED beds, and has STEMI-receiving and primary stroke center designations. Site C is an 87-bed pediatric, academic medical center with an annual ED patient volume of 53,772, 41 ED beds, with Level I pediatric trauma and primary stroke center designations. Our study included a total of 373,388 visits across the three hospitals, broken down as 152,166, 126,235, and 94,987 at sites A, B, and C, respectively.

We assessed daily operational metrics using an existing

quality improvement (QI) dataset that includes arrivals per hour, daily arrival volume (census), number of patients who left without being seen (LWBS total), percentage of census that left without being seen (LWBS percentage), median ED length of stay (LOS), median LOS of discharged patients (LOSD), median LOS of admitted patients (LOSA), and number of boarding patients at the top of the hour every hour (hourly boarder burden). At the encounter level, we collected age, arrival method, and patient acuity as indicated by the Emergency Severity Index (ESI); ESI 4 and 5 are categorized as low acuity, ESI 3 as medium acuity, and ESI 1 and 2 as high acuity.

To allow for interpretation not contextualized by ED size, we transformed hourly boarder burden into a new variable termed functional bed capacity. We calculated an estimated functional bed capacity by taking the difference between the number of licensed ED beds and the average number of boarding inpatients at the top of each hour as a percentage of licensed ED beds. As an example, if the average hourly boarder burden is 13 patients in an ED with 75 beds, then the functional. bed capacity is 82.6%. This linear transformation allows for interpretation of the impact of boarding irrespective of ED size.

Given the distribution of the outcome (LWBS) and time variables (admission to departure), we performed unadjusted and adjusted quantile regression models examining the association between LWBS and the tercile of functional bed capacity, as well as median admission-to-departure times for comparison, adjusting for other covariates. We performed a similar encounter-level analysis to assess the relationship between functional bed capacity at the time of a patient's arrival and the likelihood that the patient will LWBS, adjusting for other covariates. Quantile regression is a more robust analysis for data skewed by extreme outliers and is not limited by the assumptions of the parametric distribution of outcome or predictor variables.[16,17] We selected terciles for ease of interpretation and comparison. These calculations were performed in aggregate across all three sites, as well as individually at each site. For each site, we categorized functional bed capacity as low (first tercile), medium (second tercile), or high (third tercile) (Figure 1). All statistics were performed in SAS v9.4 (SAS Institute, Cary, NC). The unadjusted and adjusted quantile regression model results are reported for the 50th percentile.

## RESULTS

Daily operational metrics are summarized in Table 1. Key metrics include an aggregate median LWBS percentage of 6.02% with an IQR of 2.84-10.18%; median functional bed capacity of 85.21% (IQR 74.97-93.29%); and median LOSD of 331 minutes (IQR 259-388).

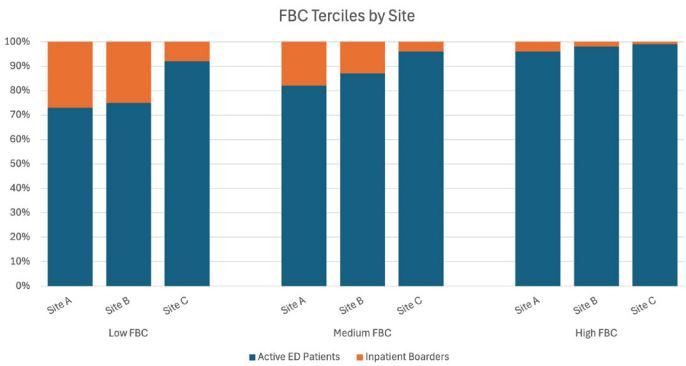


**Figure 1.** Terciles of functional bed capacity by site in a study to determine whether this operational metric is correlated with rates of left without being seen in the emergency department. *ED*, emergency department; *FBC*, functional bed capacity.

### Analysis at the Daily Level

In the unadjusted aggregate model, LWBS percentage was associated with an absolute increase of 5.22% when functional bed capacity is in the lowest tercile ($P$ <.001, Table 2), representing an 87.0% relative increase (approximately 10 patients) in comparison to the median LWBS. This association remains significant, albeit reduced, when controlling for daily census, LOSD, season, and weekends in the adjusted model ($P$ < 0.001, Table 2). In this model, LWBS is associated with an absolute increase of 1.59% when the functional bed capacity is in the lowest tercile, which represents a 26.5% relative increase (about three patients) compared to the median LWBS rate.

Other significant factors associated with increased LWBS rate include larger daily census (0.07% for each additional patient, $P$ < .001, Table 2), longer LOSD (0.05% for each minute increase, $P$ < .001, Table 2), and season of fall (+1.64%, $P$ < .001, Table 2) and summer (+0.87%, $P$ = .001, Table 2), both relative to winter. Every 15-patient increase in daily additional patients from the median resulted in two additional patients LWBS. Every 20-minute increase in LOSD from the median resulted in two additional patients LWBS. Approximately three additional patients left without being seen per day during the fall, and approximately two additional

**Table 1.** Daily operational metric summary statistics.

| Metric | Aggregate Median (IQR) | Site A Median (IQR) | Site B Median (IQR) | Site C Median (IQR) |
|---|---|---|---|---|
| Left-without-being-seen percentage | 6.0 (2.8, 10.2) | 8.9 (5.8, 12.9) | 6.02 (3.0, 9.5) | 3.3 (1.4, 6.5) |
| Length-of-stay of discharged patients in minutes | 330 (259, 388) | 379 (342, 422) | 352 (308, 396) | 232 (203, 267) |
| Functional bed capacity | 85.2 (75.0, 93.3) | 77.6 (71.6, 84.0) | 81.3 (71.6, 89.9) | 94.7 (91.2, 96.7) |
| Daily Census | 204 (165, 233) | 246 (230, 262) | 206 (191, 218) | 151 (137, 168) |

**Table 2.** Unadjusted and adjusted quantile regression models examining the association between percentage of patients who left without being seen and functional bed capacity in aggregate across three study sites at the daily level.

| Model | Covariates | Coefficient estimate | P-value | Adj-R |
|---|---|---|---|---|
| Unadjusted | Functional Bed Capacity (%) | | | 0.088 |
| | Low Tercile | 5.22 | **< .001** | |
| | Medium Tercile | 2.06 | **< .001** | |
| | High Tercile | - | - | |
| Adjusted | Functional Bed Capacity (%) | | | 0.350 |
| | Low Tercile | 1.59 | **< .001** | |
| | Medium Tercile | 0.17 | .44 | |
| | High Tercile | - | - | |
| | Median Daily Census | 0.07 | **< .001** | |
| | Median Length of Stay of Discharged Patients | 0.05 | **< .001** | |
| | Season | | | |
| | Fall | 1.64 | **< .001** | |
| | Spring | -0.47 | .06 | |
| | Summer | 0.87 | **.001** | |
| | Winter | - | - | |
| | Day Type | | | |
| | Weekday | -1.28 | **< .001** | |
| | Weekend | - | - | |

Note: Significant *P*-values are highlighted in bold.
*ADJ-R,* pseudo adjusted r-squared.

patients LWBS per day during the summer relative to winter. Weekdays compared to weekend days were significantly associated with a 1.28% decrease (approximately three fewer patients who LWBS relative to the median LWBS of 6.0%) in LWBS ($P$ <0.001, Table 2). When comparing functional bed capacity to operational variables such as daily census and LOSD, functional bed capacity has the largest impact (Table 2). Similar results were seen within each site, as shown in Table 3.

We performed a similar analysis using median admission-to-departure in place of functional bed capacity, as admission to departure has frequently been cited in boarding literature as an operational metric (Table 4). Substituting median admission to departure as a continuous variable in place of functional bed capacity yielded comparable model performance (Adj-R 0.35 vs 0.35, Tables 4 and 2) with a smaller effect size (one additional patient LWBS for every 100-minute increase in median admission to departure, $P$ < .001, Table 4).

### Analysis at the Encounter Level

To better understand the impact of functional bed capacity on an individual patient at the time of their arrival, we performed a patient-encounter level analysis examining the association between functional bed capacity at the time of ED arrival and the probability that an individual will LWBS. This model controlled for patient age, arrivals per hour at the time of the index patient's arrival, site, acuity, arrival method, season, and day of week. In this model, functional bed capacity in its lowest tercile was associated with a 91% increase in the probability of a patient LWBS ($P$ < .001, Table 5), and a 40% increase with functional bed capacity in its middle tercile ($P$ < .001, Table 5), compared to functional bed capacity in its highest tercile. Other factors associated with an increased likelihood of LWBS include low acuity with a 534% increase ($P$ < .001, Table 5) and medium acuity with a 394% increase ($P$ < .001, Table 5), season of fall with a 34% increase ($P$ < .001, Table 5) and summer with a 14% increase ($P$ < .001, Table 5) relative to winter, and weekday with a 14% increase ($P$ < .001, Table 5) relative to weekend. Arrival by emergency medical services (EMS), season of spring relative to winter, and older age were significantly associated with decreased likelihood of LWBS ($P$ < .001). Patients arriving by EMS were 39% less likely to LWBS. Patients presenting to the ED in the spring compared to winter were 19% less likely to LWBS. There was a 2% reduction in the likelihood of LWBS for each unit increase in age from the site-specific median age. Of the patients who LWBS, 9.3% were high acuity, 59.5% medium acuity, and 31.2% low acuity.

## DISCUSSION

In this retrospective, multisite, observational cohort study, we demonstrated that LWBS percentage increases with decreasing ED bed availability due to boarding of inpatients, as measured by functional bed capacity. This

**Table 3.** Unadjusted and adjusted quantile regression models examining the association between percentage of patients who left without being seen by functional bed capacity by site at the daily level.

| | Model | Covariates | Coefficient Estimate | P-value | Adj-R |
|---|---|---|---|---|---|
| Site A | | Functional Bed Capacity (%) | | | |
| | Unadjusted | Low Tercile (50.17-73.49%) | 3.66 | **< .001** | 0.035 |
| | | Medium Tercile (73.50-81.60%) | 1.11 | .13 | |
| | | High Tercile (81.61-100%) | - | - | |
| | Adjusted | Functional Bed Capacity (%) | | | 0.420 |
| | | Low Tercile (50.17-73.49%) | 1.23 | **< .001** | |
| | | Medium Tercile (73.50-81.60%) | 0.29 | .38 | |
| | | High Tercile (81.61-100%) | - | - | |
| | | Median Daily Census | 0.06 | **< .001** | |
| | | Median Length of Stay of Discharged Patients | 0.05 | **< .001** | |
| | | Season | | | |
| | | Fall | 2.40 | **< .001** | |
| | | Spring | -1.70 | **< .001** | |
| | | Summer | -0.11 | .82 | |
| | | Winter | - | - | |
| | | Day Type | | | |
| | | Weekday | -1.93 | **< .001** | |
| | | Weekend | - | - | |
| Site B | | Functional Bed Capacity (%) | | | |
| | Unadjusted | Low Tercile (41.05-75.26%) | 5.29 | **< .001** | 0.140 |
| | | Medium Tercile (75.27-86.96%) | 2.69 | **< .001** | |
| | | High Tercile (86.97-100%) | - | - | |
| | Adjusted | Functional Bed Capacity (%) | | | 0.490 |
| | | Low Tercile (41.05-75.26%) | 2.06 | **< .001** | |
| | | Medium Tercile (75.27-86.96%) | 0.54 | .05 | |
| | | High Tercile (86.97-100%) | - | - | |
| | | Median Daily Census | 0.074 | **< .001** | |
| | | Median Length of Stay of Discharged Patient | 0.043 | **< .001** | |
| | | Season | | | |
| | | Fall | 0.95 | **.002** | |
| | | Spring | -0.37 | .15 | |
| | | Summer | 1.26 | **.003** | |
| | | Winter | - | - | |
| | | Day Type | | | |
| | | Weekday | 1.21 | **< .001** | |
| | | Weekend | - | - | |

association holds true after controlling for other factors thought to influence LWBS, including day of week, season, LOSD patients, and ED arrivals. This is the first study to demonstrate a relationship between functional bed capacity and rates of LWBS, and our findings were replicable across an academic medical center, a community hospital, and a pediatric ED. After controlling for confounders, low functional bed capacity was associated with a 1.59% absolute rise in LWBS and a 26.5% increase relative to median LWBS. At the encounter level, functional bed capacity in its lowest tercile or middle tercile at the time of patient arrival was associated with an increased risk of LWBS, even after controlling confounding variables.

At the daily level, we found that low functional bed capacity was consistently associated with increased LWBS rates. At the encounter level, however, both middle and low functional bed

**Table 3.** Continued

| | Model | Covariates | Coefficient Estimate | P-value | Adj-R |
|---|---|---|---|---|---|
| Site C | | Functional Bed Capacity (%) | | | |
| | Unadjusted | Low Tercile (55.49-92.37%) | 4.76 | **< .001** | 0.097 |
| | | Medium Tercile (92.38-96.13%) | 1.53 | **< .001** | |
| | | High Tercile (96.14-100%) | - | - | |
| | Adjusted | Functional Bed Capacity (%) | | | 0.410 |
| | | Low Tercile (55.49-92.37%) | 1.25 | **< .001** | |
| | | Medium Tercile (92.38-96.13%) | -0.31 | **.02** | |
| | | High Tercile (96.14-100%) | - | - | |
| | | Median Daily Census | 0.065 | **< .001** | |
| | | Median Length of Stay of Discharged Patients | 0.054 | **< .001** | |
| | | Season | | | |
| | | Fall | 0.054 | 0.20 | |
| | | Spring | -0.11 | 0.39 | |
| | | Summer | -0.76 | **< .001** | |
| | | Winter | - | - | |
| | | Day Type | | | |
| | | Weekday | -0.76 | **< .001** | |
| | | Weekend | - | - | |

Note: Significant *P*-values are highlighted in bold.
*ADJ-R,* pseudo adjusted r-squared.

capacity at the time of a patient's arrival increased their odds of LWBS. This result was likely seen due to the averaging of our daily analysis over a 24-hour period. Even when functional bed capacity was in the middle tercile at the time of patient arrival, patients were statistically more likely to LWBS.

At the daily level, we found that LWBS rates were higher over the weekend relative to weekdays, and higher in fall relative to winter. The day-of-week association is the reverse of what was seen in the encounter-level analysis, likely because patients were analyzed by the date of arrival rather than date of LWBS. As an example, a patient who arrived on a Friday evening and LWBS on Saturday after midnight would be considered a weekend LWBS on the daily analysis but a weekday LWBS at the encounter. level. Although we were unable to account for staffing in our model, we suspect that weekend LWBS rates are driven, in part, by reduced staffing throughout the ED and hospital, which likely reduces available ED bed space and worsens throughput metrics. Patient-specific factors, such as ability or desire to wait to be seen, may also play a role in this observation. Strikingly, 68.8% of patients who LWBS during the period studied were of high or moderate acuity. This highlights the extraordinary patient safety concern of patients who LWBS.

While prior studies aiming to explain LWBS focused on other measures of ED throughput, most were performed prior to the nationwide boarding crisis currently impacting EDs. Today, EDs are tasked with improving throughput in the face of fewer care spaces and greater staffing shortages, combined with rising patient arrivals and acuity. To reduce LOS and LWBS, innovations in ED operations that have been shown to increase productivity and efficiency should be implemented whenever possible, although some commonly implemented strategies have failed to fully mitigate the effects of boarding.[18] Ultimately, efforts to increase functional bed capacity by curtailing inpatient boarding must be implemented to further drive down LWBS rates. Emergency department crowding and boarding have been studied extensively, and numerous underlying causes have been identified. The Association of Academic Chairs of Emergency Medicine summarized the problem: "The cause of ED crowding is misaligned health care economics that pressures hospitals to maintain inefficient high inpatient census levels… [and] few efforts address the economically driven root causes of ED crowding."[1] While ED leaders must innovate in the face of staggering constraints to provide better care to ED patients and reduce LWBS, the solution will necessitate a commitment from hospital leaders to invest in hospital operations.

## LIMITATIONS

Our study has several limitations. First, we were unable to account for ED or inpatient physician and nursing staffing or delays by consulting services, as these data were not available to us. We performed our analysis conservatively and assumed that all ED beds were always staffed; thus, we were likely

**Table 4.** Unadjusted and adjusted quantile regression models examining the association between percentage left without being seen by admission-to-departure time in aggregate across the three study sites at the daily level.

| Model | Covariates | Coefficient Estimate | P-value | Adj-R |
|---|---|---|---|---|
| Unadjusted | Admission-to-departure time in minutes | 0.015 | **< .001** | 0.067 |
| | Admission- to-departure time in minutes | 0.005 | **< .001** | |
| | Median Daily Census | 0.071 | **< .001** | |
| | Median Length of Stay of Discharged Patients | 0.049 | **< .001** | |
| | Season | | | |
| | Fall | 1.480 | **< .001** | |
| Fully Adjusted | Spring | -0.340 | .18 | 0.35 |
| | Summer | 0.780 | **.01** | |
| | Winter | - | - | |
| | Day Type | | | |
| | Weekday | -1.260 | **< .001** | |
| | Weekend | - | - | |

Note: Significant *P*-values are highlighted in bold.
*ADJ-R,* pseudo adjusted r-squared.

underestimating the impact of boarding in this analysis. An ideal measure of functional bed capacity would account only for open, staffed beds, which would more accurately reflect the average percentage of ED beds available to care for acute ED patients over a 24-hour period. Second, as we conducted. a retrospective study with limited access to clinical data, we were unable to account for different clinical presentations, detailed demographics, or other patient-specific factors aside from acuity, which may have resulted in unmeasured confounders. We were also unable to assess the clinical outcomes or social determinants of health of patients who LWBS nor to account for factors related to other services outside the ED. Third, our baseline rates of LWBS were not representative of the national median, and our study was performed at urban hospitals, which may limit the generalizability of our findings.

## CONCLUSION

This retrospective, observational, multisite study shows that the percentage of patients who left without being seen was independently driven by boarding inpatient volumes in the ED, as measured by functional bed capacity and by admission-to-departure times. Functional bed capacity has a larger effect than the traditional measure of admission-to departure times and can be translated as a metric across hospitals regardless of ED size.

Functional bed capacity is a new and pragmatic operational metric strongly associated with LWBS and provides an improved way to measure, study, and communicate the impact of inpatient boarding on the ED. Functional bed capacity provides an intuitive framing to the boarding crisis in a way that hospital leaders can easily understand. We propose using functional bed capacity as a metric in future studies of ED operations. Combatting rising LWBS rates must include efforts to increase functional bed capacity, which is directly related to inpatient boarding and staffing levels and requires hospital-level commitment for improvements to occur. Future studies that incorporate staffing levels to more accurately approximate functional bed capacity and better characterize its true impact on LWBS rates are needed, as is research to better characterize the clinical outcomes of patients who leave without being seen and the economic consequences of losing these encounters.

## AUTHOR CONTRIBUTIONS

Study concept and design (YB, TL, JB, JA, DS, AN); acquisition of the data (YB, JA, DS, TL, JB, AL, FO, DC, AN); analysis and interpretation of the data (YB, TM, TL, JB, AN); drafting of the manuscript (YB, TM, AN); critical revision of the manuscript for intellectual content (YB, TL, TM, JA, DS, AL, FO DC, AN); and statistical expertise (TL, JB). There was no acquisition of funding.

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**Table 5.** Encounter-level adjusted quantile regression model examining the probability of leaving without being seen based on functional bed capacity at the time of patient arrival in aggregate across the three study sites.

| Covariates | Odds Ratio | P-value | Area under ROCC |
|---|---|---|---|
| Age in years | 0.98 | **< .001** | |
| Arrivals per hour | 0.98 | **< .001** | |
| Functional Bed Capacity (%) | | | |
| Low Tercile | 1.91 | **<. 001** | |
| Medium Tercile | 1.40 | **< .001** | |
| High Tercile (reference) | - | - | |
| Site | | | |
| A | 2.16 | **< .001** | |
| B (reference) | - | - | |
| C | 0.44 | **< .001** | |
| Acuity | | | |
| Low Acuity | 6.34 | **< .001** | 0.79 |
| Medium Acuity | 4.94 | **< .001** | |
| High Acuity (reference) | - | - | |
| Arrival by EMS | 0.61 | **< .001** | |
| Season | | | |
| Fall | 1.34 | **< .001** | |
| Spring | 0.81 | **< .001** | |
| Summer | 1.14 | **< .001** | |
| Winter (reference) | - | - | |
| Day Type | | | |
| Weekday | 1.14 | **< .001** | |
| Weekend (reference) | - | - | |

Note: Significant *P*-values are highlighted in **bold**, *EMS,* emergency medical services; *ROCC*, receiver operating characteristic curve.

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# Grouping of Emergency Department-based Cardiac Arrest Patients According to Clinical Features to Assess Patient Outcomes

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**Introduction:** While research has begun to understand emergency department-based cardiac arrest (EDCA), consensus on what exactly constitutes EDCA remains unknown. In this study we aimed to explore the grouping of EDCA by using an unsupervised machine-learning algorithm and to investigate how these underlying clusters related to patient outcomes.

**Methods:** We retrieved electronic health record data from an ED in a tertiary medical center. The EDCAs were identified via the cardiopulmonary resuscitation log. We used k-means cluster analysis to group EDCAs and t-distributed stochastic neighbor embedding (t-SNE) for visualization. Primary outcomes were ED mortality and ED length of stay (LOS). The analyses were repeated using an independent ED data set, the Medical Information Mart for Intensive Care IV Emergency Department (MIMIC-IV-ED) dataset.

**Results:** From 2019 to 2022, there were 366 EDCA events. Cluster analysis identified three distinct clusters (Cluster 1 or immediate risk, n=54 [15%]; Cluster 2 or early risk, n=274 [75%]; Cluster 3 or late risk, n=38 [10%]). Cluster 1 patients had the shortest median time to EDCA (< 1 hour), followed by Cluster 2 (3 hours) and Cluster 3 (81 hours). Near cardiac arrest at triage was the most common cause of EDCA in Cluster 1, while respiratory illnesses and sepsis were more common in Cluster 3. The causes of EDCA in Cluster 2 were diverse, with predominantly cardiovascular and neurologic emergencies. The t-SNE revealed farther distances from Cluster 1 to the other two clusters, suggesting its most critical nature. Cluster 3 had the highest mortality (58%), followed by Clusters 1 (48%) and 2 (35%) (P = .01). Cluster 1 had the shortest median LOS (median, 4 hours), while Cluster 3 had the longest LOS (81 hours) (P < .001). In the independent data set, Cluster 1 remained, but Clusters 2 and 3 appeared to merge due to a shorter ED LOS overall.

**Conclusion:** We identified three novel clusters (immediate, early, and late risk) with distinct patterns in clinical presentation, putative causes of ED-based cardiac arrest, and ED outcomes. Understanding these clinical phenotypes may help develop cluster-specific interventions to prevent EDCA or intervene most appropriately. Cluster 1 patients may benefit from resuscitation efforts, and Clusters 2 or 3 patients can benefit from timely interventions for cardiac, respiratory, and neurologic emergencies. In addition, for patients with prolonged ED boarding, periodic monitoring with an early warning system may prevent a cardiac arrest event. [West J Emerg Med. 2025;26(6)1656–1666.]

## INTRODUCTION

In-hospital cardiac arrest (IHCA) continues to be a major clinical problem worldwide with substantial morbidity and mortality.[1, 2] Approximately 300,000 IHCA events occur per year in the United States.[3] While IHCA events occur in a variety of clinical settings, IHCAs in the emergency department (ED cardiac arrest [EDCA]) are less studied and understood.[4] Emergency department cardiac arrest appears to differ from other IHCA, and it may be associated with higher survival to hospital discharge (22.8%), as opposed to IHCA in the ward setting (10.8%) or intensive care unit (15.8%).[4-8] There is growing interest in studying the epidemiology of EDCA with a particular focus on the development of tools to identify and predict it.[9-12]

While research has begun to understand EDCA, consensus on what exactly constitutes it remains unknown. Emergency department cardiac arrest can be thought of as an umbrella term comprising overlapped individual items in a high-dimensional space. The compositional heterogeneity of EDCA can be studied via cluster analysis, also known as clinical phenotyping. This type of exploratory, unsupervised machine-learning algorithm aims to reveal underlying structures or biological clusters by reducing data dimensions. This technique is unbiased in the sense that subject groupings are made without any previously defined hypothesis or a priori assumption. It has shown promise in the research of other diseases such as diabetes and asthma.[13, 14], Moore et al used unsupervised cluster analysis to identify five distinct clinical phenotypes of asthma, which supports clinical heterogeneity in asthma and the need for new approaches in classifying disease severity in asthma.[14] To the best of our knowledge, however, unsupervised machine-learning has not been applied in EDCA. Understanding the underlying clusters of EDCA and their relationships with patient outcomes would have implications for risk stratification and early interventions in the ED.

To fill these knowledge gaps, we aimed to explore the EDCA subpopulations by cluster analysis and to investigate how these underlying clusters related to patient outcomes. The two-step approach (unbiased patient characterization and outcome association) also increases the validity of analysis by blinding the outcome to the associational variables, thereby avoiding a data-fishing expedition. We also sought to validate our findings on an independent United States ED dataset.

*Population Health Research Capsule*

What do we already know about this issue?
*While researchers have begun to understand emergency department cardiac arrest (EDCA), consensus on what exactly constitutes it remains unknown.*

What was the research question?
*What are the distinct clinical subgroups of EDCA, and how are these clusters associated with patient outcomes?*

What was the major finding of the study?
*Cluster 3 (late-risk group) had the highest mortality (58%), followed by Clusters 1 (immediate-risk, 48%) and 2 (early-risk, 35%) (P = .01).*

How does this improve population health?
*The identification by machine-learning of 3 EDCA subgroups with distinct patterns in time to cardiac arrest and ED outcomes suggests time-based specific interventions for each subgroup.*

## METHODS

### Study Design, Setting, and Population

We conducted a retrospective cohort study in the National Taiwan University Hospital (NTUH), a tertiary, academic medical center with approximately 2,400 beds and 100,000 ED visits per year. The ED also manages an observation unit (EDOU), which is staffed by emergency physicians. For quality improvement purposes, the department compiles an EDCA log that includes all EDCAs treated with cardiopulmonary resuscitation (CPR), including those in the EDOU. We defined EDCA as patients who arrived in the ED with vital signs and later developed cardiac arrest in the ED. Thus, out-of-hospital cardiac arrests (OHCA) without return of spontaneous circulation (ROSC) on ED arrival were excluded. The EDCA log contained basic data (demographic and administrative data) from all EDCAs. Additional clinical information was collected through periodic electronic health record (EHR) reviews, with a focus on pre-arrest factors (eg, triage data, structured chief complaints, and pre-arrest vital signs).

Data were directly extracted via structured items in the five-level Taiwan Triage and Acuity Scale (TTAS) embedded in our EHR system (not abstracted from hard-copy medical records). The computerized TTAS triage software, adapted from the Canadian Triage and Acuity Scale, has been used for ED triage in Taiwan since 2010. In this study we followed the methods of medical record review studies in emergency medicine research except for interrater reliability assessments.[15] Putative etiologies included six major categories (cardiovascular, respiratory, sepsis, trauma, near-arrest on arrival, and other) that contained 29 presumed causes of cardiac arrest (online Supplementary Table). The causes of arrest were initially assigned by resident reviewers and finalized by a board-certified attending physician. The medical record abstractors and physician reviewers of arrest etiology

were blinded to study outcomes. Monthly EDCA meetings were held to review EDCA cases and discuss possible preventive strategies on a systemic level. We used the EDCA database from its inception (January 1, 2019) to December 31, 2022 and focused on adults ≥ 18 years of age.

**Ethical Approval Statement**

This study was approved by the NTUH Institutional Review Board (reference number: 202304105RINC), which waived the requirement for patient informed consent.

**Variables**

Patient demographics and time-stamped clinical information at triage were collected, including chief complaint on presentation, mode of arrival, vital signs (temperature, heart rate, systolic and diastolic blood pressure, respiratory rate, oxygen saturation), and levels of consciousness as defined by the Glasgow Coma Scale (GCS). At ED triage, when assessing a patient's level of consciousness, the triage nurse also recorded whether there was an acute change from the patient's baseline status. Pain scores were evaluated on a numeric rating scale (NRS) of 0-10, with 0 being no pain and 10 being the worst pain imaginable. The TTAS contained information on 179 structured chief complaints. Based on computerized algorithms, the TTAS classified patients in the following order of acuity: level 1, resuscitation; level 2, emergent; level 3, urgent; level 4, less urgent; and level 5, non-urgent. The TTAS has been validated against hospitalization, ED LOS, and resource use. In our ED, for location-of-care purposes, patients were assigned a subdivision for care after triage, including non-trauma, trauma, and major trauma/resuscitation areas. We classified ED shifts as day (07 AM -2:59 PM), evening (3 pm -10:59 PM), and night (11 PM - 6:59 AM) shifts. The time interval from triage to CPR was also calculated. For patients who required multiple CPR attempts due to re-arrest, their records were counted only once (first CPR in the ED). Of note, the vital signs for patients with near-cardiac arrest at triage were set to zero due to being rushed to resuscitation without triage measurements.

**Independent Data Set to Validate the Clustering Approach**

The Medical Information Mart for Intensive Care IV Emergency Department (MIMIC-IV-ED) dataset is a large, freely available database of ED visits at the Beth Israel Deaconess Medical Center (Boston, MA, USA) between 2011–2019. The database contains approximately 425,000 ED stays. Triage information (eg,, chief complaints and vital signs), diagnostic codes, medication administration, and ED disposition were available. For validation purposes, we included adult patients with a diagnostic code of cardiac arrest (primary or secondary codes). Of them, we further excluded patients with a mention of "arrest" in their chief complaint (presumably OHCA) to arrive at the EDCA population of interest. The MIMIC-IV-ED dataset was not as granular as our own ED data, as some information was not available (eg, time to CPR or seasonality) or not derivable (etiology of arrest).

**Outcome Measures**

Primary outcomes were mortality in the ED and ED LOS. The secondary outcome was the putative cause of cardiac arrest.

**Statistical Analysis**

We used an unsupervised machine-learning algorithm, k-means with Euclidean distance, to group EDCAs. For this k-means cluster analysis, patient characteristics included demographics (age and sex) and pre-arrest information (triage vital signs, model of arrival, Glasgow Coma Score, pain score, subdivision of care, chief complaint, ED presentation [season, weekend, time of day], and time to CPR). We checked the variance inflation factor (VIF) for all features in the clustering algorithm. Multicollinearity did not seem to be a concern since all VIFs were < 10. The k-means clustering algorithm is an iterative procedure that partitions data into k clusters. The goal of this algorithm was to minimize the sum of squared distance in each cluster, thereby achieving high similarity within clusters. The procedure began with a random selection of k patients as the initial cluster center. Afterward, observations were assigned to the cluster with the closest center, and the cluster centroid was subsequently updated. The process was repeated until all observations remained in the same cluster from the previous iteration. The optimal number of clusters was determined by a large reduction in the sum of squared distances (ie, elbow statistic).[16] During the entire clustering process, the algorithm was blinded to outcome variables. The clustering procedure was first performed using the NTUH dataset and then repeated using the MIMIC-IV-ED dataset for validation purposes.

Summary statistics are presented as proportions (with 95% CI), means (with standard deviations), or medians (with interquartile ranges). To compare differences between clusters, we examined bivariate associations using Student *t*-tests, Mann-Whitney tests, chi-square tests, and chi-square trend tests, as appropriate. To visualize the underlying patterns in the multi-dimensional data, we used the 3-D *t*-distributed stochastic neighbor embedding (*t*-SNE). The *t*-SNE is a commonly used non-linear dimensionality reduction technique.[17] We plotted time to CPR using a violin plot for visualization purposes. The violin plot shows the full distribution of the data, usually smoothed by a kernel probability density estimator.

All analyses were performed using Stata 16.0 software (StataCorp, College Station, TX) and the SAS Viya software platform (SAS Institute Inc, Cary, NC). All *P*-values are two-sided, with $P < .05$ considered statistically significant.

**RESULTS**

From 2019 to 2022, there were 368 EDCAs. For the current analysis, we excluded two children < 18 years of age,

leaving a cohort of 366 adult patients. Table 1 shows the clinical characteristics of the study cohort. Overall, the mean age of these patients was 72 years, and 40% were women. The vast majority of the EDCAs were initially assigned to the non-trauma area, and 45% arrived by ambulance. A variety of chief complaints were recorded on ED presentation, with dyspnea being the most common. The triage levels were quite high, with 34% triaged to level 1. The initial mean values of vital signs and consciousness level were deranged, with a wide range of variation presented in Table 2. Most patients were pain-free. The median time from triage to CPR was only three hours. Approximately 13% of the patients' arrest rhythm was shockable, 8% was asystole, and 79% was pulseless electrical activity (PEA).

**Table 1.** Baseline clinical characteristics of emergency department patietns with cardiac arrest.

| Variable | N = 366 |
|---|---|
| Age, mean (SD), yr | 72.0 (15.5) |
| Female sex, n (%) | 146 (39.9) |
| Season, n (%) | |
| Spring (Mar. – May) | 93 (25.4) |
| Summer (Jun. – Aug.) | 90 (24.6) |
| Fall (Sep. – Nov.) | 98 (26.8) |
| Winter (Dec. – Feb.) | 85 (23.2) |
| Weekend, n (%) | 104 (28.4) |
| Presenting Time, n (%) | |
| 7 AM - 2:59 PM | 153 (41.8) |
| 3 PM - 10:59 PM | 138 (37.7) |
| 11 PM - 6:59 AM | 75 (20.5) |
| Subdivision, n (%) | |
| Non-trauma | 344 (94.0) |
| Trauma | 10 (2.7) |
| Major trauma | 12 (3.3) |
| Arrival by ambulance, n (%) | 166 (45.4) |
| Most common chief complaint, n (%) | |
| Dyspnea | 90 (24.6) |
| Chest pain | 49 (13.4) |
| Fever | 34 (9.3) |
| Consciousness change | 24 (6.6) |
| Injury | 20 (5.5) |
| Abdominal pain | 18 (4.9) |
| Triage level, n (%) | |
| 1 (highest acuity) | 123 (33.6) |
| 2 | 131 (35.8) |
| 3 | 110 (30.1) |
| 4 | 2 (0.6) |
| 5 (lowest acuity) | 0 (0) |
| Vital sign at triage | |
| Systolic blood pressure, mean (SD), mm Hg | 105.5 (53.5) |
| Diastolic blood pressure, mean (SD), mm Hg | 61.9 (31.0) |
| Heart rate, mean (SD), beats per minute | 88.3 (35.4) |
| Body temperature, mean (SD), °C | 36.4 (3.6) |
| Respiratory rate, mean (SD), breaths per minute | 20.5 (7.3) |
| Oxygen saturation, median (IQR), % | 97 (94-99) |
| Glasgow Coma Scale, mean (SD) | |
| Eye | 3.4 (1.1) |
| Verbal | 3.8 (1.8) |
| Motor | 5.0 (1.8) |
| Acute change of consciousness, n (%) | 170 (46.5) |
| Pain score (0-10), median (IQR), % | 0 (0-0) |
| Time from triage to CPR, median (IQR), hour | 3 (0-19) |
| Shockable arrest rhythm, n (%) | 48 (13.1) |

*CPR,* cardiopulmonary resuscitation; *IQR,* interquartile range; *mm Hg,* millimeters of mercury.

As shown in the Online Supplementary Figure, the clustering algorithm identified three clusters as there was a kink in the within sum of squares at k = 3 (number of clusters). Of these 366 patients experiencing IHCA, 54 patients were organized into Cluster 1 (14.8%), 274 patients in Cluster 2 (74.9%), and 38 patients in Cluster 3 (10.4%) (Table 2). The three clusters did not differ with regard to age, sex, presenting season, weekend, time of the day, subdivision, or mode of arrival. In terms of chief complaint upon presentation to the ED, Cluster 1 had more complaints of change in consciousness or injury, Cluster 2 had more complaints of chest pain or fever, and Cluster 3 had more complaints of dyspnea or abdominal pain. Furthermore, Cluster 1 patients were mostly triaged to level 1, Cluster 2 to level 2, and Cluster 3 to level 3.

Vital signs also reflected the different levels of acuity across the three clusters; for example, Cluster 1 had highly abnormal vital signs. The trend of decreasing acuity from Cluster 1 to 3 appeared the same in relation to the GCSlasgow Coma Scale and acute change in consciousness. Most patients were pain-free, although there was a slight difference across clusters. Cluster 2 had a higher rate of shockable rhythm at arrest, but this was not statistically significant. An important clinical difference across the three clusters was time from triage

**Table 2.** Patient characteristics of each cluster signifying risk of cardiac arrest.

| Variable | Cluster 1 (n = 54) | Cluster 2 (n = 274) | Cluster 3 (n = 38) | P-value |
|---|---|---|---|---|
| Age, mean (SD), yr | 70.7 (16.1) | 71.9 (15.5) | 77.7 (14.0) | .07 |
| Female sex, n (%) | 19 (35.2) | 111 (40.5) | 17 (44.7) | .64 |
| Season, n (%) | | | | .79 |
| Spring (Mar. – May) | 13 (24.1) | 71 (25.9) | 9 (23.7) | |
| Summer (Jun. – Aug.) | 9 (16.7) | 72 (26.3) | 9 (23.7) | |
| Fall (Sep. – Nov.) | 17 (31.5) | 71 (25.9) | 10 (26.3) | |
| Winter (Dec. – Feb.) | 15 (27.8) | 60 (21.9) | 10 (26.3) | |
| Weekend, n (%) | 20 (37.0) | 72 (26.3) | 12 (31.6) | .25 |
| Presenting Time, n (%) | | | | .08 |
| 7 AM - 2:59 PM | 26 (48.2) | 106 (38.7) | 21 (55.3) | |
| 3 PM - 10:59 PM | 17 (31.5) | 106 (38.7) | 15 (39.5) | |
| 11 PM - 6:59 AM | 11 (20.4) | 62 (22.6) | 2 (5.3) | |
| Subdivision, n (%) | | | | .44 |
| Non-trauma | 50 (92.6) | 256 (93.4) | 38 (100.0) | |
| Trauma | 1 (1.9) | 9 (3.3) | 0 (0) | |
| Major trauma | 3 (5.6) | 9 (3.3) | 0 (0) | |
| Arrival by ambulance, n (%) | 32 (59.3) | 120 (43.8) | 14 (36.8) | .06 |
| Most common chief complaint, n (%) | | | | .02 |
| Dyspnea | 13 (24.1) | 65 (23.7) | **12 (31.6)** | |
| Chest pain | 7 (13.0) | **39 (14.2)** | 3 (7.9) | |
| Fever | 1 (1.9) | **29 (10.6)** | 4 (10.5) | |
| Consciousness change | **9 (16.7)** | 13 (4.7) | 2 (5.3) | |
| Injury | **6 (11.1)** | 14 (5.1) | 0 (0) | |
| Abdominal pain | 0 (0) | 15 (5.5) | **3 (7.9)** | |
| Other | 18 (33.3) | 99 (36.1) | **14 (36.8)** | |
| Triage level, n (%) | | | | < .001 |
| 1 (highest acuity) | **37 (68.5)** | 81 (29.6) | 5 (13.2) | |
| 2 | 7 (13.0) | **114 (41.6)** | 10 (26.3) | |
| 3 | 10 (18.5) | 77 (28.1) | **23 (60.5)** | |
| 4 | 0 (0) | **2 (0.7)** | 0 (0) | |
| 5 (lowest acuity) | 0 (0) | 0 (0) | 0 (0) | |
| Vital sign at triage* | | | | |
| Systolic blood pressure, mean (SD), mm Hg | 3.7 (13.5) | **121.4 (34.9)** | 136.1 (31.8) | < .001 |
| Diastolic blood pressure, mean (SD), mm Hg | 2.4 (8.7) | **71.2 (19.9)** | 79.7 (18.5) | < .001 |
| Heart rate, mean (SD), beats per minute | **44.4 (51.2)** | 96.3 (25.8) | 92.8 (19.9) | < .001 |
| Body temperature, mean (SD), °C | **34.2 (8.5)** | 36.8 (1.5) | 36.9 (0.8) | .003 |
| Respiratory rate, mean (SD), breaths per minute | **11.2 (11.4)** | 22.1 (4.9) | 22.1 (4.1) | < .001 |
| Oxygen saturation, median (IQR), % | 0 (0-95) | **97 (95-99)** | 97 (96-98) | < .001 |

**Table 2.** Continued.

| Variable | Cluster 1 (n = 54) | Cluster 2 (n = 274) | Cluster 3 (n = 38) | P-value |
|---|---|---|---|---|
| Glasgow Coma Scale, mean (SD) | | | | |
| Eye | **1.8 (1.2)** | 3.7 (0.8) | 3.9 (0.5) | < .001 |
| Verbal | 1.5 (1.5) | 4.2 (1.5) | **4.3 (1.6)** | < .001 |
| Motor | **2.3 (2.0)** | 5.5 (1.3) | 5.6 (0.9) | < .001 |
| Acute change of consciousness, n (%) | **45 (83.3)** | 110 (40.2) | 15 (39.5) | < .001 |
| Pain score (0-10), median (IQR), [range] | 0 (0-0), [0-8] | **0 (0-0), [0-10]** | 0 (0-0), [0-8] | .03 |
| Shockable arrest rhythm, n (%) | 7 (13.0) | 40 (14.6) | 1 (2.6) | .12 |
| Time from triage to CPR, median (IQR), hour | 0 (0-3) | 3 (1-13) | **80.5 (70.0-97.0)** | < .001 |

Significant differences with the highest percentage/value are highlighted in bold.
*The vital signs for patients with near cardiac arrest at triage were set to zero due to being rushed to resuscitation without triage measurements.
*CPR,* cardiopulmonary resuscitation; *IQR,* interquartile range; *mm Hg,* millimeters of mercury.

to CPR, with medians of 0, 3, and 80.5 hours for Cluster 1, 2, and 3, respectively. Figure 1 depicts the distributions of time to CPR across the three clusters via a violin plot. In terms of high-dimensional distance measures reduced to a 3-D plot (Figure 2), *t*-SNE revealed much farther distances from Cluster 1 to the other 2 clusters, suggesting its unique and most critical nature.

Table 3 characterizes each cluster based on the putative causes of cardiac arrest. Cluster 1 patients comprised more trauma patients; it also saw the highest rate of OHCA with ROSC or near-IHCA at triage. Cluster 2 comprised a higher prevalence of diagnoses related to the cardiovascular system and a variety of "other" diagnoses (n = 90). The most common diagnoses in the

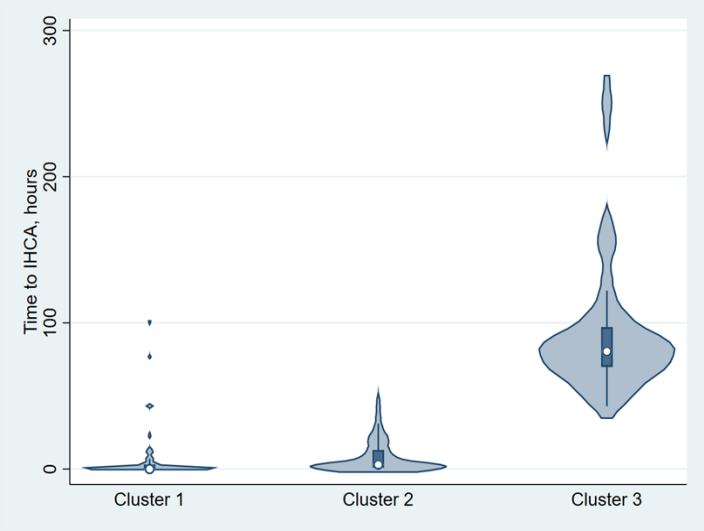


**Figure 1.** Violin plots showing the distribution of time to in-hospital cardiac arrest requiring cardiopulmonary resuscitation by cluster. Cluster 1 represents an immediate risk, Cluster 2 represents an early risk, and Cluster 3 represents a late risk. For each cluster, the median is shown as a circle, and the first-to-third interquartile range is shown as a shaded box.
*IHCA,* in-hospital cardiac arrest.

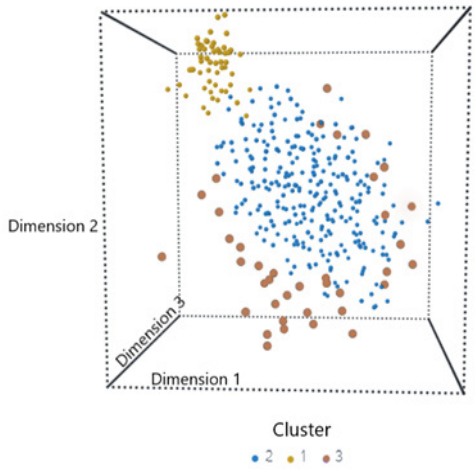


**Figure 2.** The t-SNE plot. Each circle represents a patient. The t-SNE visualizes the three clusters of data in the three-dimensional space, revealing farther distances from Cluster 1 (upper left corner, immediate risk) to the other two clusters (Cluster 2, early risk; Cluster 3, late risk). The plotted dimensions are abstract and don't correspond to original features. They are latent dimensions that best preserve local similarities and show distances between observations.
*t-SNE,* t-distributed stochastic neighbor-embedding.

**Table 3.** Putative cause of cardiac arrest.

| | Cluster 1 (immediate risk) (n=54) | Cluster 2 (early risk) (n=274) | Cluster 3 (late risk) (n=38) | P-value |
|---|---|---|---|---|
| Diagnosis | | | | <0.001 |
| CV | 13 (24.1) | **73 (26.6)** | 4 (10.5) | |
| Sepsis | 6 (11.1) | 2 (11.7) | **10 (26.3)** | |
| Respiratory | 11 (20.4) | 59 (21.5) | **15 (39.5)** | |
| Trauma | **4 (7.4)** | 14 (5.1) | 0 (0.0) | |
| Other | 12 (22.2) | **90 (32.9)** | 9 (23.7) | |
| OHCA with ROSC or near IHCA at triage | **8 (14.8)** | 6 (2.2) | 0 (0.0) | |

Significant differences with the highest percentage/value were highlighted in bold.
*CV,* cardiovascular; *IHCA,* in-hospital cardiac arrest; *OHCA,* out-of-hospital cardiac arrest; *ROSC,* return of spontaneous circulation.

other category were gastrointestinal bleeding (n = 19), advanced cancer with multiple causes (n = 18), cerebrovascular accident (n = 9), hyperkalemia (n = 7), and head and neck cancer bleeding (n = 5). Cluster 3 held the most diagnoses of sepsis and respiratory illnesses (mainly pneumonia).

Table 4 reveals the outcomes of patients assigned to each cluster. Cluster 3 patients had the highest mortality (58%), followed by Clusters 1 (48%) and 2 (35%) ($P = .01$). The ED LOS was longest in Cluster 3 (median, 81 hours), followed by Clusters 2 (median, 6 hours) and 1 (median, 4 hours) ($P < .001$).

**Table 4.** Study outcomes by cluster.

| | Cluster | | | |
|---|---|---|---|---|
| Outcome | 1 (immediate risk) (n = 54) | 2 (early risk) (n = 274) | 3 (late risk) (n = 38) | *P*-value |
| Mortality, n (%) | 26 (48.2) | 97 (35.4) | **22 (57.9)** | 0.01 |
| ED length of stay, median (IQR), hour | 4.0 (3.0-7.0) | 6.0 (3.0-20.0) | **80.5 (70.0-93.0)** | <0.001 |

Significant differences with the highest percentage/value are highlighted in bold.
*ED,* emergency department; *IQR,* interquartile range.

### Independent Dataset

From 2011 to 2019, there were 207 EDCAs in the independent dataset MIMIC-IV-ED**.** Table 5 shows the clinical characteristics of the cohort. Approximately 72% of the patients arrived by ambulance, and 73% were triaged at level 1. After the clustering procedure, only two clusters were identified. A total of 154 patients were organized into Cluster 1 (74%) and 53 patients in Cluster 2 (26%) (Table 6). Cluster 1 patients' acuity was much higher than Cluster 2, as more patients arrived by ambulance and were triaged at level 1 in Cluster 1. Regarding chief complaints and outcomes (Table 7), Cluster 1 patients comprised patients with a motor vehicle collision, comatose status, or ST-elevation myocardial infarction, and transferred patients. By contrast, Cluster 2 patients comprised patients with dyspnea, chest pain, altered mental status, or syncope. Emergency department mortality was similar between the two groups, with a slightly shorter ED LOS in Cluster 1 patients.

## DISCUSSION

Our exploration into the heterogeneity of 366 patients who experienced in-hospital cardiac arrest in the ED yielded three distinct clinical phenotypes. As a result of unsupervised machine-learning, time to CPR appeared to be the most important feature when characterizing EDCA, and a trimodal temporal pattern was identified. Near-cardiac arrest at ED triage and OHCA with ROSC were the most common causes of EDCA in Cluster 1 patients, while respiratory illness and sepsis were the most common causes of EDCA in Cluster 3 patients. The causes of EDCA in Cluster 2 patients were quite diverse, including cardiovascular diseases and other causes. Regarding outcomes, Cluster 3 patients had the longest ED. LOS and highest mortality. Cluster 1 patients had the second highest mortality and the shortest time to CPR and ED. LOS. Cluster 1 patients also possessed a critical nature that distinguished themselves in the dimensional plot. In the independent dataset, Cluster 1 remained, but Clusters 2 and 3

**Table 5.** Baseline clinical characteristics of emergency department patients with cardiac arrest in the Medical Information Mart for Intensive Care-IV Emergency Department dataset.

| Variable | N = 207 |
|---|---|
| Age, mean (SD), yr | 64.2 (20.9) |
| Female sex, n (%) | 91 (44.0) |
| Arrival by ambulance, n (%) | 149 (72.0) |
| Most common chief complaint, n (%) | |
| Abdominal pain | 4 (1.9) |
| Fever | 2 (1.0) |
| Dyspnea | 12 (5.8) |
| Dizziness | 1 (0.5) |
| Chest pain | 12 (5.8) |
| Other | 176 (85.0) |
| Emergency Severity Index, n (%) | |
| 1 (highest acuity) | 152 (73.4) |
| 2 | 47 (22.7) |
| 3 | 8 (3.9) |
| 4 | 0 (0) |
| 5 (lowest acuity) | 0 (0) |
| Vital sign at triage* | |
| Systolic blood pressure, mean (SD), mm Hg | 32.2 (55.3) |
| Diastolic blood pressure, mean (SD), mm Hg | 18.4 (32.4) |
| Heart rate, mean (SD), beats per min | 21.1 (38.2) |
| Body temperature, mean (SD), °C | 8.0 (15.1) |
| Respiratory rate, mean (SD), breaths per min | 4.9 (8.9) |
| Oxygen saturation, median (IQR), % | 0 (0-0) |
| Glasgow Coma Scale < 15, n (%) | 37 (17.9) |
| Pain score (0-10), median (IQR), % | 0 (0-0) |

*The vital signs for patients with near cardiac arrest at triage were set to zero due to being rushed to resuscitation without triage measurements
*SD,* standard deviation; *IQR,* interquartile range, *mm Hg,* millimeters of mercury.

appeared to merge due to a shorter ED LOS overall.

Resuscitation care is especially important for patients in Cluster 1. This was the subgroup comprising patients with trauma and near-IHCA at triage or OHCA with ROSC. The time from triage to CPR was < one hour, and the mortality rate was quite high. We considered this group to be immediate and very high risk. As stated in the Methods section and Table 2 footnote, the vital signs for patients with near-cardiac arrest at triage were set to zero due to being rushed to resuscitation without triage measurements. As such, the vital signs in this group were highly abnormal. Because of the very short time to cardiac arrest, this group would especially benefit from earlier and intensive interventions. Realistically, within this ultra-short time frame, it is less likely for any of these patients to have undergone detailed laboratory examinations and workup. Immediate resuscitation with Advanced Cardiovascular Life Support (ACLS) may be key to reversing the deteriorating course of these peri-arrest patients.[18] Combined with the advantages of the ED where there is 24-hour onsite physician coverage and quick access to Advanced Life Support equipment, timely management of imminent EDCA should be possible.[19]

We considered the patients of Cluster 2 as the early- and medium-to-high-risk group. With a median time from CPR to triage of 3 hours, IHCA was impending, but not as quickly as Cluster 1. As a result, there may be more time available for clinical decision-making over the ED stay. The most common putative causes of cardiac arrest in this group are diverse, as results indicated causes ranging across the gastrointestinal system, stroke, and cancer, among others. Additionally, because the patients in this cluster presented with somewhat normal vital signs, the question could be asked: why do these patients deteriorate somewhat acutely? The subtle clues may be buried in the initial clinical presentation of the patient at triage. For example, are there subtle physical or vital signs suggesting imminent gastrointestinal or head and neck cancer bleeding that could subsequently lead to shock or airway issues? Are there unrecognized neurologic signs indicating a life-threatening stroke?

This cluster could benefit from machine-learning algorithms that incorporate large amounts of traditional and unconventional data (physical examination images or videos) to detect clinical deterioration. For example, our recent research used triage ECG images to accurately detect EDCA seven hours prior to arrest.[20] Another study used video at triage to predict hospitalization via computer vision algorithms.[21] Further research and data collection can more clearly define identifying characteristics in a time-sensitive clinical setting.

The patients of Cluster 3 saw deterioration to EDCA within approximately three days of ED arrival; we considered this cluster as the late EDCA group. In Taiwan, these patients are classified as "ED boarders" awaiting inpatient beds, many of whom are nursing home residents. These patients often had multiple comorbidities and required more coordination effort in finding an inpatient bed. Overall, the median ED LOS during the study period for patients who were admitted through the ED was 23 hours, which was much shorter than that for this boarder population (80.5 hours). These patients presented to the ED with largely normal vital signs and were initially assigned to a less severe triage level. Data indicates that the most common putative causes of cardiac arrest for patients in this cluster were sepsis and pneumonia, consistent with the common infectious causes of IHCA on the ward.[22] Furthermore, with a greater time frame from triage to CPR, this cluster may benefit greatly from periodic monitoring (eg, early warning system) to prevent a cardiac arrest event. The major difference between inpatient IHCA and the "boarder EDCA" populations was less frequent monitoring and more staff handovers, likely leading to the

**Table 6.** Patient characteristics of each cluster in the Medical Information Mart for Intensive Care-IV Emergency Department dataset.

| Variable | Cluster 1 (n = 154) | Cluster 2 (n = 53) | P-value |
|---|---|---|---|
| Age, mean (SD), yr | **61.7 (21.4)** | 71.6 (17.8) | < .001 |
| Female sex, n (%) | 65 (42.2) | 26 (49.1) | .39 |
| Arrival by ambulance, n (%) | **119 (77.3)** | 30 (56.6) | .004 |
| Most common chief complaint, n (%) | | | < .001 |
| Abdominal pain | 0 (0.0) | **4 (7.6)** | |
| Fever | 1 (0.7) | **1 (1.9)** | |
| Dyspnea | 5 (3.3) | **7 (13.2)** | |
| Dizziness | 0 (0.0) | **1 (1.9)** | |
| Chest pain | 7 (4.6) | **5 (9.4)** | |
| Other | **141 (91.6)** | 35 (66.0) | |
| Emergency Severity Index, n (%) | | | < .001 |
| 1 (highest acuity) | **143 (92.9)** | 9 (17.0) | |
| 2 | 11 (7.1) | **36 (67.9)** | |
| 3 | 0 (0.0) | **8 (15.1)** | |
| 4 | 0 (0.0) | 0 (0.0) | |
| 5 (lowest acuity) | 0 (0.0) | 0 (0.0) | |
| Vital sign at triage* | | | |
| Systolic blood pressure, mean (SD), mm Hg | 1.3 (9.3) | **122.2 (27.7)** | < .001 |
| Systolic blood pressure, mean (SD), mm Hg | 0.5 (4.5) | **70.5 (19.6)** | < .001 |
| Heart rate, mean (SD), beats per minute | 0.9 (7.8) | **80.0 (28.9)** | < .001 |
| Body temperature, mean (SD), °C | 0 (0.0) | **31.1 (13.2)** | < .001 |
| Respiratory rate, mean (SD), breaths per minute | 0.4 (3.1) | **18.1 (6.9)** | < .001 |
| Oxygen saturation, median (IQR), % | 0 (0-0) | **97 (94-99)** | < .001 |
| Glasgow Coma Scale < 15, n (%) | 31 (20.1) | 6 (11.3) | .15 |
| Pain score (0-10), median (IQR), [range] | 0 (0-0) | **0 (0-2)** | < .001 |

Significant differences with the highest percentage/value were highlighted in bold.
*The vital signs for patients with near cardiac arrest at triage were set to zero due to being rushed to resuscitation without triage measurements.
*IQR,* interquartile range; *mm Hg*, millimeters of mercury.

highest mortality in the cluster. We previously developed a deep learning-based early warning score that may be helpful in detecting EDCA in advance.[23] Nonetheless, this boarder EDCA population was less relevant to other EDs with a shorter LOS, as indicated by this cluster being no longer relevant in the US MIMIC-ED data set.

With a preliminary understanding of the three novel EDCA clusters, the prospect of developing a more concrete consensus on what constitutes EDCA could become a reality. Current guidelines on IHCA may benefit from a separate section on EDCA, considering its diverse patient population of both time-sensitive critical conditions and a variety of initially stable medical conditions that may later deteriorate in the ED.[24, 25] Specifically, Cluster 2 patients deserve more research as there was still a three-hour time window to prevent deterioration in this patient population with diverse causes of EDCA. In the trauma literature, a trimodal distribution of trauma deaths has been described based on the time interval from injury to death.[26]

Similar to this concept, we proposed a trimodal EDCA framework (immediate, early, and late) for the three clusters of EDCA based on the time interval from ED arrival to CPR. For EDs with fewer boarding issues, this trimodal framework may reduce to a bimodal (immediate and early) pattern. We feel that the goal for the independent dataset is to test the clustering approach in a different patient population, and a slightly different pattern, or decreased model performance, should be acceptable.

## LIMITATIONS

This study has some potential limitations. First, this

**Table 7.** Chief complaints and study outcomes by cluster in the Medical Information Mart for Intensive Care-IV Emergency Department dataset.

| | Cluster 1 (n = 154) | | Cluster 2 (n = 53) | |
|---|---|---|---|---|
| Chief complaint free text (most common) | | | | |
| MVC | 35 (22.7) | Dyspnea | 9 (17.0) | |
| Transfer | 28 (18.2) | Chest pain | 7 (13.2) | |
| Coma | 21 (13.6) | Altered mental status | 7 (13.2) | |
| STEMI | 18 (11.7) | Syncope | 7 (13.2) | |
| Outcome | | | | P-value |
| Mortality, n (%) | 56 (36.4) | | 26 (49.1) | .10 |
| ED length of stay, median (IQR), hour | 4.0 (2.5-5.7) | | **5.2 (4.0-8.0)** | < .001 |

Significant differences with the highest percentage/value are highlighted in bold.
*ED,* emergency department; *IQR,* interquartile range, *MVC,* motor vehicle collision; *STEMI,* ST-elevation myocardial infarction.

research was limited by including two medical centers in different countries. To replicate the three phenotypes identified in our study, further research needs to be conducted in a variety of different EDs with more recent data. Second, to date there has been no consensus on the definition of EDCA.[27] We arbitrarily included OHCA cases with ROSC because they arrived in the ED with vital signs and were likely to re-arrest in the ED. In addition, this population was likely excluded from the independent dataset. Perhaps future expert meetings need to consider the formal definition of EDCA for research standardization purposes. Finally, unsupervised machine-learning has some disadvantages, including the lack of a priori knowledge and no objective evaluation metrics. However, we have carefully pre-selected relevant features and attempted to interpret the findings using existing knowledge.

## CONCLUSION

By way of unsupervised machine learning algorithms via cluster analysis, we identified and characterized three distinct ED cardiac-arrest phenotypes through the perspective of different pre-arrest variables. Quantifying similarities and dissimilarities of high-dimensional data allowed us to identify the three clusters, thereby performing subsequent outcome association. Simply put, time is of the essence when characterizing EDCA, and a trimodal temporal pattern was identified. Namely, an ED patient may be at immediate, early, and late risk for EDCA during his/her ED stay. A better understanding of these clinical phenotypes may help develop cluster-specific and time-appropriate intervention strategies to avoid EDCA and patient deaths. Specifically, Cluster 1 patients may benefit from resuscitation coordinated by an excellent resuscitation team. To prevent clinical deterioration in Cluster 2 or 3 patients, emergency clinicians should familiarize themselves with early clues in cardiac, pulmonary, and neurologic emergencies to provide timely interventions for these EDCA-prone conditions. In addition, for patients with prolonged ED boarding, periodic monitoring with an early warning system may prevent a cardiac arrest event.

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# Pursuit of Optimal Vagal Maneuvers in Stable Supraventricular Tachycardia: A Network Meta-Analysis

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**Introduction:** Vagal maneuvers are first-line therapy for hemodynamically stable supraventricular tachycardia (SVT), yet the relative efficacy of the standard Valsalva Maneuver (SVM), modified Valsalva maneuver (MVM), carotid-sinus massage (CSM), and head-down deep breathing (HDDB) remains uncertain. We undertook a network meta-analysis (NMA) to define the optimal technique and explore age- and sex-related effect modification.

**Methods:** We searched nine databases from inception to January 2025 for randomized controlled trials involving adults (≥ 18 years of age) with stable SVT treated with at least two of the four maneuvers. Primary outcomes were conversion to sinus rhythm after a single attempt after multiple attempts, and by the end of the trial. Secondary outcomes were the need for rescue intravenous (IV) antiarrhythmic drugs and maneuver-related adverse events (AEs). Bayesian random-effects NMA generated risk ratios (RR) with 95% credible intervals (CrIs); surface under the cumulative ranking curve (SUCRA) quantified hierarchy. We performed consistency, publication bias, and sensitivity analyses, and network meta-regression for mean age and female proportion.

**Results:** Nineteen trials (n = 2,545) formed a connected network. The MVM was more than doubly effective for single-attempt conversion relative to the SVM (RR 2.71, 95% CrI, 2.26-3.31) and outperformed CSM (RR 6.57, 3.33-14.94) and HDDB (RR 1.30, 0.35-4.66); SUCRA = 88.7%. At the end of the trial, the MVM retained superiority over the SVM (RR 1.25, 1.03-1.56) and ranked the highest success rate (SUCRA = 81.3%). The MVM also reduced IV drug use vs the SVM (RR 0.64, 0.55-0.73) and CSM (RR 0.59, 0.37-0.90). No maneuver differed in multiple-attempt success or AEs. The HDDB technique was ranked highest in safety (SUCRA = 82.4%) but was supported only by a single, small study. Meta-regression showed no age or sex interaction. Inconsistency was minimal; the Egger test suggested small-study effects only for the IV-drug endpoint ($P$ = .03).

**Conclusion:** The MVM provides the greatest likelihood of rapid sinus rhythm restoration and the least need for rescue pharmacotherapy without increasing AEs, supporting its adoption as the default vagal strategy for SVT. Larger, standardized trials are warranted to confirm safety differentials and long-term outcomes. [West J Emerg Med. 2025;26(6)1667–1678.]

## INTRODUCTION

Supraventricular tachycardia (SVT) is an arrhythmia originating at or above the atrioventricular node, typically presenting with a narrow QRS complex and a heart rate > 100 beats per minute.[1] It encompasses three primary subtypes: atrioventricular nodal reentrant tachycardia (AVNRT); atrioventricular reentrant tachycardia (AVRT), and atrial tachycardia. AVNRT is the most frequently observed subtype. Overall, SVT is the second most common tachyarrhythmia.[2,3] Rehron et al reported that approximately 1.26 million individuals in the United States are affected, with women showing higher overall prevalence (70.5 per 100,000 per year) compared to men (44.7 per 100,000).[4]

Although region-wide incidence data remain scarce, clinical reports from South Asia indicate that SVT is a major arrhythmia; for example, hospital series in Pakistan cites SVT as the most frequent arrhythmia, followed by atrial fibrillation and bradyarrhythmias.[5] Patients often present with palpitations, chest discomfort, dyspnea, lightheadedness, or syncope.[6] In hemodynamically stable individuals, current European Society of Cardiology and American Heart Association guidelines recommend initiating treatment with a vagal maneuver—often carotid sinus massage (CSM) or the Valsalva maneuver—to restore normal sinus rhythm. If ineffective, intravenous (IV) adenosine and, if needed, other antiarrhythmics (verapamil, diltiazem, or beta-blockers) are administered, while synchronized cardioversion is reserved for hemodynamically unstable cases or pharmacological failure.[7,8] Although typically effective, these medications can cause adverse events (AEs), such as hypotension or bradycardia, making non-pharmacological vagal maneuvers an attractive first-line option.[7,9]

Vagal maneuvers can be traced back to 1704 when Antonio Maria Valsalva first described a forced expiration against a closed glottis to modulate cardiac arrhythmias.[10] Although the standard Valsalva maneuver (SVM) is widely employed, it exhibits inconsistent success rates and can be uncomfortable. Ashraf et al and Günaydın et al reported that the modified Valsalva maneuver (MVM) was more than twice as effective as SVM in restoring sinus rhythm (58% vs 20% and 37.5% vs 17.4%, respectively).[11,12] Similarly, Appelboam et al found that the MVM significantly improved conversion rates to sinus rhythm, from 17% with the SVM to 43% with the modified technique.[13]

The MVM involves completing the strain phase—forced exhalation against resistance, typically into a 10 mL syringe—in a semi-recumbent position, followed by immediate supine repositioning with passive leg raise after the strain. This approach aims to enhance venous return and vagal tone, and the use of a syringe helps standardize the technique.[7] CSM is often limited by some contraindications, such as recent myocardial infarction, stroke, transient ischemic attack, or significant carotid disease. Further evidence from Huang et al and Abdulhamid et al suggests that the MVM outperforms the standard technique while maintaining a favorable safety profile.[12,14] However, fewer data exist on head-down deep breathing (HDDB), and its effectiveness remains unclear, necessitating further investigation to identify which maneuver optimally balances efficacy and safety.

We conducted a network meta-analysis (NMA) to assess the comparative effectiveness of the SVM, MVM, CSM, and HDDB in restoring sinus rhythm, reducing the need for emergent IV antiarrhythmic therapy, and minimizing AEs among adults with stable SVT. A network meta-regression (NMR) further evaluated whether age or sex modifies treatment success. Determining the best vagal strategy could enhance patient outcomes, lessen reliance on pharmacological agents, and lower healthcare costs in managing stable SVT.

*Population Health Research Capsule*

What do we already know about this issue?
*Vagal maneuvers are firstline therapy for stable supraventricular tachycardia (SVT), but efficacy is inconsistent.*

What was the research question?
*Among adults with stable SVT, which vagal maneuver maximizes conversion and minimizes intravenous drug use and adverse events?*

What was the major finding of the study?
*The modified Valsalva maneuver provides the greatest likelihood of restoration of rapid sinus rhythm: risk ratio 2.71; 95% CrI, 2.26-3.31; P < .001.*

How does this improve population health?
*Using the modified Valsalva speeds drugfree cardioversion, decreasing emergency department resource use, exposure to IV medications, and potential adverse effects.*

## METHODS

### Protocol Registration and Reporting Guidelines

The study was conducted and reported under a prespecified protocol registered in the International Prospective Register of Systematic Reviews (PROSPERO; CRD42025636018). All methods followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses for Network Meta-Analyses (PRISMA-NMA) guidelines.[15]

### Eligibility Criteria

Eligible studies were randomized controlled trials (RCT)

enrolling adults (≥ 18 years of age) diagnosed with stable SVT, including paroxysmal SVT, AVNRT, and AVRT, confirmed by electrocardiogram (ECG). Participants had to receive one or more of the non-pharmacological vagal maneuvers described above as the initial attempt to terminate SVT. Studies were required to compare at least two different vagal maneuvers and to report at least one of the following outcomes: successful conversion of SVT to sinus rhythm after a single attempt, multiple attempts, or by the end of the trial; requirement for emergency IV antiarrhythmic agents; and occurrence of any AEs related to the maneuver. A single attempt was defined as a conversion to sinus rhythm after one application of the maneuver, while multiple attempts referred to the cumulative success after repeated applications of the same maneuver within the acute management period and before any other intervention, such as IV antiarrhythmic therapy or direct current cardioversion. Success by the end of the trial was assessed at the final observation point predefined by each study, typically minutes to hours post-intervention and inclusive of additional therapies. Emergency IV antiarrhythmic drug use was defined as the need for agents such as adenosine, verapamil, or sotalol after failed non-pharmacological maneuvers, and AEs included transient bradycardia, hypotension, syncope, or carotid hypersensitivity directly attributable to the maneuver.

Exclusion criteria encompassed pediatric populations (< 18 years of age), patients with hemodynamic instability requiring immediate electrical cardioversion, structural heart disease, and concomitant arrhythmias. We also excluded studies that reported pharmacological or electrical therapy was used as a first-line or concurrent intervention rather than as rescue therapy following a vagal maneuver. Additionally, studies that did not include at least one of the specified vagal maneuvers as part of a randomized comparison, or employed non-standard or poorly described maneuvers, were not considered. Observational studies, case series, case reports, non-original research, and studies providing insufficient outcome data were likewise excluded.

**Data Sources and Search Strategy**

We performed a comprehensive literature search on January 1, 2025, covering nine electronic databases (EuropePMC, ScienceDirect, Google Scholar, PubMed, EBSCOhost, ProQuest, Cochrane Library, Wiley Online Library, and SAGE Journals) from their inception to January 2025. The search used both free-text keywords and Medical Subject Headings terms (eg, "valsalva maneuver," "vagal maneuver," "carotid sinus massage," "head-down deep breathing," "ice immersion," "diving reflex," "retch reflex," "supraventricular tachycardia," "paroxysmal supraventricular tachycardia," "wolff parkinson white," "randomized controlled trial"), in combination with Boolean operators ("AND," "OR"). The complete list of keywords is shown in Table S1. In addition, we manually examined reference lists of pertinent articles and reviews to identify any studies potentially missed by the initial database search.

**Study Selection and Data Extraction**

All retrieved citations were imported into EndNote X9 (Clarivate Analytics, Philadelphia, PA) for duplicate removal. Three authors (JEG, YS, and SAW) independently screened titles and abstracts, followed by full-text evaluations based on the predetermined eligibility criteria. Discrepancies were resolved through discussion or consultation with senior authors (KW and LPS). Three authors (SSI, AS, and CPA) performed data extraction using a standardized form that captured detailed study information, including the study identifier, publication year, design, database used, study settings, inclusion and exclusion criteria, the definition of SVT, and the maneuver applied (with sample sizes per group). We also recorded baseline participant demographics and clinical characteristics, encompassing mean age (years), percentage of female participants, systolic and diastolic blood pressure in millimeters of mercury (mm Hg), pulse rate (bpm), and the prevalence of type 2 diabetes mellitus, ischemic heart disease, and hypertension. Five principal outcomes were extracted: successful conversion of SVT to sinus rhythm after a single attempt; after multiple attempts; by the end of the trial; the requirement for emergency IV antiarrhythmic agents; and the occurrence of maneuver-related AEs.

**Risk of Bias Assessment**

Two authors (SSI and GT) independently evaluated the risk of bias for each included study using the Cochrane risk of bias 2 (RoB 2) tool for RCTs, which encompasses five domains: bias arising from the randomization process; bias due to deviations from intended interventions; bias due to missing outcome data; bias in the measurement of outcomes; and bias in the selection of the reported result. Each domain was rated as "low risk," "some concerns," or "high risk."[16] Discrepancies were resolved through discussion with the senior authors (KW and LPS).

**Data Synthesis and Statistical Analysis**

We conducted all statistical analyses using R v4.4.2 (The R Foundation for Statistical Computing, Vienna, Austria). The primary NMA employed Bayesian random-effects models via the gemtc (Network Meta-Analysis Using Bayesian Methods, R package v1.0-2), BUGSnet (Bayesian inference using Gibbs sampling to conduct NETwork meta-analysis, v1.1.2), and BNMA (Bayesian Network Meta-Analysis using 'JAGS', R package v1.6.0) packages.[17-19] We estimated risk ratios (RR) with 95% CrI for all outcomes. Four Markov chain Monte Carlo samplings were each run for 20,000 iterations with a burn-in of 5,000 iterations, and diffuse priors were employed for all parameters. Consistency was appraised via node-splitting techniques.[20] The surface under the cumulative

ranking (SUCRA) curve was generated to rank the interventions for each outcome and visualized using a litmus rank-o-gram.[21]

### Meta-Regression and Sensitivity Analysis

Bayesian covariate NMA was carried out with the gemtc package to explore whether mean age and female percentage (standardized such that one unit equals two standard deviations from the mean) modified the effects of each vagal maneuver on the specified outcomes.[17] Two additional sensitivity analyses were conducted: one excluding studies deemed to be at high risk of bias; and another employing a frequentist random-effects NMA through the netmeta (NMA using frequentist methods, R package v3.1-1) package to confirm the robustness of the findings.[22] For outcomes with more than 10 studies, publication bias was evaluated using the Egger regression test with weighted regression and multiplicative dispersion, incorporating the standard error as the predictor. A *P*-value < .05 was considered statistically significant.[23] Additional sensitivity tables and plots are available from the authors upon request.

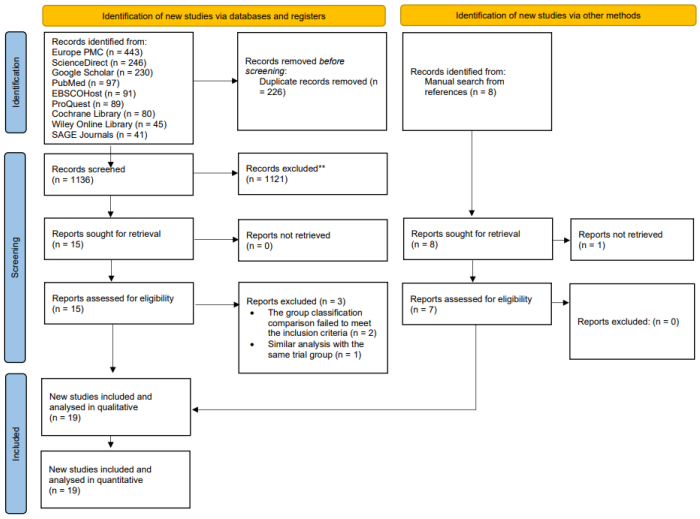


**Figure 1.** PRISMA flow diagram in a network meta-analysis of vagal maneuvers for stable supraventricular tachycardia. *PRISMA,* Preferred Reporting Items for Systemic reviews and Meta-Analyses.

## RESULTS

The database search identified 1,362 records: 443 from EuroPMC; 246 from ScienceDirect; 230 from Google Scholar; 97 from PubMed; 91 from EBSCOhost; 89 from ProQuest; 80 from the Cochrane Library; 45 from Wiley Online Library; and 41 from Sage Journals. After removing 226 duplicate articles, the remaining records were screened, yielding 15 records that were retrieved and assessed for eligibility. An additional manual search of reference lists yielded eight studies from a Chinese database not covered by the international databases, resulting in 23 articles for full-text retrieval. Of these, the full text was unavailable for one study.[24] Three studies were subsequently excluded, two because of different interventions and one due to duplicate trial data.[25-26] The remaining 19 articles were included in the review.[11,13-14,27-43] The selection process is detailed in Figure 1.

We evaluated all included studies using the Cochrane RoB 2 tool (Figure 2). Among the 19 studies, two were classified as low risk of bias, 13 had some concerns, and four were deemed high risk. Bias arising from the randomization process was identified in seven studies due to insufficient details on their randomization procedures.[27,32,35,36,38,41,43] Thirteen studies lacked adequate information on participant selection, including pre-intervention exclusions or a detailed schematic of the selection process, leading to potential bias from missing outcome data.[11,29,30,32,40,43] Outcome measurement bias was a concern in 11 studies, mainly because AEs were susceptible to subjective interpretation by participants or assessors. In some cases, the assessors were unspecified or not blinded.[11,27,28,30,32,33,35,37,38,40,41] All 19 studies were considered low risk for bias due to deviations from intended interventions and selective outcome reporting. [11,13,27-43]

We included 19 RCTs published between 1997–2024 (Table 1). These investigations were conducted in 17 Asian countries and one non-Asian country (Singapore, the United Kingdom, Turkey, China, Egypt, and Pakistan), involving 2,398 patients diagnosed with SVT. Various vagal maneuvers were assessed for SVT termination: the SVM in 18 studies (1,152 patients); the MVM in 17 studies (1,058 patients); CSM in three studies (169 patients), and HDDB in one study (19 patients). The mean age was 51.56 ± 13.73 years, and 54.07% of participants were female. Baseline cardiovascular parameters varied across studies, with a mean systolic blood pressure of 130.70 ± 23.17 mm Hg, a mean diastolic blood pressure of 83.04 ± 15.55 mm Hg, and a mean initial pulse rate of 150.31 ± 48.87 bpm. Comorbidities also varied, including type 2 diabetes mellitus in 21.47% of participants, coronary artery disease in 25.61%, and hypertension in 33.99%. Detailed participant demographics, clinical characteristics, and maneuver protocols are summarized in Table 1.

### Network Meta-Analysis of Single-Attempt Conversion

A total of 15 RCTs (14 two-arm and one multi-arm) involving 1,921 participants evaluated the MVM, CSM, and HDDB in a connected network (Figure S1). Across these trials, 607 successful single-attempt conversion events were reported. The Bayesian network meta-analysis indicated that the MVM had significantly higher single-attempt success than the SVM (RR 2.71, 95% CrI, 2.26-3.31). Both the MVM and SVM, as well as HDDB, also demonstrated significantly greater single-attempt conversion rates compared with CSM (the MVM vs CSM: RR 6.57, 95% CrI 3.33-14.94; HDDB vs CSM: RR 5.06, 95% CrI 1.18-22.26; SVM vs CSM: RR 2.41,

**Figure 2.** Risk-of-bias summary using the Cochrane risk-of-bias 2 tool for 19 randomized trials of four vagal maneuvers in stable supraventricular tachycardia.

95% CrI 1.24-5.37). Other pairwise comparisons were not statistically significant (Table S2). According to SUCRA values (Table S3), illustrated by the litmus rank-o-gram (Figure S2), the MVM had the highest probability of being the most effective maneuver for single-attempt conversion of SVT (88.72%), followed by HDDB (73.47%), SVM (37.08%), and CSM (0.73%).

We performed sensitivity analyses by excluding studies at high risk of bias, yielding 12 trials (1,693 participants, 517 events), and conducting a frequentist NMA to complement the primary Bayesian approach. In both cases, the network remained connected, and the relative treatment effects were broadly consistent with the Bayesian NMA findings, reaffirming the superiority of the MVM in achieving single-attempt conversion from SVT to sinus rhythm.

**Network Meta-Analysis of Multiple-Attempt Conversion**

Eleven RCTs (10 two-arm and one multi-arm) involving 1.752 participants evaluated four maneuvers in a connected network (Figure S1). Across these studies, 213 successful multiple-attempt conversion events were reported. The Bayesian NMA results (Table S2) indicated no statistically significant pairwise differences among the maneuvers. However, the MVM achieved the highest SUCRA value (76.46%), followed by HDDB (60.48%), the SVM (38.99%), and CSM (24.07%) (Table S3, Figure S2). No high-risk-of-bias studies were identified for multiple-attempt conversion; therefore, sensitivity analysis was conducted solely using a frequentist NMA. The network remained connected, and the relative treatment effects were broadly consistent with the Bayesian findings.

**Network Meta-Analysis of End-to-Trial Conversion**

Nineteen RCTs (18 two-arm and one multi-arm) involving 2,545 participants evaluated four maneuvers in a connected network (Figure S1) for successful conversion of SVT to sinus rhythm by the end of the trial. Across these studies, 2,051 end-of-study conversion events were reported. The Bayesian NMA showed a statistically significant advantage for the MVM over the SVM (RR 1.25, 95% CrI, 1.03-1.56), whereas other pairwise comparisons were not significant (Table S2). According to SUCRA values (Table S3 and Figure S2), the MVM had the highest probability of being the most effective maneuver (81.30%), followed by HDDB (67.82%), the SVM (36.66%), and CSM (14.22%).

We performed sensitivity analyses by excluding high-risk-of-bias studies—yielding 15 trials (2,079 participants, 1,652 events)—and by conducting a frequentist NMA. In both instances, the network remained connected, and the relative treatment effects were broadly consistent with the Bayesian findings, reaffirming the MVM's superiority for end-of-trial conversion of SVT.

**Network Meta-Analysis of Intravenous Antiarrhythmic Requirement**

Twelve RCTs (all two-arm) involving 1,525 participants compared four maneuvers in a connected network (Figure S1). Across these studies, 1,009 events were reported. The Bayesian NMA showed that the MVM significantly reduced the need for IV antiarrhythmic drugs compared with both the SVM (RR 0.64, 95% CrI, 0.55-0.73) and CSM (RR 0.59, 95% CrI, 0.37-0.90). At the same time, other pairwise contrasts were not statistically significant (Table S2). According to SUCRA values (Table S3 and Figure S2), the MVM had the highest probability of minimizing IV antiarrhythmic requirements (87.07%), followed by HDDB (68.93%), the SVM (28.31%), and CSM (15.69%).

Sensitivity analyses were carried out by excluding high-risk-of-bias studies (yielding nine trials, 1,127 participants, and 762 events) and conducting a frequentist NMA. In both instances, the network remained connected, and the relative treatment effects were broadly consistent with the Bayesian estimates, reinforcing the MVM's superiority in reducing IV antiarrhythmic use.

**Network Meta-Analysis of Adverse Events**

Thirteen RCTs (12 two-arm and one multi-arm study) involving 1,845 participants evaluated four maneuvers in a connected network (Figure S1). Across these trials, 140 events were reported. The Bayesian NMA did not reveal any statistically significant differences among the maneuvers

**Table 1.** Baseline characteristics of 2,545 participants randomized to four vagal maneuvers for stable supraventricular tachycardia.*

| Study | Year | Country | Groups | N | Procedure | | | Age (years) | Female (%) | Initial Pulse (bpm) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Position | Action/Device | Additional Details | | | |
| Lim[27] | Aug 1997 | Singapore | SVM | 62 | Sitting upright | Blowing into a mouthpiece (6-inch tube to sphygmomanometer) | N/A | 47.20 ± 18.30 | 57.40 | N/A |
| | | | CSM | 86 | Supine, head tilted to opposite side | Finger pressure with an up–down and postero-medial massaging to compress the carotid sinus | Compresses the carotid sinus between the examiner's fingers and the cervical vertebrae | | | N/A |
| Appelboam (REVERT)[13] | Aug 2015 | United Kingdom | SVM | 214 | Semi-recumbent (45°) | Blowing | Reassessment of cardiac rhythm was done initially by a 3-lead ECG | 54.50 ± 16.80 | 63.00 | 179.00 ± 29.00 |
| | | | MVM | 214 | Initially flat with legs raised at 45° (15.00 s), then semi-recumbent | Blowing | Postural change from flat to semi-recumbent | 55.10 ± 16.30 | 58.00 | 172.00 ± 29.00 |
| Çorbacıoğlu[28] | May 2017 | Turkey | SVM | 28 | Sitting upright | Deep breath, then blow into a syringe | The patient's response was assessed by ECG monitoring | 49.54 ± 15.62 | 53.60 | 178.21 ± 27.34 |
| | | | MVM | 28 | Initially sitting, then supine with legs raised at 45° | Deep breath, then blow into a syringe | Sudden switch from sitting to supine with leg elevation | 43.97 ± 15.38 | 64.30 | 180.35 ± 32.02 |
| Ting[29] | Nov 2017 | China | SVM | 80 | Semi-recumbent | Blowing into a syringe | Maintain the same position for 1 minute | 52.00 ± 8.40 | 30.00 | 173.00 ± 8.00 |
| | | | MVM | 80 | Semi-recumbent | Blowing into a syringe | Change to supine with legs elevated at 45° for 15 seconds (s) and return to semi-recumbent position for 45 seconds | 54.00 ± 8.90 | 28.80 | 176.00 ± 8.00 |
| Aslam[30] | Dec 2018 | Pakistan | SVM | 50 | Supine | Forcible exhalation against a closed airway (mouth closed, nose pinched) | N/A | 40.10 ± 13.10 | 70.00 | N/A |
| | | | CSM | 50 | N/A | Gentle, solid pressure massaging of the right carotid sinus | N/A | 38.60 ± 11.80 | 60.00 | N/A |

**Table 1.** Continued.

| Study | Year | Country | Groups | N | Procedure | | | Age (years) | Female (%) | Initial Pulse (bpm) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Position | Action/Device | Additional Details | | | |
| | | | SVM | 33 | Sitting upright | Deep breath, then push a plunger by blowing into a syringe (connected to a sphygmomanometer) | N/A | 57.79 ± 16.27 | 68.90 | 167.00 ± 30.99 |
| Ceylan[31] | Jun 2019 | Turkey | MVM | 32 | Initially sitting, then supine with legs raised at 45° | Deep breath, then push a plunger by blowing into a syringe (connected to a sphygmomanometer) | Sudden change to supine with leg elevation | 48.93 ± 19.40 | 62.20 | 167.00 ± 31.04 |
| | | | CSM | 33 | Supine, head tilted to opposite side | Finger pressure with an upward/downward then postero-medial massaging to compress the carotid sinus | The carotid sinus is located just below the angle of the mandible | 62.28 ± 15.49 | 68.90 | 165.86 ± 27.89 |
| Youssef[32] | Nov 2019 | Egypt | SVM<br>MVM | 24<br>16 | N/A | N/A | N/A | N/A | 63.00 | N/A |
| | | | SVM | 33 | Semi-recumbent | Blowing into a manometer | Maintain the same position for 1 minute | 55.10 ± 2.20 | 57.58 | 178.88 ± 1.83 |
| Cheng[33] | Feb 2020 | China | MVM | 33 | Semi-recumbent | Blowing into a 10 mL syringe | Change to supine with legs elevated at 45° for 15 seconds and return to semi-recumbent position for 45 seconds | 58.00 ± 1.80 | 69.70 | 183.94 ± 2.49 |
| Xiao[34] | Apr 2020 | China | SVM | 20 | Semi-recumbent | Blowing into a 10 mL syringe | Maintain the same position for 45 s | 53.83 ± 9.61 | 35.00 | N/A |
| | | | MVM | 20 | Semi-recumbent | Blowing into a 10 mL syringe | Lower limb elevation to 45°-90° for 45 s | 54.85 ± 9.73 | 45.00 | N/A |
| Chen[35] | Jun 2020 | China | SVM | 119 | Sitting | Blowing into a 10 mL syringe | N/A | N/A | N/A | N/A |
| | | | MVM | 119 | Supine with legs elevated at 90° | Standard maneuver (blowing implied) | Change to supine with 90° leg elevation | | | N/A |
| Fang[36] | Jul 2020 | China | SVM | 48 | Semi-recumbent | Blowing into a syringe | N/A | 47.73 ± 9.81 | 51.10 | N/A |
| | | | MVM | 48 | Semi-recumbent | Standard maneuver (blowing implied) | Change to supine with legs elevated at 45-90° for 15 s and return to semi-recumbent position | 48.15 ± 8.35 | 41.70 | N/A |

**Table 1.** Continued.

| Study | Year | Country | Groups | N | Procedure | | | Age (years) | Female (%) | Initial Pulse (bpm) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Position | Action/Device | Additional Details | | | |
| Qinquan[37] | Aug 2020 | China | SVM | 63 | Semi-recumbent | Inhale deeply, then blow into a 10 mL syringe | While holding breath | 56.00 ± 8.00 | 50.80 | N/A |
| | | | MVM | 70 | Semi-recumbent | Inhale deeply, then blow into a 10 mL syringe | Change to supine with legs elevated at 45° for 3-5 s | 55.00 ± 7.00 | 55.70 | N/A |
| Huang[38] | Nov 2020 | China | SVM | 34 | Semi-recumbent | Blowing into a 10 mL syringe | Maintain the same position for 1 minute | 53.20 ± 1.90 | 53.00 | 178.67 ± 2.01 |
| | | | MVM | 34 | Initially semi-recumbent, then flat with legs raised at 45° | Blowing into a 10 mL syringe | Change to supine with legs elevated at 45° for 15 s, then return to semi-recumbent for 45 s before reassessment | 56.00 ± 2.10 | 59.00 | 180.83 ± 2.39 |
| Wang[39] | Dec 2020 | China | SVM | 181 | Semi-recumbent | Blowing into a 10 mL syringe | Patient maintains the position for 1 min before reassessment via ECG | 49.29 ± 13.59 | 59.10 | 79.18 ± 15.22 |
| | | | MVM | 180 | Initially semi-recumbent, then flat with legs raised at 45° | Blowing into a 10 mL syringe | After exhalation, the patient was placed supine with legs raised at 45° for 15 s, then returned to semi-recumbent for 45 s before reassessment via ECG | 51.76 ± 12.02 | 53.30 | 75.71 ± 18.26 |
| Bing[40] | Mar 2021 | China | SVM | 31 | Semi-recumbent | Blowing into a liquid pressure gauge | Patient maintains the position for 45 s before reassessment via ECG | 52.47 ± 3.30 | 38.70 | N/A |
| | | | MVM | 32 | Initially semi-recumbent, then flat with legs raised at 45° | Blowing into a liquid pressure gauge | After exhalation, the patient was placed supine with legs raised at 45° for 15 s, then returned to semi-recumbent for 30 s before reassessment via ECG | 52.63 ± 3.42 | 41.70 | N/A |
| Lim[41] | Jul 2021 | Singapore | HDDB | 19 | Lie on a flat bed with a head-down tilt of 30-45° | Five deep breaths and breath-holding Repetitions were carried out in one attempt | The patients were instructed to take full, deep breaths and hold them by counting to 10 before exhaling. | 50.20 ± 19.00 | 57.90 | 174.00 ± 23.60 |
| | | | MVM | 19 | Initially semi-recumbent, then flat with legs raised at 45° | Forced expiration through disposable tubing against a digital manometer | Change to supine with legs elevated at 45° for 15 s, then return to semi-recumbent for 45 s before reassessment | 54.50 ± 14.30 | 42.10 | 173.00 ± 23.50 |

**Table 1.** Continued.

| Study | Year | Country | Groups | N | Procedure | | | Age (years) | Female (%) | Initial Pulse (bpm) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Position | Action/Device | Additional Details | | | |
| Shoukat[42] | Apr 2023 | Pakistan | SVM | 31 | Sitting upright | Inhale deeply, then blow into a 10 mL syringe | Patient maintains the position for 1 min before reassessment with cardiac monitor | 42.20 | 54.80 | 190.00 |
| | | | MVM | 31 | Semi-recumbent | Inhale deeply, then blow into a 10 mL syringe | Change to supine with legs elevated at 45° for 15 s, then return to semi-recumbent for 45 s before reassessment with cardiac monitor | 45.10 | 54.80 | 185.30 |
| Ashraf[11] | May 2023 | Pakistan | SVM | 50 | Semi-recumbent | Blowing into a 20 mL syringe | Patient maintains the position for 1 min before reassessment with ECG at one minute and then at three-minute intervals. | 50.66 ± 11.58 | 56.00 | 185.70 ± 17.41 |
| | | | MVM | 50 | Semi-recumbent | Blowing into a 20 mL syringe | Change to supine with legs elevated at 45° for 15 s, then returns to semi-recumbent for 45 s before reassessment with ECG at one minute and then at three-minute intervals. | 46.48 ± 10.81 | 52.00 | 184.94 ± 18.20 |
| Hamzah[43] | April 2024 | Iraq | SVM | 51 | Semi-recumbent | Forced expiration into a 10 ml syringe | N/A | | | N/A |
| | | | MVM | 52 | Initially flat with legs raised at 45° (15.00 s), then semi -recumbent | Blowing | Postural change from flat to semi-recumbent | 49.60 ± 11.88 | 61.20 | N/A |
| Summary¶ | | | | 2,398 | | | | 51.56 ± 13.73 | 54.07 | |

† Plus-minus values are means ± SD.
¶ Accounting for only the available data.
*Extended baseline variables available on request
*CSM,* carotid sinus massage; *ECG,* electrocardiography; *HDDB,* head down deep breathing; *MVM,* modified Valsalva maneuver; *N/A,* Not Available; *SVM,* standard Valsalva maneuver.

(Table S2), although HDDB achieved the highest SUCRA value (82.41%), followed by CSM (45.52%), the SVM (40.86%), and the MVM (31.20%) (Table S3 and Figure S2). We carried out sensitivity analyses by excluding high-risk-of-bias studies (yielding nine trials, 1,127 participants, and 762 events) and by conducting a frequentist NMA. In both instances, the network remained connected, and the relative treatment effects were broadly consistent with the Bayesian estimates.

**Inconsistency and Publication bias**

Node-splitting analyses showed no meaningful disagreement between direct and indirect estimates (all $P > .05$) except for end-of-trial conversion, where CSM vs the SVM ($P = .03$) and the MVM vs the SVM ($P = .02$) indicated significant inconsistency. For IV antiarrhythmic requirements, no comparison contained both direct and indirect data; thus, inconsistency could not be evaluated. Funnel plots and Egger regression revealed no small-study effects for any outcome

except IV antiarrhythmic requirement (Egger $P = .03$), indicating small-study effects for this endpoint (Figure S3).

### Network Meta-Regression

A NMR examined whether age or female sex (scaled so that one unit corresponds to a 2 SD increase in the original dataset) influenced the outcomes. All the 95% CrI encompassed zero; hence, age and female did not appear to be statistically significant modifiers of the outcomes.

## DISCUSSION

This NMA establishes the MVM as the most effective vagal strategy for the acute termination of stable SVT. The MVM produced more than double the effectiveness for single-attempt conversion relative to the SVM (RR 2.71, 95% CrI, 2.26-3.31) and retained superiority—albeit with a smaller margin—at the end-of-trial assessment (RR 1.25, 95% CrI 1.03–1.56). The need for rescue IV antiarrhythmic therapy likewise fell by one-third with the MVM compared with the SVM, while CSM and HDDB lagged across all efficacy endpoints. No maneuver differed significantly in multiple-attempt success or adverse-event frequency, underscoring the overall safety of vagal techniques when applied to hemodynamically stable patients.

Our findings align with and extend earlier evidence. Huang et al (2022) and Lan et al (2021) both reported the MVM's dominance for first-attempt conversion; the present analysis confirms this advantage in a larger evidence base that now includes five post-2021 trials and a fourth maneuver (HDDB).[14,44] The MVM's physiologic edge likely derives from two complementary components: the forced expiratory strain elevates intrathoracic pressure and vagal efferent tone, while the immediate supine repositioning with leg-raise augments venous return and baroreceptor activation—key determinants of atrioventricular-node refractoriness.[45]

The MVM ranked first for end-of-trial conversion (SUCRA = 81.3%) and was the only maneuver to show a statistically significant benefit over the SVM (RR 1.25, 95% CrI, 1.03-1.56). Credible intervals for every other pairwise comparison crossed unity; thus, no additional maneuver could be declared superior once repeat attempts and pharmacologic rescue were permitted. Consistent with our findings, Huang et al (2022) also reported higher end-of-trial success with the MVM compared with the SVM (RR 2.20, 95% CrI, 1.94=2.50) and CSM (RR 3.62, 95 % CrI 2.04–6.39).[14,44,46] The modest inconsistency detected in comparisons involving the SVM probably stems from heterogeneity in strain duration and pressure targets rather than from fundamental differences in therapeutic effect.

The MVM also yielded the most favorable profile for IV drug-sparing. Reduced adenosine or calcium-channel blocker use may translate into shorter emergency department length of stay, fewer hypotensive episodes, and lower cost, reinforcing guideline recommendations that prioritize non-pharmacologic therapy in stable SVT. These findings accord with the meta-analysis by Ahmed et al (2020), which likewise showed higher conversion success and reduced IV antiarrhythmic demand with the MVM vs the SVM.[47] By contrast, the apparent adverse effects advantage of HDDB—highest SUCRA yet statistically non-significant—derives from a single, small trial and should be viewed as hypothesis-generating. In that study, 89.5% of HDDB recipients and 73.7% of the MVM recipients reported no adverse effects, and no major cardiovascular events occurred in either group.[41]

NMR showed that neither mean age nor female proportion modified treatment effects, supporting the maneuver's applicability across adult demographic spectra. Nevertheless, future work should explore pediatric and prehospital settings, where ergonomic constraints and patient cooperation differ. By integrating indirect with direct evidence, this analysis offers the most comprehensive quantitative comparison of vagal maneuvers to date. It substantiates current European and American guidelines while providing clinicians with a clear hierarchy that can streamline bedside decision-making: attempt the MVM first; revert to pharmacologic rescue only if conversion fails or contraindications emerge.[7,8]

## LIMITATIONS

Several caveats temper these conclusions. First, safety comparisons are underpowered—particularly for HDDB and CSM—owing to sparse event counts and limited study numbers. Second, all included trials focused on immediate or short-term outcomes; data on recurrence, long-term safety, and patient-reported comfort are lacking. Third, the Egger test signaled possible publication bias for the IV-drug endpoint, raising the prospect that small, negative studies remain unpublished. Fourth, dosing and technique variations (eg, strain pressure, duration, leg-raise angle) were incompletely reported, precluding formal subgroup analyses that might refine procedural best practice. Finally, four high-risk-of-bias trials were included because the comparisons provided were essential, and the available data were limited. These trials lacked clear details on randomization, participant selection, and blinding of outcome assessors—particularly for subjective safety outcomes. Their inclusion was necessary to maintain network connectivity and ensure a complete analysis.

## CONCLUSION

The MVM provides the highest likelihood of prompt sinus-rhythm restoration and the lowest reliance on rescue IV therapy among other contemporary vagal techniques, without increasing AEs. When no contraindication exists, it should be adopted as the default first-line maneuver for stable SVT, with the SVM, HDDB, or CSM reserved for situations in which the MVM is impractical or unsuccessful. Larger randomized trials—especially those incorporating standardized procedural protocols and longer follow-up—are needed to confirm safety differentials and to evaluate cost-effectiveness and recurrence prevention.

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*Conflicts of Interest*: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. No author has professional or financial relationships with any companies that are relevant to this study. There are no conflicts of interest or sources of funding to declare.

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# Comparison of Pretreatment in European Society of Cardiology Acute Coronary Syndrome Guidelines

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**Introduction:** Most patients with acute coronary syndrome (ACS) die before hospitalization. Early diagnosis and effective interventions can prevent the disease from worsening. In this single-center, retrospective study we aimed to investigate the appropriateness of the pretreatment of patients referred to the emergency department of our hospital, a percutaneous cardiac intervention (PCI) center, with a prediagnosis of ACS under the previously published European Society of Cardiology guidelines (2017 and 2020) and the new guidelines published in 2023.

**Methods:** Based on the date of publication of the European Society of Cardiology's most recent ACS guidelines (August 25, 2023), we divided patients admitted between August 25, 2022–August 24, 2024, into two groups: patients who were evaluated and received pretreatment under the previous guidelines; and patients who were evaluated and received pretreatment under the new guidelines.

**Results:** Of 1,675 patients screened for enrollment who were referred to our PCI center with prediagnosis of ACS, after exclusion criteria, we report on 1,450 (86.6%). Pretreatment (before PCI) compliance rate with all aspects of the previous and new guidelines was low, at 9.8%. Study patients were 69.9% (n = 1,013) male with mean age of 63.9 ± 13.0 years. Comparing the compliance rate between the new versus previous guidelines, for individual components, we found better compliance for aspirin administration (72.6 vs. 66.2%) and anticoagulants (40.3 vs. 22.7%), while for P2Y12 inhibitors, we found lower compliance (58.9 vs. 70.0%, all p< .001). For the subset of patients with ST-elevation myocardial infarction, P2Y12 inhibitors were used less appropriately under the new vs. previous guidelines (31.4 vs. 55.0%, p < .001).

**Conclusion:** The compliance rates with the previous and new guidelines for ACS pretreatment by physicians working in hospitals without PCI centers were low. Pretreatment compliance during the new guideline period was lower than compliance during the prior guideline period. [West J Emerg Med. 2025;26(6)1679–1687.]

## INTRODUCTION

Acute coronary syndrome (ACS) is a clinical condition that causes myocardial ischemia and infarction due to partial or complete occlusion of the coronary vessels by atherosclerotic plaque. The diagnosis is based on clinical findings, electrocardiographic (ECG) evaluation, and cardiac enzyme results. Despite advances in the diagnosis and treatment of ACS, the mortality rate from cardiovascular

disease is very high worldwide. Half of these deaths are due to ischemic heart disease.[1,2] Most patients with ACS die before hospitalization. The cause of mortality is fatal dysrhythmias triggered by ischemia. Early diagnosis of ACS and effective interventions can prevent the disease from worsening.

Patients diagnosed with ACS are placed into three categories according to clinical, ECG, and cardiac enzyme results: ST-elevation myocardial infarction (STEMI); non-ST elevation acute coronary syndrome (NSTEMI); and unstable angina pectoris (USAP). In recent years, STEMI rates have been decreasing, and NSTEMI rates have been increasing. This is because of the widespread use of high-sensitivity troponin.[3]

The main aim of treatment is to ensure the patency of the coronary vessels and myocardial perfusion at an early stage and to prevent myocardial damage and related complications.[4–6] For this purpose, patients diagnosed with ACS should receive primary percutaneous intervention (PCI) within 60–90 minutes.[7] The sooner perfusion is achieved after the onset of the thrombotic process, the easier it is to achieve the treatment goal. Pretreatment until reaching PCI is also of great importance in the management and treatment of ACS. For this purpose, antithrombotic and anticoagulant therapies are recommended for diagnosed patients.[8–10] The European Society of Cardiology (ESC) periodically publishes guidelines for the management of ACS that are recognized and followed by all countries. Increased guideline adherence in treating ACS in hospitals potentially reduces major adverse cardiac events, heart failure, and mortality. The updated ESC guideline released on August 25, 2023, included some changes regarding the pretreatment of patients diagnosed with ACS.[11]

In this single-center, retrospective study we aimed to investigate the appropriateness of the pretreatment of patients referred to the emergency department (ED) of our hospital, a PCI center, with a prediagnosis of ACS under the previous and new ESC guidelines.

*Population Health Research Capsule*

What do we already know about this issue?
*Pretreatment adherence to acute coronary syndrome (ACS) guidelines improves early outcomes, yet compliance is often suboptimal in non-percutaneous cardiac intervention (PCI) centers.*

What was the research question?
*Has pretreatment compliance changed under the 2023 ACS guideline in patients referred from non-PCI centers?*

What was the major finding of the study?
*Compliance dropped from 11.5% to 8.2% under the new guidelines (P = .03), and conformity to P2Y12 inhibitors in STEMI declined (55.0 to 31.4%, P = .001).*

How does this improve population health?
*Identifying gaps in guideline adherence highlights the need for ongoing training to optimize ACS pretreatment and outcomes.*

## METHODS

### Study Design and Setting

We conducted an analysis of patients referred to the ED of a tertiary-care hospital, the only PCI center in the province, with ACS prediagnosis from external centers between August 25, 2022–August 24, 2024. Approval for the study was obtained from the local ethics committee on January 22, 2025 (decision no. 2025/15).

### Patient Selection and Data Collection

The patient group included patients who were referred to our ED from external centers with a prediagnosis of ACS and were considered to have ACS by the cardiologists at our hospital, and admitted to the cardiology service or coronary intensive care unit (ICU). We excluded patients based on the exclusion criteria described in Figure 1. We divided patients admitted between August 25, 2022,–August 24, 2023 into two groups based on the date of the ESC ACS guideline published on August 25, 2023: the first group included patients who were evaluated and received pretreatment under the previous guidelines; and the second group included patients who were evaluated and received pretreatment under the new guidelines. We included in the study 684 patients evaluated while the previous guidelines were in effect and 766 patients evaluated in accord with the most recent guidelines after the exclusion criteria were applied.

### Study Protocol

We studied patients with a prediagnosis of ACS who were evaluated by general practitioners or emergency physicianss in external centers and referred to the ED of a tertiary-care hospital, the only PCI center in the province. Patients admitted to the ED were initially evaluated by emergency medicine (EM) residents or attending emergency physicians. The remaining patients were seen by cardiologists. We excluded patients who were not considered to have ACS and were discharged. The remaining patients were admitted to the cardiology service or cardiology ICU with diagnoses of STEMI, NSTEMI, or USAP. These hospitalized patients constituted the participants in the study.

We collected patient data using the computer-based hospital information management system standard for all

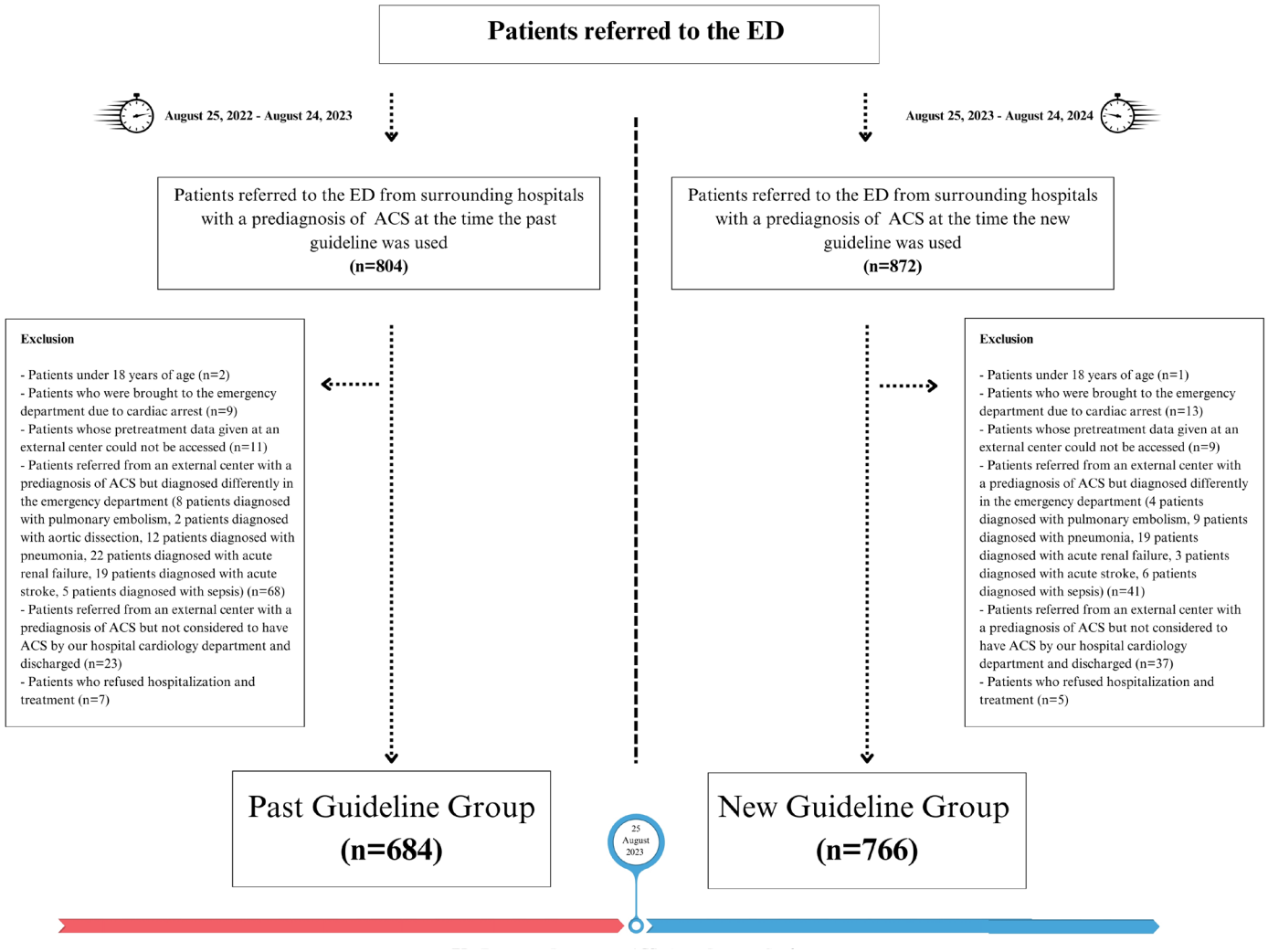


**Figure 1.** Patient flow chart grouped according to the previous and new European Society of Cardiology guidelines for treating acute coronary syndrome, showing inclusion and exclusion criteria.
*ACS,* acute coronary syndrome; *ED,* emergency department.

provincial hospitals, along with patient files and referral reports. We recorded demographic information (age, sex, and comorbidities), final diagnosis, pretreatments given at an external center (aspirin, P2Y12 inhibitors, anticoagulants), reperfusion treatments (medical, stent, coronary artery bypass), and mortality (at 48 hours and 30 days).

Three EM residents and one attending emergency physician scanned all data for the referred patients for two years in six-month periods and created data tables. The first year was considered the period when the prior ESC guidelines were in effect, and data were collected by two EM residents. The last two six-month periods were considered to be the time frame when the new guidelines were in effect, and data were collected by one EM resident and one attending emergency physician. All four physicians who collected the data were blinded to each other. The collected data were evaluated and statistically analyzed by two different emergency care specialists who were blinded to each other and to the other physicians who collected the data. To ensure optimization for retrospective review in EM research papers, we applied the following method criteria: "abstractor training; case selection criteria; variable definition; abstraction forms; performance monitoring; blind to hypothesis; medical record identification; sampling method; data management plan for missing data; institutional review board approval."[12] In addition, since this study was retrospective observational, we applied the Strengthening the Reporting of Observational Studies in Epidemiology guidelines to ensure optimization.[13]

**Study Objective**

The primary objective of the study was to investigate the compliance of physicians working in hospitals without PCI centers under the previous and new ESC guidelines for the application of ACS pretreatment.

**Statistical Analysis**

We performed all analyses using Jamovi v1.6 statistical software (The Jamovi Project [2021] Computer Software, Sydney, Australia). Categorical data are expressed as frequencies (n) and percentages. Normally distributed continuous variables are presented as mean plus standard deviation, and non-normally distributed data are presented as median and interquartile range (IQR). The normality of distribution was assessed using the Shapiro-Wilk test. We compared continuous variables in independent groups using the *t*-test in the case of normal distribution and the Mann-Whitney U test in the case of non-normal distribution. Comparisons of categorical data were conducted using the chi-squared test. In all statistical analyses, *P* values < .05 were considered significant.

## RESULTS

The study population consisted of 1,450 patients (after exclusion criteria were applied to 1,676 patients) referred to our PCI center with a prediagnosis of ACS. We included 684 from the period during which the previous guidelines were in effect, and 766 patients from the period during which the new guidelines were in effect. Of the patients included in the study, 1,013 (69.9%) were male. The mean age of the patients was 63.9 ± 13.0 years. The most common comorbidities were hypertension (75.5%), coronary artery disease (38.6%), and diabetes mellitus (34.1%). In patients hospitalized with a prediagnosis of ACS, the most common diagnosis was NSTEMI (55.4%). The rates of STEMI and USAP diagnoses were 30% and 14.6%, respectively. Stents were implanted in 47.9% of inpatients. Aspirin (69.6%) was the medication most commonly given to patients for the pretreatment of ACS in external centers; P2Y12 inhibitors were given to 64.1% of the patients, and anticoagulants were given to 32%. The mortality rate was 2.6% within 48 hours and 4.8% within 30 days. The pretreatment compliance rate with the previous and new guidelines was 9.8%. Demographic data for the patients and their baseline characteristics are shown in Table 1.

**Table 1.** Patients' demographic data and baseline characteristics of patients.

| Characteristics | All Patients (N=1,450) |
|---|---|
| Sex | |
| Male, n (%) | 1,013 (69.9) |
| Female, n (%) | 437 (30.1) |
| Age (years), mean sd± | 63.9 ± 13.00 |
| Comorbidities | |
| Hypertension, n (%) | 1,095 (75.5) |
| Diabetes, n (%) | 494 (34.1) |
| Coronary artery disease, n (%) | 559 (38.6) |
| Atrial fibrillation, n (%) | 214 (14.8) |
| Chronic kidney disease, n (%) | 194 (13.4) |
| Stroke, n (%) | 119 (8.2) |
| Neoplasia, n (%) | 92 (6.3) |
| Diagnostics | |
| USAP, n (%) | 211 (14.6) |
| NSTEMI, n (%) | 804 (55.4) |
| STEMI, n (%) | 435 (30.0) |
| Pre-PCI Treatments | |
| Aspirin, n (%) | 1,009 (69.6) |
| P2Y12 inhibitors, n (%) | 930 (64.1) |
| Anticoagulation, n (%) | 464 (32.0) |
| Mortality | |
| 48 hours, n (%) | 38 (2.6) |
| 30 days, n (%) | 69 (4.8) |
| Guideline Periods for Treated Patients | |
| Previous Guideline n (%) | 684 (47.2) |
| New Guideline n (%) | 766 (52.8) |
| Conformity to Guideline*, n (%) | 142 (9.8) |

*All pre-PCI treatments eligible.
*NSTEMI,* myocardial infarction without ST-segment elevation; *PCI,* percutaneous cardiac intervention; *STEMI,* myocardial infarction with ST-segment elevation; *PCI,* percutaneous cardiac intervention; *USAP*, unstable angina pectoris.

An evaluation of the pretreatment for all patients showed that the compliance rate for the administration of aspirin and anticoagulants under the new guidelines was significantly higher than the compliance rate under the previous guidelines (*P* < .001, *P* < .001, respectively). while the compliance rate for the administration of P2Y12 inhibitors was significantly lower under the new guidelines compared with the compliance rate under the previous guidelines (*P* = .001). An analysis of the compliance of all pretreatments with the guidelines showed that the rate of compliance with the new guidelines was lower than the rate of compliance with the previous guidelines (*P* = .03) (Figure 2).

No statistical significance was found between the pretreatment given to USAP patients under the previous guidelines and that given to USAP patients under the new guidelines in terms of aspirin, P2Y12 inhibitor, and anticoagulant use. Likewise, no statistically significant difference was found between the two periods in terms of compliance rates with pretreatment guidelines (*P* = .67). When we compared compliance with the previous guidelines for pretreatments given to patients with NSTEMI with compliance under the new guidelines, the compliance rate of anticoagulation with the new guidelines was statistically higher than the compliance rate with the previous guidelines (*P* = .001), whereas no statistical difference was found between the two periods in the use of aspirin and P2Y12 (*P* = .71 and *P* = .26, respectively). No statistically significant

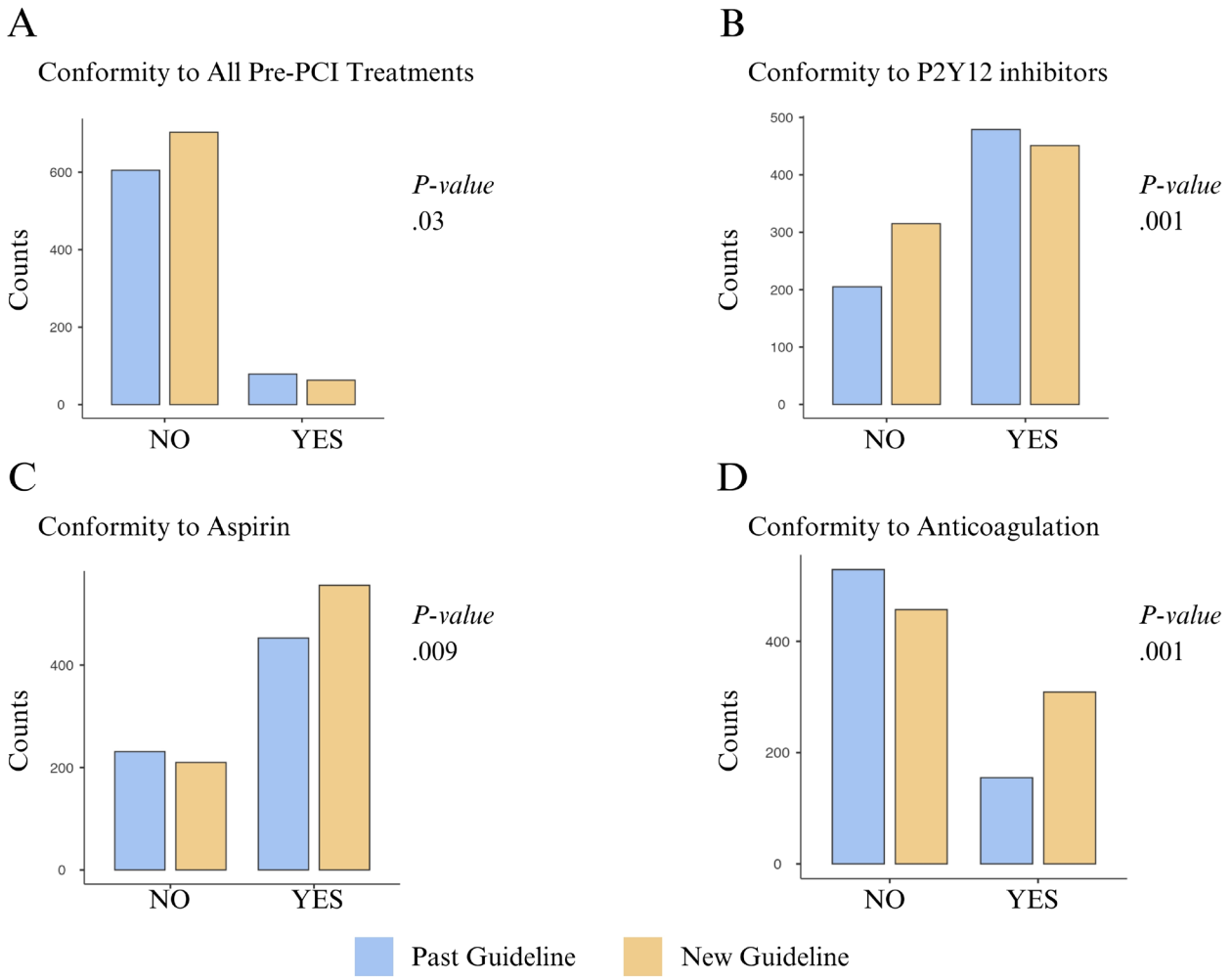


**Figure 2.** Bar plot of the conformity of the percutaneous cardiac intervention treatments with the between in groups (previous and new European Society of Cardiology guidelines).
*PCI,* percutaneous cardiac intervention.

difference was found when all pretreatments were compared according to the guidelines ($P = .24$).

When the compliance rate of pretreatments given to patients with STEMI under the two different guidelines was compared separately, we found that aspirin and anticoagulants were used more appropriately under the new guidelines ($P = .001$ and $P = .001$, respectively), while P2Y12 inhibitors were used less appropriately ($P = .001$) under the new guidelines. The compliance rate of all pretreatments with the new guidelines was statistically lower than the compliance rate with the previous guidelines ($P = .001$). Details of the compliance of pretreatments given to ACS patients with the previous and new guidelines are shown in Table 2.

## DISCUSSION

Pretreatment is an important component in the management of patients presenting with ACS. The treatment plan varies according to the patient's comorbidities, bleeding status, diagnostic group (STEMI, NSTEMI, or USAP), and time to PCI. An aspirin-loading dose should be started as soon as possible in all ACS patients, regardless of the diagnostic group.[14] Parenteral anticoagulation is recommended for all patients with ACS at the time of diagnosis.[15,16] Under both the previous and new guidelines, routine pretreatment with P2Y12 inhibitors is not recommended for patients with NST-ACS (NSTEMI and USAP) with unknown coronary anatomy and planned early invasive management (< 24 hours).[8,17,18] The August 25, 2023, update to the ESC ACS guidelines contained some pretreatment changes. In the previous guideline, "Routine pretreatment with P2Y12 inhibitors should be performed at the time of diagnosis in STEMI" was recommended class 1, evidence level A, whereas in the new guideline, the recommendation is class IIb, evidence level B.[4,11,19] As a result of this update, clinicians have commented that pretreatment with P2Y12 inhibitors in STEMI patients should be left to the cardiologists at the PCI center rather than given at the time of diagnosis. The impact of this change is

**Table 2.** Statistical analysis of the conformity of pre-percutaneous cardiac intervention treatments to the guideline between groups (previous and new European Society of Cardiology guidelines).

| All Diagnostics | All Patients | Previous-Guideline Patients | New-Guideline Patients | P-Values |
|---|---|---|---|---|
| Conformity to aspirin, n (%) | 1,009 (69.6) | 453 (66.2) | 556 (72.6) | .009 |
| Conformity to P2Y12 inhibitors, n (%) | 930 (64.1) | 479 (70.0) | 451 (58.9) | .001 |
| Conformity to anticoagulation, n (%) | 464 (32.0) | 155 (22.7) | 309 (40.3) | .001 |
| Conformity to all Pre-PCI treatments, n (%) | 142 (9.8) | 79 (11.5) | 63 (8.2) | .03 |
| USAP | | | | |
| Conformity to aspirin, n (%) | 110 (52.1) | 54 (50.0) | 56 (54.4) | .52 |
| Conformity to P2Y12 inhibitors, n (%) | 181 (85.8) | 92 (85.2) | 89 (86.4) | .79 |
| Conformity to anticoagulation, n (%) | 16 (7.6) | 8 (7.4) | 8 (7.8) | .92 |
| Conformity to all Pre-PCI treatments, n (%) | 5 (2.4) | 2 (1.9) | 3 (2.9) | .67 |
| NSTEMI | | | | |
| Conformity to aspirin, n (%) | 543 (67.5) | 265 (66.9) | 278 (68.1) | .71 |
| Conformity to P2Y12 inhibitors, n (%) | 570 (70.9) | 288 (72.7) | 282 (69.1) | .26 |
| Conformity to anticoagulation, n (%) | 221 (27.5) | 85 (21.5) | 136 (33.3) | .001 |
| Conformity to all Pre-PCI treatments, n (%) | 66 (8.2) | 28 (7.1) | 38 (9.3) | .24 |
| STEMI | | | | |
| Conformity to aspirin, n (%) | 356 (81.8) | 134 (74.4) | 222 (87.1) | .001 |
| Conformity to P2Y12 inhibitors, n (%) | 179 (41.1) | 99 (55.0) | 80 (31.4) | .001 |
| Conformity to anticoagulation, n (%) | 227 (52.2) | 62 (34.4) | 165 (64.7) | .001 |
| Conformity to all Pre-PCI treatments, n (%) | 71 (16.3) | 49 (27.2) | 22 (8.6) | .001 |

*NSTEMI,* myocardial infarction without ST-segment elevation; *PCI,* percutaneous cardiac intervention; *STEMI*, myocardial infarction with ST-segment elevation; *USAP*, unstable angina pectoris.

also evident in our study. There was no significant difference between the pretreatment of patients under the previous and new guidelines in terms of compliance with the guidelines for the use of P2Y12 inhibitors in patients with USAP and NSTEMI, whereas under the new guidelines, P2Y12 inhibitors were used less appropriately for STEMI patients.

The rate of appropriate pretreatment with a combination of aspirin, P2Y12 inhibitors, and anticoagulants was 9.8% in all patients included in the study: 11.5% in patients treated during the period when the previous guideline was in effect, and 8.2% in patients treated after the new guideline came into effect. These results suggest that clinicians working in hospitals without PCI centers have deficiencies in guideline-appropriate pretreatment. The lower compliance with pretreatments specified in the new guidelines compared with compliance under the previous guidelines indicates that adaptation to the new guideline has not yet occurred. It is known that the knowledge and performance of clinicians increase with continuous theoretical and practical training.[20,21] Clinicians working in noneducational hospitals should also be made aware of the current guidelines. In a multicenter study on inhospital ACS management guidelines, PCI within 90 minutes, cardiac risk scoring tools, and secondary prevention medications were the three main factors that reduced heart failure and mortality in patients.[22] Many studies have focused on these factors. In our study we took a different approach and looked at guideline compliance of ACS pretreatment but did not focus on patients' clinical outcomes. In this respect, our

study is unique and has the potential to be improved.

The biggest change in the new guidelines regarding pretreatment is related to the use of P2Y12 inhibitors in STEMI. In our study, we found that the appropriate use of P2Y12 inhibitors in the pretreatment of patients with STEMI decreased under the new guidelines. The change in the recommendation class and level of evidence for the use of P2Y12 inhibitors in STEMI in the new guidelines has caused confusion among clinicians. The scientific community has responded to this change with a range of opinions. Per the Dutch Society of Cardiology, based on the PLATO and TRITON studies and considering the current healthcare logistics in the Netherlands and the fact that PCI procedures are usually performed with the radial approach, it is thought that the risk of bleeding may be low and, therefore, the routine use of P2Y12 inhibitors in pretreatment can be continued.[23–25] Considering that the risk of bleeding may increase in countries with poor logistic conditions (such as rugged terrain and long distances) and in countries where the femoral approach is preferred, it is better not to apply pretreatment with P2Y12 inhibitors in STEMI.

Per the ATLANTIC study, using P2Y12 inhibitors in premedication in STEMI patients had no significant effect on thrombolysis in myocardial infarction or ST-segment elevation resolution before the interventional procedure.[8] However, it may increase the risk of minor and major bleeding. We did not investigate whether the use of P2Y12 inhibitors in the premedication of patients with STEMI caused the expected bleeding complications. However, further studies on this subject are needed. In our study, we found that although the appropriate use of P2Y12 inhibitors decreased with the implementation of the new guidelines, the appropriate use of aspirin and anticoagulants increased significantly. The fact that the recommendation class and level of evidence for aspirin and anticoagulants have not changed in the new guidelines may have caused clinicians to use these drugs with more confidence.

We found no statistical difference between the previous and new guideline periods in terms of the appropriate use of P2Y12 inhibitors in the pretreatment of patients with NST-ACS (NSTEMI and USAP). The 2014 ACCOAST study, found that P2Y12 inhibitors given to NST-ACS patients in pretreatment were not associated with a decrease in any ischemic event, including mortality, compared to the group not given P2Y12 inhibitors, and caused an increase in bleeding risk.[26] In the ESC 2015 guidelines published following this study, the recommendation class of P2Y12 inhibitors in the pretreatment of NST-ACS was downgraded from I to III.[27] A 10-year cohort study conducted by Ueyama et al found no statistical difference between NST-ACS patients given P2Y12 and patients not given P2Y12 in terms of mortality, major bleeding, and re-myocardial infarction, and the duration of hospitalization was prolonged in the group given P2Y12.[28] The fact that the new guidelines are the same as the previous guidelines in this regard has ensured that clinicians continue to comply with the guidelines.

In our study, we found that aspirin (69.6%) was the most commonly used drug in pretreatment in all patients. In patients with USAP, NSTEMI, and STEMI, the rates of aspirin use were 52.1%, 67.5%, and 81.8%, respectively. This finding suggests that the practice of using aspirin increases with the increasing severity of the diagnosis. However, the two large, randomized controlled trials, ACUITY and HORIZONS-AMI, found that aspirin use in pretreatment was associated with a decrease in 30-day mortality in NST-ACS patients but not in STEMI patients.[29–31] Therefore, aspirin use in pretreatment should be given more importance, especially in patients with NST-ACS. We also found that the rates of use of P2Y12 inhibitors in pretreatment in patients with USAP, NSTEMI, and STEMI were 14.2%, 29%, and 61%, respectively. The use of P2Y12 inhibitors in STEMI was significantly greater than in USAP and NSTEMI. The rates of use of P2Y12 inhibitors in STEMI during the previous guideline period compared with the new guideline period were 55% and 68.6%, respectively.

Although the level of evidence for the use of P2Y12 inhibitors in the pretreatment of STEMI decreased in the new guidelines, the rate of use increased. This is another finding indicating that clinicians have not yet adapted to the new guidelines. The restriction of the use of P2Y12 inhibitors in the pretreatment of NST-ACS, starting with the previous guidelines, may be the reason for the low utilization rates. We think that the use of P2Y12 inhibitors in STEMI will decrease over the coming years and, therefore, studies on this subject should be conducted.

In our study, the rates of anticoagulant use in pretreatment in patients with USAP, NSTEMI, and STEMI were 7.6%, 27.5%, and 52.2%, respectively. As with aspirin and P2Y12 inhibitors, we saw that clinicians were using anticoagulants in pretreatment more frequently with the increasing severity of the diagnosis. A meta-analysis conducted by Oler et al of six randomized controlled trials showed that the addition of heparin to aspirin in USAP and NSTEMI patients resulted in a 33% reduction in mortality and ischemic outcomes.[32] The most recent guidelines recommend giving anticoagulation to all ACS patients at the time of diagnosis, and the recommendation class and level of evidence is 1A. Based on the results of the current study, clinicians should be strongly encouraged to give anticoagulation in pretreatment, especially to USAP and NSTEMI patients.

Among the reasons for the decrease in compliance with current guidelines, we can particularly mention the lack of up-to-date training on guidelines among clinicians who do not work in teaching clinics and the fact that guidelines are only published in English. To eliminate these problems, the ESC needs to train instructors who will provide accredited training on guidelines in various countries. At the same time, translations of the guidelines into the most widely used languages worldwide (eg, German, Spanish, French, Chinese) should be published simultaneously with the original language version, thereby eliminating language barriers and enabling more clinicians to access the latest guidelines.

## LIMITATIONS

Our study has several strengths, including a clear data-extraction protocol, blinding procedures, and the high number of patients included (N = 1,450). However, this study has some limitations. The first limitation is the difficulty of data collection and the limited causal inferences due to the use of a retrospective study design. To overcome this challenge and to minimize selection bias, we used objective criteria for case selection. Another limitation is that the study was conducted in a single center, which may raise concerns about the generalizability of the results. A further limitation is that the P2Y12 inhibitors prasugrel, ticagrelor, and clopidogrel were not investigated separately. Similarly, unfractionated heparin and low-molecular-weight heparin given for anticoagulation were not investigated separately. Subgroup studies could be designed to investigate the appropriateness of these agents separately. In centers without PCI, some drugs may not have been available for some periods and, therefore, appropriate treatment may not have been administered.

Since the pretreatment practitioners included many different types of clinicians (eg, general practitioners, family physicians, and emergency clinicians), no comparison was made. Finally, the low number of USAP diagnoses in the study may be due to the fact that the diagnosis was made solely on the basis of clinical anamnesis rather than definitive evidence, such as STEMI and NSTEMI. Neither did we investigate the impact of guideline compliance on clinical outcomes (eg, mortality, bleeding). Prospective studies with larger groups should be planned to address these limitations.

## CONCLUSION

The rates of compliance with both the previous and new European Society of Cardiology guidelines for pretreatment of acute cardiac syndrome by physicians working in hospitals without PCI centers were low. Pretreatment compliance during the new guideline period was lower than compliance during the previous guideline.

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# Housing Insecurity among Emergency Department Patients with Opioid Use Disorder

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**Introduction**: Emergency departments (ED) have increasingly engaged in screening and treatment initiation for patients with opioid use disorder (OUD). Patients with OUD, however, may also be impacted by significant social need, including housing insecurity. We sought to consider the incidence of homelessness and housing insecurity in patients engaged in an ED-initiated medication for opioid use disorder (MOUD) program.

**Methods**: We performed a secondary analysis, with specific consideration of housing status, on data obtained from a prospective, ED-initiated MOUD study conducted at an urban, academic hospital, inclusive of enrollments from July 2019–February 2022. We obtained data from participant interviews conducted at study intake and at three months to include the question: "In the past 30 days, where have you been living most of the time?" We used descriptive statistics and Pearson chi-square analyses to assess the data.

**Results**: Of 315 participants, most were White (79.4 %), male (64.4 %), and between the ages of 25-44 (74.6%). At intake, 66 (20.9%) reported active homelessness, including 44 (14.0%) unsheltered. An additional 157 (49.8%) met criteria for housing insecurity. Men were more likely to be experiencing homelessness (25.1% men reported homelessness vs 13.4% women, $P = .01$). In contrast, women trended toward housing insecurity more than their male counterparts (45.8% men with housing insecurity vs 57.1% women, $P = .05$). At three-month follow-up, 141 were able to be reached, with a predominance of housed individuals (118 housed; 46.8%); in contrast only 34.8% of persons experiencing homelessness) (23 participants) were able to follow up at three months ($P = .07$). Significant differences between sexes noted at intake resolved. No significant differences were found at intake or three months when considering race or age comparisons.

**Conclusion**: Patients in the ED who are engaged in care for OUD are disproportionately (70.8%) impacted by homelessness and housing insecurity; further, sex may play an exacerbating role. Emergency department-initiated MOUD treatment may have a positive impact on housing status, suggested by this study; however, the study was limited due to large loss to follow-up, especially among those with housing insecurity. [West J Emerg Med. 2025;26(6)1688–1695.]

## INTRODUCTION

In response to the worsening opioid epidemic, emergency clinicians and emergency departments (ED) have increasingly engaged in screening, brief intervention, and treatment initiation for opioid use disorder (OUD).[1] Opioid-related ED visits have nearly tripled in recent years. Numerous studies indicate that starting OUD treatment for patients while they are still in the ED significantly raises the chances of subsequent treatment retention[2] and is associated with abstinence from illicit drug use and improved quality of life.[3]

Homelessness is yet another growing public health concern in the United States (US). Most recent point-in-time counts

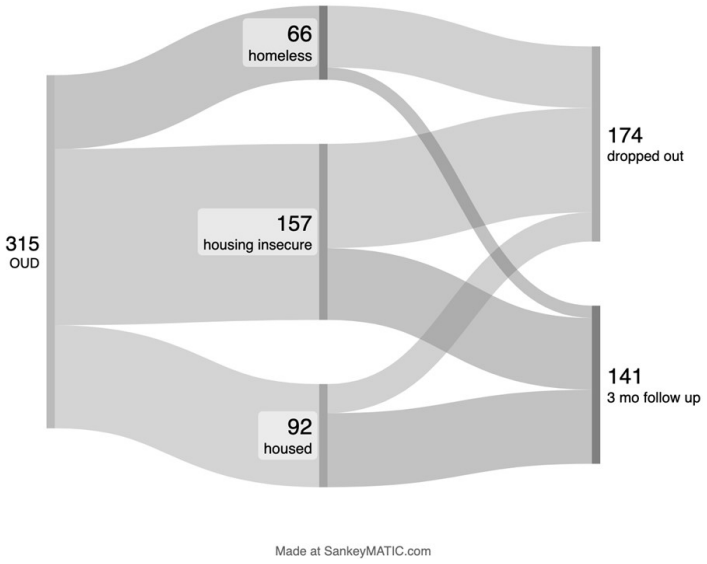


**Figure 1.** Plot of participants enrolled in a medication for opioid use disorder program and 3-month dropout vs follow- up rate.
*At 3 months, 11 participants remain homeless, 64 with housing insecurity, 66 housed.
*OUD,* opioid use disorder; *mo,* month.

*Population Health Research Capsule*

What do we already know about this issue?
*Homelessness and housing insecurity are frequently associated with opioid use disorder (OUD), and ED-related visits have nearly tripled.*

What was the research question?
*What is the incidence of homelessness and housing insecurity in patients engaged in an ED-initiated medication for opioid use disorder program?*

What was the major finding of the study?
*70.7% of people with OUD presenting to the ED have housing insecurity or are homeless (P = .01).*

How does this improve population health?
*This study provides evidence that persons with OUD disproportionately struggle with housing insecurity and suggests clinicians should consider this social risk.*

suggest that well over half a million persons in the US are experiencing homelessness on any given night.[4,5] The ED plays a significant role for this cohort. The rate of persons experiencing homelessness who use the ED, often as a safety-net healthcare resource, has more than doubled in the past decade.[6] Persons experiencing homelessness often face significant barriers to routine medical care, which contributes to increased ED use.[7] Homelessness and housing insecurity are frequent social comorbidities associated with substance use disorder and OUD. Study reports vary but suggest that 16-50% or more of this cohort suffer from a substance use disorder. The overlap and bidirectional association between homelessness and opioid use, in particular, can be quite profound.[8,9]

Although ED-initiated screening and treatment programs for OUD have generally demonstrated positive impact, it is unclear how they might impact persons experiencing homelessness specifically.[9] Housing-insecure patients may have economic, transportation, or other situational barriers that could make post-ED treatment adherence and definitive linkage challenging.[10] Further, while acute opioid withdrawal or opioid overdose presentations may make OUD relatively easier to identify, homelessness and/or housing insecurity might be more challenging for a clinician to ascertain unless the question is explicitly asked and answered.[11] Finally, little is known about how ED-initiated OUD treatment might affect housing status. Thus, we sought to characterize the incidence of homelessness and housing insecurity in patients engaged in an ED-initiated medications for opioid use disorder (MOUD) program; we further aimed to consider the association of ED-initiated OUD treatment with housing status over time. A better understanding of the impact of this particular social need among this cohort could guide future interventions in the ED and public health space.

## METHODS

We performed a secondary analysis of previously collected data from a prospective study. The primary study objective was to identify ED patients impacted by OUD, initiate them on MOUD from the ED, and link them to definitive care. To better understand the impact of specific social determinants of health on this cohort, we focused on study participants more specifically by housing status in this secondary analysis.

The ED-based MOUD initiation program was conducted from July 2019–February 2022, at the University of Alabama Birmingham (UAB) University Hospital. The UAB Institutional Review Board reviewed and approved this study. The UAB Hospital is an urban, academic ED with a volume of > 75,000 annual patient visits. The ED-based MOUD program was supported by the Substance Abuse and Mental Health Services Administration (SAMHSA, #H79TI081609), and a detailed protocol has been previously described.[11] Patients presenting to the ED with a primary complaint of non-fatal opioid overdose, opioid withdrawal, requesting opioid detoxification, or otherwise meeting *Diagnostic and Statistical Manual of Mental Disorders, 5th Ed,* criteria for moderate to severe OUD, were considered for study inclusion, following medical stabilization and clearance. Emergency physicians engaged potential enrollees in a brief, negotiated interview to confirm OUD

diagnosis and to assess motivation to begin treatment for OUD. A subsequent physician-activated order in the electronic health record notified research staff, 24/7, of a physician-confirmed eligible patient. Exclusion criteria included patients who were already actively engaged in a MOUD treatment program, and those who were medically or psychiatrically unstable, unable to consent, or otherwise considered to be part of a vulnerable population (eg, pregnant; incarcerated/in police custody). Research staff conducted enrollment and assisted with linkage to follow-up care. Emergency physicians provided a 10-day prescription of buprenorphine/naloxone at time of enrolled patient discharge to bridge the patient pharmaceutically until follow-up appointment. As required by SAMHSA Government Performance and Results Modernization Act (GPRA) assessments, our research staff collected comprehensive patient-specific information including general demographics, substance use and misuse information, as well as mental health and physical health quality of life variables, at time of enrollment and by a community tracking service agency at three-months post-enrollment (SAMHSA, 2019); this included a housing-specific GPRA variable: "In the past 30 days, where have you been living most of the time?" Follow-up responses were most typically solicited via phone although the tracking agency also facilitated in-person meetings for data capture via in-person shelter visits, for instance. Responses were characterized as a) securely housed (eg, own apartment, room, trailer or house); b) housing insecure (eg, someone else's apartment, room, trailer or house, hotel or motel, halfway house or transitional housing); c) sheltered homeless; or d) unsheltered homeless. Unsheltered homelessness was defined as sleeping on the streets, outdoors in a tent, in a car, or any other location not intended for human habitation.

General descriptive statistics were considered, and we used the Pearson chi-square test for comparative analyses. We used JMP Pro 17 (SAS Institute Inc, Cary, NC) for all statistical analyses, and statistical tests were performed at $\alpha = 0.05$ significance level. Data organization and analysis were conducted with consideration of the Strengthening the Reporting of Observational Studies in Epidemiology guidelines.[12]

## RESULTS

During the study time frame, 866 patients presented for OUD-related complaints: 551 (63.6%) did not meet eligibility criteria, and 315 ultimately completed enrollment. The majority of those enrolled were White (79.4 %), male (64.4 %), and 25-44 years of age (74.6 %) (Table 1). Of note, 78.1% of screen fails were White; sex of screen fails was unavailable. At the time of enrollment, overall reported rates of homelessness and housing insecurity were 20.9% and 49.8%, respectively, accounting for most (70.8%) of the participants. Men (25.1%) were more frequently observed to be experiencing homelessness at enrollment than women (13.4%; $P = .01$). No significant differences were noted in housing-specific demographics with regard to age at time of enrollment. All persons experiencing homelessness were more frequently observed to report unsheltered homelessness (66.7%) as compared to sheltered. Residing in someone else's apartment, trailer, or house (70.7%) was the most common form of housing insecurity reported, more frequently by women (53.5%) and younger participants (78.3%).

At three months' post ED-enrollment, 141 (44.8%) participants were able to be reached for repeat GPRA assessment, including housing demographic variable inquiry (Table 2). At three months, the incidence of persons experiencing homeless decreased to 7.8%, although housing insecurity (45.4%) remained relatively unchanged. Most of these persons (63.6%) remained unsheltered. Significant demographic differences noted in sex at intake did not persist at three months. Younger participants, 18-24 years of age, continued to report high rates of housing insecurity, namely living in someone else's apartment, room, trailer, or house, at three months.

When considering those who reported homelessness at intake specifically, 23 (34.8%) were able to be reached for three-month assessment, including 16 men (31.3% of initial male cohort) and seven women (46.7% of initial female homeless cohort), and 20 White participants (35.1% of initial White homeless cohort), two Black participants (28.6% of initial Black cohort). This is in comparison to a 47.4% three-month follow-up rate for those not experiencing homelessness at intake. Of those 23 reporting being homeless at intake who completed three-month assessment, 17 (73.9 % or 25.8% of initial cohort) reported now being housed, including 12 (75.0%) men and five (71.4%) women; three reported remaining in a shelter (two men, one woman), and three remained unsheltered (two men and one woman). In comparison, 171 persons did not follow up, which included 139 White (80.0%), 120 men (69.0%); no statistical difference between groups was found. Twenty-three (34.8%) of the initial 66 persons experiencing homelessness were able to be reached for three-month assessment, including 16 men (31.3% of initial male homeless cohort) and 7 women (46.7% of initial female homeless cohort), and 20 White (35.1% of initial White homeless cohort), 2 Black (28.6% of initial Black homeless cohort) (one "other"-Hispanic). This is in comparison to a 47.4% three-month follow-up rate for those not experiencing homelessness at intake. While a follow-up trend is apparent, favoring those not experiencing homelessness at intake, it did not reach statistical significance ($P = .07$).

Of note, since intake, one male participant went from previously characterized as "housed" to residing in a shelter, and four women went from "housed" to unsheltered (all White). Each of these individuals were classified as "housing insecure" at intake (four residing in someone else's place and one [female] residing in a hotel).

## DISCUSSION

Emergency departments serve as the primary healthcare setting for a significant portion of persons experiencing

**Table 1**. Intake housing-based demographics of patients engaged in a medication for opioid use disorder program initiated in the emergency department.

| Demographic | Persons Experiencing Homelessness (PEH)* | At Risk/Housing Insecure (excludes PEH) | ALL PEH and Housing Insecure | PEH comparison P-value | Housing Insecure comparison P-value | ALL PEH and Housing Insecure comparison P-value |
|---|---|---|---|---|---|---|
| Total N = 315 | 66 (20.9%) | 157 (49.8%) | 223 (70.8%) | | | |
| Sex | | | | | | |
| Male (n = 203; 64.6%) | 51 (25.1%)<br>16 (7.9)%) sheltered<br>35 (17.2%) unsheltered | 93 (45.8%)<br>82 (40.4%) Someone else's apartment, room, trailer, or house<br>6 (3.0%) Hotel/motel<br>5 (2.5%) Halfway house/Transitional housing | 144 (70.9%) | .01 | .05 | .94 |
| Female (n = 112; 35.6%) | (13.4%)<br>6 (5.4%) sheltered<br>9 (8.0%) unsheltered | (57.1%)<br>60 (53.5%) Someone else's apartment, room, trailer, or house<br>4 (3.5%) Hotel/motel | 79 (70.5%) | | | |
| Race[m,n]<br>Black (n = 58; 18.4%) | 7 (12.1%)<br>2 (3.4%) sheltered<br>5 (8.6%) unsheltered | (51.7%)<br>29 (50.0%) Someone else's apartment, room, trailer, or house<br>1 (3.3%) Hotel/motel | 37 (63.8%) | .07 | .57 | .50 |
| White (n = 250; 79.4%) | 57 (22.8%)<br>19 (7.6%) sheltered<br>38 (15.2%) unsheltered | 119 (47.6%)<br>110 (44.0%) Someone else's apartment, room, trailer, or house<br>9 (3.6%) Hotel/motel<br>6 (2.4%) Halfway house/Transitional housing | 171 (68.4%) | | | |
| Other (n = 5; 1.6%) | 2 (40.0%)<br>1 (20.0%) sheltered<br>1 (20.0%) unsheltered | 2 (40.0%)<br>2 (40.0%) Someone else's apartment, room, trailer, or house | 4 (80.0%) | | | |

[m]two "declined/refused to answer;" [n] "other" excluded from statistical analyses.

homelessness in the US, constituting over a half million ED visits per year.[13] Intake housing demographics in this study underscore this relationship and highlight the marked overlap between OUD and homelessness in particular; one in five participants in this OUD-focused intervention was experiencing homelessness at time of study enrollment, an incidence much higher than the range of 0.5-13.8% of persons experiencing homelessness among all ED patients reported in prior studies.[14] While the local overlap of the incidence of homelessness and ED use is unclear, in our study time frame the incidence of homelessness we noted was also higher than local reports, which note that approximately 15% of the population of Jefferson County (location of UAB) were living with severe housing insecurity issues in 2021.[4] Further, most of the persons experiencing homelessness in this review were unsheltered, primarily living on the streets; this may be in large part due to sobriety requirements imposed by local shelters and transitional housing options.[15] This incidence of social need highlights the potential role and impact of the ED in this cohort.

The male-dominated incidence of persons experiencing homelessness in this study was consistent with national trends; however, the sex-specific difference was inflated. The 2022 Alabama point-in-time count found that women accounted for 43.5% of homeless and men accounted for 55.9%, in contrast to 22.7% and 77.3%, respectively, in this intake cohort. Locally, in Jefferson County the 2021 point-in-time count found that women accounted for 28% of persons experiencing homelessness and men accounted for 72%, in relative alignment with our study percentages.[4] This somewhat

**Table 1**. Continued.

| Demographic | Persons Experiencing Homelessness (PEH)* | At Risk/Housing Insecure (excludes PEH) | ALL PEH and Housing Insecure | PEH comparison P-value | Housing Insecure comparison P-value | ALL PEH and Housing Insecure comparison P-value |
|---|---|---|---|---|---|---|
| Age[s]<br>18-24<br>(n = 23; 7.3%) | 1 (4.3%)<br>1 (4.3%) sheltered | 18 (78.3%)<br>17 (73.9%) Someone else's apartment, room, trailer, or house<br>1 (4.3%) Halfway house/Transitional house | 19 (82.6%) | .44[t] | .32[t-] | .19[v] |
| 25-34<br>(n = 105; 33.3%) | 20 (19.0%)<br>7 (6.7%) sheltered<br>13 (12.4%) unsheltered | 58 (55.2%)<br>52 (49.5%) Someone else's apartment, room, trailer, or house<br>4 (3.8%) Hotel/motel<br>1 (1.0%) Halfway house/Transitional house | 78 (74.3%) | | | |
| 35-44<br>(n = 130; 41.3%) | 34 (26.2%)<br>11 (8.5%) sheltered<br>23 (17.7%) sheltered | 60 (46.2%)<br>52 (40.0%) Someone else's apartment, room, trailer, or house<br>5 (3.8%) Hotel/motel<br>3 (2.3%) Halfway house/Transitional house | 94 (72.3%) | | | |
| 45-54<br>(n = 40; 12.7%) | 9 (22.5%)<br>3 (7.5%) sheltered<br>6 (15.0%) unsheltered | 18 (45.0%)<br>16 (40.0%) Someone else's apartment, room, trailer, or house<br>1 (2.5%) Hotel/motel<br>1 (2.5%) Halfway house/Transitional house | 27 (67.5%) | | | |
| 55-64<br>(n = 13; 4.1%) | 2 (15.4%)<br>2 (15.4%) unsheltered | 4 (30.8%)<br>4 (30.8%) Someone else's apartment, room, trailer, or house | 6 (46.2%) | | | |
| >65<br>(n = 4; 1.3%) | 0 (0) | 1 (25.0%)<br>1 (25.0%) Someone else's apartment, room, trailer, or house | 1 (25.0%) | | | |

*Missing data: one "don't know"; one "refused"; [m] two "declined/refused to answer;" [n]"other" excluded from statistical analyses; [s] > 65 excluded from statistical analyses;[t] 18-24 and 55-64 age categories excluded; [v] 18-24 age category excluded.

elevated unmet housing need in men with OUD, however, suggests that there may be additional sex-specific variables impacting housing access in this population specifically. These variables may be related to social support networks, which may be more limited in men, and/or prior criminal justice system involvement or concomitant externalizing mental health issues, both of which may contribute to homelessness and are more common in men.[16,17] From a racial perspective, while the 2022 point-in-time count in Alabama revealed that 57.3% of homeless were Black and 37.6% were White in this study, most (86.4%) were White. This difference is reflective of the local demographics of the opioid epidemic.[18] Younger participants were more frequently observed to be categorized as "housing insecure," specifically to be living with someone else, although this may be most reflective of age rather than a true social determinant in this younger subgroup.

Housing status at three months is interesting to consider; notably, the incidence of homelessness decreased. A quarter of those previously experiencing homelessness were housed at three months. This may be due to a number of conjectured

**Table 2**. Demographics by housing status at three-month follow-up.

| Demographic | Persons Experiencing Homelessness (PEH) | At Risk/Housing Insecure (excludes PEH) | ALL PEH and Housing Insecure | PEH comparison P-value | Housing Insecure comparison P-value | ALL PEH and Housing Insecure comparison P-value |
|---|---|---|---|---|---|---|
| Total N = 141 | 11 (7.8%) | 64 (45.4%) | 75 (53.2%) | | | |
| Sex | | | | | | |
| Male (n = 83; 58.9%) | 5 (6.0%)<br>3 (3.6%) sheltered<br>2 (2.4%) unsheltered | 41 (49.4%)<br>40 (48.2%) Someone else's apartment, room, trailer, or house<br>1 (1.2%) Hotel/motel | 46 (55.4%) | .35 | .25 | .54 |
| Female (n = 58; 41.1%) | 6 (10.3%)<br>1 (1.7%) sheltered<br>5 (8.6%) unsheltered | 23 (39.7%)<br>22 (37.9%) Someone else's apartment, room, trailer, or house<br>1 (1.7%) Hotel/motel | | | | |
| Race^ | | | | | | |
| Black (n = 31; 22.0%) | 2 (6.5%)<br>2 (6.5%) unsheltered | 15 (48.4%)<br>15 (48.4%) Someone else's apartment, room, trailer, or house | 17 (54.8%) | - | .76 | .84[a] |
| White (n = 106; 75.2%) | 8 (7.5%)<br>3 (2.8%) sheltered<br>5 (4.7%) unsheltered | 48 (45.3%)<br>46 (44.7%) Someone else's apartment, room, trailer, or house<br>2 (1.9%) Hotel/motel | 56 (52.8%) | | | |
| Other (n = 3; 2.1%) | 1 (33.3%)<br>1 (33.3%) sheltered | 1 (33.3%)<br>1 (33.3%) Someone else's apartment, room, trailer, or house | 2 (66.7%) | | | |
| Age[s] | | | | | | |
| 18-24 (n = 7; 5.0%) | 0 (0) | 6 (85.7%)<br>6 (85.7%) Someone else's apartment, room, trailer, or house | 6 (85.7%) | - | .60[b] | .89 |
| 25-34 (n = 53; 37.6%) | 5 (9.4%)<br>3 (5.7%) sheltered<br>2 (3.8%) unsheltered | 22 (41.5%)<br>22 (41.5%) Someone else's apartment, room, trailer, or house | 27 (50.9%) | | | |
| 35-44 (n = 51; 36.2%) | 4 (7.8%)<br>1 (2.0%) sheltered<br>3 (5.9%) unsheltered | 22 (43.1%)<br>20 (41.7%) Someone else's apartment, room, trailer, or house<br>2 (4.2%) Hotel/motel | 26 (50.9%) | | | |
| 45-54 (n = 21; 14.8%) | 2 (9.5%)<br>2 (9.5%) unsheltered | 10 (47.6%)<br>10 (47.6%) Someone else's apartment, room, trailer, or house | 12 (57.1%) | | | |
| 55-64 (n = 7; 5.0%) | 0 (0) | 4 (51.7%)<br>4 (51.7%) Someone else's apartment, room, trailer, or house | 4 (57.1%) | | | |
| >65 (n = 2; 1.4%) | 0 (0) | 0 (0) | 0 (0) | | | |

Missing Data: ^ one "unknown" race; [a] "other" excluded from statistical analysis; [b] 18-24, 55-64, and > 65 excluded from statistical analysis.

reasons: 1) stabilization through treatment resulting in improvement in overall well-being, to include increased stability in housing situations;[3] 2) access to supportive services such as housing assistance programs and case management; 3) improved interpersonal functioning and employment opportunities; 4) reduction in high-risk behaviors such as criminal behaviors; 5) reintegration into supportive networks and reconnection with family, friends, and community resources; 6) and enhanced self-efficacy and coping skills, enabling one to better address housing-related issues and maintain stable living situations. Initiating treatment for OUD addresses both the substance use itself and the underlying factors that contribute to homelessness.[19] By providing a venue and initiating a path for definitive care, ED-initiated treatment for OUD may empower individuals to work toward achieving stable housing alongside long-term recovery.

However, while the incidence of persons experiencing homelessness decreased at three-month follow-up, housing insecurity among this cohort remained relatively elevated and unchanged. This may represent the time it takes to acquire "own" housing; three months may not be sufficient, particularly in a cohort that is often dealing with multiple social and interpersonal hurdles. Further, there were actually several persons, mostly women, who transitioned from "housed" at intake (albeit housing insecure) to experiencing unsheltered homelessness at three-month follow-up. This may suggest that the participants' prior housing situation may have been associated with or actually been contingent upon an active substance misuse network; subsequent participation in OUD treatment may have complicated this housing relationship as the participant sought drug-free housing options, resulting in homelessness. This subgroup, in addition to those others in this cohort who continued to experience homelessness, might benefit most from a "Housing First" model approach.

Housing First is an evidence-backed strategy that focuses on securing permanent housing for individuals experiencing homelessness, especially those with complex needs like SUD or mental health challenges. This approach does not require individuals to participate in treatment or achieve abstinence before receiving housing. This model posits that providing a person with housing first, alongside or prior to OUD treatment, creates a foundation on which the process of recovery can begin.[20] This type of model has demonstrated that following concomitant housing provision and treatment participation, participants are able to successfully obtain and maintain independent housing while decreasing or eliminating substance use and improving health outcomes.[21] An ED-based intervention that address *both* OUD and housing issues simultaneously may be beneficial to those persons experiencing both.

## LIMITATIONS

This study was conducted at a single site and, thus, results may not be generalizable to all locations or populations. In the design of this study, as a secondary analysis, the reviewers were not blinded to the study hypothesis. Further, while not statistically significant, the relatively high drop-out rate, particularly of persons experiencing homelessness, at three-month follow-up may have led to selection bias and, therefore, may have limited our interpretation of follow-up data. Additionally, the demonstrated trend of reduced homelessness at three-month follow-up may reflect improved capacity to contact persons no longer experiencing homelessness, resulting in additional selection bias. This high loss of follow-up among PEH is consistent with previously published studies.

In addition, our analysis did not find a difference between those who followed up and those who did not. As noted, follow-up surveys were most frequently obtained via phone, occasionally in person. This decreased follow-up is anticipated as people struggling with housing insecurity or homelessness in addition to OUD often also have unreliable forms of communication due to associated socioeconomic factors, as described earlier in this paper. Consistent with all survey-based data, participant responses are also subject to reporting bias. Finally, it warrants noting that the project time frame is inclusive of the COVID-19 pandemic, which may have impacted the study population and their associated demographics.

## CONCLUSION

This study adds to the existing evidence that persons with substance use disorders such as opioid use disorder, who use the ED, disproportionately struggle with homelessness and housing insecurity; further, while deserving of additional causal-focused consideration, it may also suggest a potential impact of ED-initiated treatment for OUD on housing status. Emergency clinicians engaging in treatment initiation for OUD should consider that this social risk may be present in their patients and consider concomitant interventions, if available, to address both issues. Future acute-care interventions with focus on the opioid epidemic should consider deliberate inclusion of concomitant housing pathways or intercessions alongside OUD treatment initiation.

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# Interfacility Transfers from the Emergency Department for Non-contracted Insurance Status Disproportionately Affect Minority Patients

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**Introduction:** Transfers between emergency departments (ED) can have an important impact on patient care and experience. We examined interfacility transfers from an academic ED due to insurance status to determine whether they disproportionately affected minority demographics.

**Objective:** Our objective was to determine whether interfacility transfers for non-contracted insurance status disproportionately affected minority patients in our hospital ED.

**Methods:** We extracted data from the hospital's electronic health record system. Records for patients who underwent facility transfer were reviewed to determine which transfers were due to insurance contracting status. We compared the number of patients transferred for insurance incompatibility with the number admitted to the same hospital as initially seen in the ED, either to observation or inpatient status, for groups with socioeconomic minority status including Hispanic, Hispanic non-White, Black, Native American, and non-English speaking.

**Results:** We identified 2,031 total interfacility transfers. Of these, 735 (36.2%) met inclusion criteria, and 49.7 % (366/735) of these transfers were due to insurance incompatibility. The total transfer rate for all patients was .93% (366/39,299). Increased transfer rates due to insurance incompatibility were observed for all minority demographics queried. The most severe disparity in effect size was for non-English speakers (2.06% compared to 0.90% for English-speakers; 2.32 odds ratio [OR], P < .001). Patients with Hispanic ethnicity experience insurance transfer in 1.31% of cases compared to 0.87% for non-Hispanic whites (OR 1.52, P < .001). The insurance transfer rate for all non-White patients was elevated at 1.11%, but this did not rise to the level of statistical significance (OR 1.28, P = .06).

**Conclusion:** In our single-center ED study, minority patient populations were disproportionately impacted by interfacility transfers for non-contracted insurance status. We found increased transfer rates due to insurance incompatibility for all minority demographics queried. The most severe disparity was found for non-English speakers and patients with Hispanic ethnicity. [West J Emerg Med. 2025;26(6)1696–1701.]

## INTRODUCTION

In 1986, the US Congress passed the Emergency Medical Treatment and Active Labor Act (EMTALA).[1.] Its entry into law came after numerous reports in the popular press and medical literature describing the practice of patient "dumping," whereby patients were transferred between facilities for inability to pay before stabilization of their medical condition.[1] In 1984, one study of dumping practices found that patients subject to these transfers were more likely to be minorities.[2]

The EMTALA was more successful than previously existing measures in ensuring adequate emergency care before transfer, broadly requiring that facilities must medically screen patients for an emergency medical condition and stabilize that condition to the extent a facility's capability allows without regard to a patient's ability to pay.[1] Despite EMTALA's success in changing emergency department (ED). practice, evidence remains that uninsured patients are more likely to experience inter-hospital transfer from the ED with some diagnoses.[3]

Even in the setting of EMTALA, inter-hospital transfer for insurance status is possible once a condition has been stabilized in the emergent setting. These transfers may still have an impact on patient care, although this potential impact has not been well evaluated by the existing literature. One study examined transfers using data from both a Centers for Medicare & Medicaid Services database and 2013 data from the American Hospital Association, finding that inter-hospital transfer was associated with higher cost, longer overall length of stay, lower odds of discharge to home, and higher risk of 3- and 30-day mortality in certain conditions.[4] This study was not specific to ED transfers for insurance status and may not be representative of the impact on patient care seen in patients transferred following stabilization of their emergency medical condition.

As part of the 2021 Consolidated Appropriations Act passed by Congress, the No Suprises Act (NSA), was intended to limit the practice of "balance billing" patients for out-of-network care. The act requires facilities to bill at median in-network rates until a patient can consent to safe transfer (which may go beyond the point of stabilization under EMTALA).[5] The law. sought to limit the cost to patients for out-of-network emergency care.

In its litigation regarding implementation of the NSA, the American College of Emergency Physicians (ACEP) highlighted the effect of insurer negotiating power on the emergency care reimbursement landscape.[6] A 2015 ACEP poll found that one-third of emergency physicians had considered leaving medicine due to decreases in reimbursement from insurers.[6] Some advocacy groups have argued, therefore, that the responsibility to avoid exorbitant out-of-network costs to patients rests both with hospitals and with insurers, who can expand their network of coverage by increasing contracted reimbursement rates.[7] Although no specific data exist to suggest that the NSA has resulted in increased interfacility transfer rates for out-of-network patients, one potential unintended consequence of this legislation is that it financially disincentivizes EDs from managing out-of-network patients beyond the initial medical stabilization required by EMTALA.

In this study we aimed to highlight the potential importance of social equity in discussions and decisions concerning contracted status and hospital provision of emergency care in the post-EMTALA and No Suprises Act setting.

*Population Health Research Capsule*

What do we already know about this issue?
*Inter-hospital transfers are associated with higher costs, increased length of stay, and higher 3- and 30-day mortality in certain conditions.*

What was the research question?
*Do emergency department transfers for non-contracted insurance status disproportionately impact minority populations?*

What was the major finding of the study?
*Non-contracted insurance transfers for non[1] English speakers occur more often compared to English speakers (OR 2.32, P < .001) and patients with Hispanic ethnicity compared with non-Hispanic Whites (OR 1.52, P < .001).*

How does this improve p-opulation health?
*This study sheds light on a systemic barrier that minority populations face within our healthcare system and the ethics of transfers for non-contracted insurance status.*

## METHODS

We extracted data from the hospital's electronic health record (EHR) (Epic Systems Corporation, Verona, WI) and analyzed the data using Microsoft Excel (Microsoft Corporation, Redmond, WA). The study period covered ED visits from January 1, 2021–December 31, 2023, and records for all patients who presented to the ED during the study period were queried. We included records only if the final disposition was admission to an in-facility floor, the in-facility observations unit, or a facility transfer.

Records for patients who underwent facility transfer were reviewed to determine which transfers were due to insurance contracting status. Abstraction of records was performed by live chart review with each chart reviewed by one reviewer. In designing the chart review, reference was made to universal standards of quality as described by Worster et al, 2005.[8] Specifically, each abstractor was trained before data collection.

Although reviewers were not blinded to the purpose of the study, variables were operationalized objectively. For patients in which the chart made explicit reference to insurance status as a reason for transfer those patients were coded "insurance transfers." Where there was no overt reference to insurance status (eg, where "patient preference" alone was cited) the chart was coded as a non-insurance transfer. Interobserver reliability was, therefore, not tested due to the objectivity of the review criteria, although quality control was performed by random sampling, with the first author reviewing a selection of each of the other reviewer's charts to ensure established objective criteria had been followed. We excluded patients transferred to access care not provided at our facility's hospital. To expedite review, all pediatric patients were excluded given that our facility does not provide pediatric inpatient services, and we also excluded any patient whose principal payor was in-network.

We compared the number of patients transferred for insurance incompatibility with the number admitted either to observation or inpatient status at our hospital for groups with socioeconomic minority status. Race was extracted from the EHR, where it was coded according to inputs obtained from survey data at the time of registration upon presentation to the ED. Race was self-reported by patients on these surveys. We allocated survey field values for race to assigned racial categories for statistical analysis, with values including two racial groups counted twice, except that patients ascribed both "White" and another race were counted in the non-White racial group.

A total of 2,031 records of interfacility transfers and 60,235 records of admissions were identified. Of these, we selected 735 records of interfacility transfer for manual review after the initial screening discussed above. Specifically, we excluded those patients who were transferred for care not available at our facility (pediatrics, trauma, obstetrics) as these transfers were, by definition, unrelated to insurance status.

## RESULTS

We identified 336 transfers due to insurance incompatibility. The total transfer rate for all patients was .93% (366/39,299). Significantly increased transfer rates due to insurance incompatibility were observed for Hispanic patients (1.31% of all patients either admitted or transferred compared to 0.87% for non-Hispanic Whites; 1.52 odds ratio (OR), $P < .001$) and non-English speakers (2.06% compared to 0.90% for English-speakers; 2.32 OR, $P < .001$). The absolute number of patients who experienced transfers due to insurance in the groups of Black (24), American Indian (4) and Asian (14) patients was low. Data for these groups were analyzed in aggregate and did not rise to the level of significance (1.11% of all patients either admitted or transferred compared to 0.87 for non-Hispanic Whites; 1.28 OR = .06). For the combined group of non-White, Hispanic, or non-English speaking patients the rate of transfers due to insurance was 1.30% (compared to 0.84% for White, non-Hispanic English speakers; 1.55 OR, $P < .001$). Among patients transferred for non-contracted insurance status, the most common insurance type was Medicare Advantage plans, with 194 (53%) patients transferred.

## DISCUSSION

Each minority group highlighted in our analysis had a higher rate of insurance transfers than any of the reference non-minority groups. Hispanic and non-Hispanic ethnicities were considered, while race was categorized into groups

**Table 1.** Percentage of demographic groups in cohort transferred from the emergency department (ED) due to non-contracted insurance vs patients admitted to the hospital directly from the ED.

| | Number of insurance transfers | Total admitted | Total (admitted and transferred) | Percentage insurance transfer |
|---|---|---|---|---|
| Hispanic | 49 | 3,686 | 3,735 | 1.31% |
| Non-White | 45 | 4,004 | 4,049 | 1.11% |
| All non-White and White Hispanic | 90 | 7,331 | 7,421 | 1.21% |
| White (non-Hispanic) | 274 | 31,365 | 31.693 | 0.87% |
| Non-English speaking | 24 | 1.142 | 1.166 | 2.06% |
| English speaking | 342 | 37,791 | 38,133 | 0.90% |
| All minority groups combined* | 100 | 7,617 | 7,717 | 1.30% |
| White, non-Hispanic, English-speaking | 264 | 31,079 | 31,343 | 0.84% |
| Total transfers** | 366 | 38,933 | 39,299 | 0.93% |

*All minority groups combined" refers to patients who were non-White, Hispanic, or non-English speaking, adjusted for double-counting.
**Total transfers is not a sum of the columns above due to double-counting for patients who fit multiple subcategories.

**Table 2.** Odds ratio calculations for each minority group transferred from the emergency department due to non-contracted insurance status.

| | Percentage insurance transfer | Comparison group | Odds ratio | 95% CI | P-value |
|---|---|---|---|---|---|
| Hispanic ethnicity | 1.31% | White, non-Hispanic | 1.52 | 1.15-2.13 | < .001** |
| Non-White race | 1.11% | White, non-Hispanic | 1.28 | 0.96 -1.82 | 0.06 |
| All non-White race and white Hispanic | 1.21% | White, non-Hispanic | 1.41 | 1.14-1.84 | < .001** |
| White (non- hispanic) | 0.87% | Reference | 1.00 | Reference | Reference |
| Non-English speaking | 2.06% | English speaking | 2.32 | 1.53-3.53 | < .001** |
| English speaking | 0.90% | Reference | 1.00 | Reference | Reference |
| All minority groups combined | 1.30% | White, non-Hispanic, English speaking | 1.55 | 1.23-1.95 | < .001** |
| White, non- Hispanic, English-speaking | 0.84% | Reference | 1 | Reference | Reference |

**Comparison was made to reference groups as specified. Each reference group had a lower incidence of insurance transfers from the emergency department than any minority group analyzed.

**Table 3.** Number and percentage of patients with each insurance type transferred from the emergency department due to non-contracted insurance status.

| Financial status | Number of transfers | Percentage of insurance transfers |
|---|---|---|
| Commercial Non-Contract | 22 | 6.0% |
| Medicaid Non-Contract | 149 | 40.7% |
| Medicare Advantage Non-Contract | 194 | 53.0% |
| Self-Pay | 1 | 0.3% |
| Total | 366 | 100% |

including White, Asian/Pacific Islander, Black, and Native American. Our dataset would have enabled comparison of transfer rates in each of these individual racial groups to the reference group, but this would have required significant time spent aligning the manual coding of race in inpatient records with categories used in this study. Although statistical significance may have been achieved with respect to one of the subgroup elements, we analyzed the non-White group in aggregate; and since we did not find a significant result, we did not pursue analysis that could have drawn conclusions regarding each of these subgroups.

Future analysis could use a methodological approach that would make individual subgroup analysis more technically feasible for the size of the study to make further claims in this regard. In addition, the number of patients with non-White race seen in our ED is low. Consequently, the number of patients in these racial categories experiencing insurance transfer was also low in absolute terms. Due to the very low absolute numbers of these patients seen, a healthcare facility serving larger populations of these patients might be better suited to draw granular conclusions with respect to each individual racial category.

For each group other than the combined group of non-White race patients, the odds ratio to the relevant non-minority reference group was statistically significant to $P < .05$. In particular, non-English speaking patients appeared to be significantly burdened by interfacility insurance transfers, with a rate just over 2% compared to 0.9% for English-speaking patients. This is of relevance given the other barriers these patients face in the healthcare system generally.[9]

At our hospital, most insurance transfers (93.7%) were of Medicare and Medicaid patients. Patients with Medicare Advantage plans experienced a major impact. We did not specifically analyze insurance plan type as a risk factor for insurance transfer. This is because an assumption of our study is that the only factor involved in the decision to make an insurance transfer when inpatient treatment is appropriate is whether a patient's insurance is a contracted type for inpatient admission, and this will be consistent across all patients with a given insurance type. The high percentage of patients with these insurance types in the transferred group, therefore, reflects the non-contracted status of these insurances. Acceptance of Medicaid is voluntary for hospitals, although refusal of Medicaid patients has been a source of debate in medical ethics.[10]

Patients experiencing rejection from private practices due to Medicaid status are more likely to defer care or use hospital EDs to access physicians,[11] although we did not find evidence describing the degree of prevalence or impact of broader policies to refuse service to Medicaid patients. It is not possible to definitively state from our analysis whether the high number of Hispanic and non-English speaking patients experiencing insurance transfers is causally attributable to a higher number of patients in these groups requiring care on Medicare and Medicaid plans compared to White, English-speaking patients. However, public data indicate that minoritized groups in the United States, including

Hispanic and non-English-speaking patients, are more likely to require these safety net services for a complex set of reasons. Additionally, literacy in complex healthcare coverage requirements and benefits may be lower in these populations.[12]

The employer-based health insurance paradigm may also create disparities for minoritized individuals who face higher barriers to obtaining employment.[13] The impact of this type of transfer on patient care has not been extensively researched. As discussed above, previous efforts to examine the impact of interfacility transfer in national datasets have found significant impacts, but these were not specific to patients transferred due to insurance status. Because of the requirements imposed by EMTALA, these patients should be medically stable before transport, and the clinical threshold for stability may be functionally higher given the reason for transfer is non-clinical. Further studies of the clinical impact of these transfers could add impact to research on their potential disparities.

Refusal of Medicaid services is likely due to the level of reimbursement provided by plans, and the same holds true for refusal of patients with Medicare Advantage plans. Medicare Advantage plans were developed as part of the Tax Equity and Fiscal Responsibility Act, in part as a mechanism to transfer risk from fee-for-service Medicare from the government to risk-based insurers who would cover members in exchange for a monthly per-capita payment.[14] Payments for inpatient service from Medicare Advantage plans, however, may be 5.6% less than traditional fee-for-service Medicare.

An important balance exists for hospital administrators seeking to make insurance contracting decisions. On one hand, hospitals must make adequate financial recovery to continue serving patients and fulfilling their community mission. These decisions are even more challenging at academic hospitals as their mission includes education and research, both of which require substantial financial investment. Still, decisions not to accept Medicaid or other insurance plans can have important impacts on patients seeking care, and institutions must seriously consider the ethics of such practices, including, above all, a responsibility to not negatively impact patient care. Furthermore, our research suggests that impacts on patients may be disproportionately borne by minority groups. This adds another layer to the ethical implications of such practices and further entrenches systemic barriers to care for these patient populations. As discussed above, further research may help to elucidate the impact these transfers have on clinical care and assist hospitals in making decisions that appropriately balance reasonable reimbursement requirements with the duty to provide high-quality patient care.

### Previous Studies

Interfacility transfers have been studied in other, specific contexts such as in cancer patients[16] and pediatric trauma patients.[17] Studies specific to the ED include one that examined patients with ST-elevation myocardial infarction[18] and one of patients experiencing inbound transfers to an academic ED.[19] In each of these examples, insurance status was evaluated as a potential exposure to the overall risk of transfer, for any reason. In our study, we reviewed charts to determine the specific reason for transfer, such that insurance transfers could be explicitly reviewed. A benefit of this approach is that it removes potential confounders, including the possibility that socioeconomic variables impact the overall risk of transfer including for non-insurance reasons such as complexity of trauma. Previous studies have used national databases such as the National Inpatient Sample, which allows for greater generalizability although it may not permit the granularity of review included in our study.

## LIMITATIONS

This study represents a single-site review of trends in interfacility transfer for non-contracted insurance status. Previous studies have used national datasets to understand the impact of transfers on clinical care, although it is difficult to determine from these which transfers were due to insurance status. In our hospital's records, while a code was applied to indicate the reason for transfer, it frequently read "Patient preference" in cases where non-contracted status was discussed in the medical record as the reason for that preference. This meant that manual review of transfers had to be performed to identify specific language in notes in the chart detailing insurance as the reason for transfer, and that wider study of this topic would likely require facility-by-facility review of datasets. Finally, our hospital ED is in an area where US Census data indicates a median income of $106,058. Therefore, our sample may not be reflective of the socioeconomic status of patients presenting to the ED in other locations.

## CONCLUSION

In our single-center ED study, minority patient populations were disproportionately impacted by interfacility transfers for non-contracted insurance status. We found increased transfer rates due to insurance incompatibility for all minority demographics queried. The most severe disparity was found for non-English speakers and patients of Hispanic ethnicity.

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# Pediatric Upper Extremity Firearm-related Injuries: A Level I Pediatric Trauma Center Experience

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**Introduction:** Firearm injuries have become increasingly more common in the pediatric population; however, there is a paucity of literature examining the management of these pediatric firearm-related injuries (FRI) specifically as they affect the upper extremity. This study identifies demographic and environmental risk factors in pediatric upper extremity FRIs and evaluates the severity of injury, concomitant injuries, and rates of surgical intervention in pediatric patients treated at a Level I pediatric trauma center over 20 years.

**Methods:** We completed a retrospective analysis on 540 patients <18 years of age with FRIs at a single institution from 2001 – 2020. Of these, 72 (13%) had FRIs involving the upper extremity. The patients were stratified into groups based on whether they had received operative intervention or a bedside procedure for their injury and on their year of presentation between two decades (2001 – 2010 vs. 2011 – 2020). We obtained upper extremity injury-specific variables along with hospital demographics. The primary outcomes in this study included hospital length of stay, number of bullet wounds, motor and sensory deficits, and amputation.

**Results:** In the last 10 years, the rate of upper extremity FRIs observed in the pediatric population has increased by 380% at our institution (15 vs. 57, $P < .001$). After 2010, cases were more likely to present with an increased number of gunshot wounds per patient (1.14 vs. 1.98, 95% confidence interval [CI] -0.94 - 0.24, $P = .03$) but were less likely to require admission to the intensive care unit (19% vs. 67%, $P < .001$). When stratifying by intervention, both the operative intervention and bedside procedure groups had a similar number of gunshot wounds (1.86 vs 1.76, 95% CI -0.52 - 0.43, $P = .86$). The operative intervention group was more likely to have had a soft tissue injury (68% vs. 35%, $P = .005$) and motor deficit at follow-up (45% vs.15%, $P = .02$). Patients in the operative intervention group had longer lengths of stay (9.66 vs. 2.25 days, 95% CI -1.16 - -0.21, $P < .01$) and more morbid injuries despite similar patient demographics.

**Conclusion:** In the last decade, an increased frequency of pediatric upper extremity firearm-related injuries was noted despite a stagnant state population. Emphasis should continue to be placed on education and improving firearm safety in settings in which children are present. [West J Emerg Med. 2025;26(6)1702–1709.]

## INTRODUCTION

Hand and upper extremity injuries are one of the leading causes of presentation to trauma and emergency departments in the pediatric population.[1] Injury to the upper extremities can impair joints, bones, neurovascular structures, and the surrounding soft tissues leading to substantial

morbidity and loss of function.[2] Previously, firearm-related injuries (FRI) in children were reported rarely; however, in recent years pediatric firearm injuries have become increasingly more common.[3,4] Firearm-related injuries in the pediatric population can cause disparate damage to both soft tissue and bone in children due to their small body habitus and lead to complex injury patterns and presentations.[4]

Using data from recent years, the Government Accountability Office estimates the initial hospital cost of FRI in the United States (in both pediatric and adult populations) to be over one billion dollars annually.[5] Although the pediatric population accounts for only a small percentage of these injuries, further studies have shown that the economic burden of these injuries can be substantial.[6-8] Pediatric FRIs have been associated with higher hospital costs and resource utilization than motor vehicle collisions, and a study done by Bongiorno et al found the average cost of FRIs among children in the US to be approximately 45,000 dollars per patient.[8,9] Despite the increased incidence of FRIs in children, the literature describing the patterns or morbidity of FRIs to the hand and upper extremities in children is sparse and inconsistently presented.

Several studies have examined FRIs in the pediatric population at large. These studies often use national data repositories or samples, without granular or center-specific clinical data examining these firearm injuries as it relates to the hand or musculoskeletal system in children.[10-12] This is the opposite of what we find reviewing the more extensive literature available regarding upper extremity firearm injuries in the adult population. In the context of adult firearm injuries, males are more affected by both fatal and nonfatal FRIs than females, with Black, young adult males being the most likely to sustain non-fatal wounds to the upper extremity.[13,14] Firearm-related injuries to the hands also appear to be a common site of injury and much less likely to require hospitalization than a more proximal location.[14] Therefore, a review and analysis of the pediatric population affected by FRIs to the hand and upper extremity remains necessary.

In this retrospective cohort study, we characterized upper extremity firearm injuries in children to describe the impact associated with management of these injuries. We sought to identify the differences in epidemiology and descriptive characteristics of pediatric firearm injuries over the last 20 years at our state's only Level I pediatric trauma and tertiary care referral center. We hypothesized that there would be a substantial increase in the complexity and incidence of firearm-related injuries over the last 20 years in children.

*Population Health Research Capsule*

What do we already know about this issue?
*Unintentional firearm related injury is the fourth leading cause of death among infants (age <1 yr) and is the number one cause of death among children and teens (aged 1-17yrs).[24]*

What was the research question?
*This study sought to identify whether there was a significant decade-interval increase in firearm related upper extremity injuries, with corresponding demographic and environmental risk factors.*

What was the major finding of the study?
*In the last 10 years, the rate of upper extremity firearm related injuries observed in the pediatric population has increased by 380% at our institution (15 vs. 57, P < .001).*

How does this improve population health?
*In the last decade, an increased frequency of pediatric upper extremity firearm-related injuries was noted despite a stagnant state population. Unintentional firearm injury deaths of children are preventable.*

## METHODS

### Study Design

We completed an institutional review board-approved, retrospective analysis on all patients <18 years of age with FRIs to the upper extremity treated at the only Level I pediatric hospital in the state of Alabama between January 1, 2001–December 31, 2020. We employed elements of optimal chart review discussed by Worster and Bledsoe.[15] The abstractors were trained and used data abstraction forms to collect data. Inclusion/exclusion criteria as well as variables were defined prior to case selection. Inclusion criteria included <18 years of age and the mechanism of injury being firearm-related (ie, ballistic). We collected data via electronic health record by reviewing all subsequent inpatient and outpatient charts for each individual patient. From the 20-year database of over 540 firearm-injured pediatric patients (including children with all sustained FRIs) we identified 72 with upper extremity involvement (Figure 1). The 72 patients were then stratified based on whether they had received operative intervention (OR group) or bedside procedure (BP group) for their upper extremity injury, and by the year of presentation (January 1, 2001 – December 31, 2010 vs January 1, 2011 – December 31, 2020). The OR group was classified as the need for surgery at the time of initial presentation.

### Primary Variables and Outcomes of Interest

Demographic variables obtained included age, sex, race/ethnicity, insurance status, and ZIP code/county. Race data were categorized as Black, White, Hispanic and other. Geographical

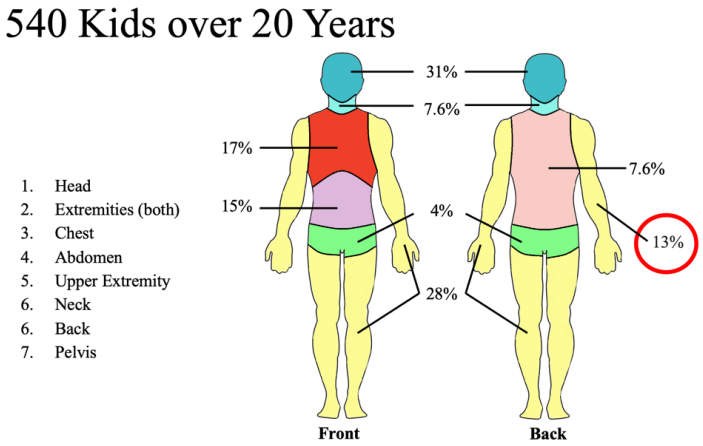


**Figure 1.** Firearm-related upper extremity injury vs injury to other parts of the body at a Level I pediatric trauma center.

data, based on patient residence, was broadly collected and then categorized as Jefferson County (the county where Children's of Alabama is located), or other. Additional information included the following: when (season, month, year) and where (inside vs outside the home) the shooting occurred; intentionality of shooter; shooter identification (father, mother, self, etc); shooting classification (bystander, intruder, gun cleaning, etc); number of gunshot wounds; gun type; and storage reported (locked vs unlocked). We obtained medical data regarding the upper extremity injury (ie. structures involved, degree of injury) along with hospital demographics (ie, length of stay [LOS]/ admission, procedures performed in the operating room vs bedside), number of follow-ups, and overall clinical outcomes, if available. The primary outcomes in this study included hospital LOS, number of bullet wounds, motor and sensory deficits, and amputation.

### Statistical/Analytical Approach

We reported descriptive statistics as means ± standard deviation for continuous variables and frequency with percentage for categorical variables. We assessed differences in outcomes between groups using two-sided independent *t*-tests for continuous variables and $\chi^2$ tests for categorical variables. All statistical significance was referenced to *P*-values of $< .05$. Because we attempted to evaluate as many cases as were available in the EHR, no power analysis was performed.

## RESULTS

A total of 72 patients were included in this study: 15 patients from 2001–2010 and 57 patients from 2011 – 2020 (Table 1). The cohort had an average age of 11.7 years with most being male (69%), Black (83%), and insured by Medicaid (54%). In the 10-year period 2011 - 2020, the incidence of gunshot wounds to the upper extremity in the pediatric population increased by 380% at our institution (15 vs. 57, $P < .001$) (Figure 2). Despite this substantial increase in volume, the age (11.7 ± 5.0), race (predominantly Black), and insurance status did not change ($P > .05$). After 2010, cases were more likely to present with an increased number of gunshot wounds per patient (1.1 vs. 2, $P = .03$). A higher percentage of these patients were taken to the OR; however, that difference was not significant (47% vs. 54%, $P = .59$). Those patients presenting between 2011–2020 did experience a significantly shorter length of hospitalization (4.5 vs. 12.5 days $P = .01$) and were less likely to be admitted to the pediatric intensive care unit (19% vs. 66% $P < .001$) than the 2001 – 2010 group. When stratifying by operative intervention, the 38 children in the OR group had similar general demographics and a similar number of gunshot wounds when compared to the 34 in the bedside procedure group (1.9 vs 1.8; $P = .86$) (Table 2). The OR group was more likely to have an accompanying bony injury (85%), tendon injury (24%), soft tissue injury (68%), shoulder-joint FRI (21%), and motor deficit at follow-up (50%) than the BP group ($P < .05$). The OR groups also participated in significantly more occupational therapy (46% vs. 15% $P = .02$) than the BP group. The BP group was less likely to be admitted to the hospital for more than 24 hours and, when admitted, experienced significantly shorter hospital LOS (9.7 vs. 2.3 days $P = .01$). Significantly more patients in the BP group were shot inside their primary residence; however, there was no difference between groups in the known presence of firearms inside the home ($P = .28$) or in intention ($P = .32$).

When looking at the entire cohort, only two patients lost a limb/digit, 31% had motor deficits, and 16% had sensory deficits at follow-up. Black children were more likely to have non-upper extremity concomitant injuries (41.3% vs. 9.1% $P = .04$) and be a victim of intentional FRIs (incidence 6% vs. 9.1% in White children, $P < .001$). Blacks also presented with a significantly higher number of gunshots per patient (1.0 vs. 2.0 $P = .003$) Patients from Jefferson County (in which a large metropolitan population resides and where the pediatric trauma center itself is located) were more likely to have worse injuries involving the wrist, arterial injury, tendon injury, and retained bullets ($P < .05$).

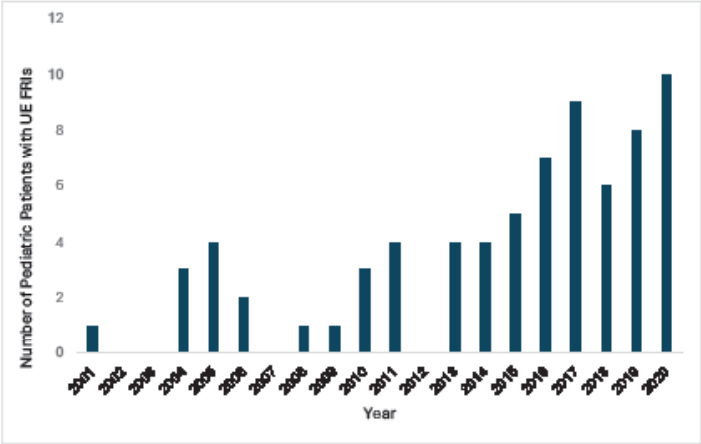


**Figure 2.** Pediatric upper extremity firearm-related injuries by year at our institution.
*UE,* upper extremity; *FRI,* firearm-related injuries.

**Table 1.** Demographics of pediatric upper extremity firearm related injuries stratified by decade of presentation

| | 2001-2010 (n=15) | 2011-2020 (n=57) | Total (N=72) | P-value |
|---|---|---|---|---|
| Male sex | 8 (53%) | 42 (74%) | 50 (69%) | .23 |
| Race/ethnicity | | | | .68 |
| Black | 13 (87%) | 46 (81%) | 59 (82%) | |
| White | 2 (13%) | 10 (18%) | 12 (17%) | |
| Age at injury | 11.45 (5.07) | 11.72 (5.05) | 11.67 (5.02) | .85 |
| Insurance | | | | .78 |
| Medicaid | 8 (53%) | 31 (54%) | 39 (54%) | |
| Private | 4 (27%) | 11 (19%) | 15 (21%) | |
| None | 3 (20%) | 15 (26%) | 18 (25%) | |
| Number of gunshot wounds | 1.14 (0.36) | 1.98 (2.65) | 1.81 (2.39) | .03 |
| Required operative intervention | 7 (47%) | 31 (54%) | 38 (53%) | .59 |
| Non-upper extremity concomitant injury | 9 (60%) | 13 (23%) | 22 (31%) | .02 |
| Injury location | | | | |
| Neck/plexus | 4 (27%) | 2 (4%) | 6 (8%) | < .01 |
| Scapula/clavicle | 2 (13%) | 1 (2%) | 3 (4%) | .05 |
| Shoulder | 3 (20%) | 6 (11%) | 9 (13%) | .32 |
| Upper arm | 5 (33%) | 23 (40%) | 28 (39%) | .62 |
| Elbow | 1 (7%) | 8 (14%) | 9 (13%) | .44 |
| Lower arm | 1 (7%) | 10 (18%) | 11 (15%) | .30 |
| Wrist | 1 (7%) | 5 (9%) | 6 (8%) | .79 |
| Hand/digits | 3 (20%) | 15 (26%) | 18 (25%) | .62 |
| Nerve injury | 5 (33%) | 8 (14%) | 13 (18%) | .08 |
| Artery injury | 4 (21%) | 3 (5%) | 6 (8%) | .01 |
| Bone injury | 6 (40%) | 32 (56%) | 38 (53%) | .27 |
| Tendon injury | 3 (20%) | 7 (12%) | 10 (14%) | .44 |
| Soft tissue injury | 8 (53%) | 30 (53%) | 38 (53%) | .96 |
| No bullet retained (In/out) | 3 (20%) | 17 (30%) | 20 (8%) | .45 |
| Hand injury specific clinic f/u | 8 (53%) | 32 (56%) | 40 (56%) | .17 |
| Motor deficit | 4 (27%) | 18 (32%) | 22 (31%) | .92 |
| Sensory deficit | 2 (13%) | 9 (16%) | 11 (16%) | .97 |
| Loss of limb/digit | 0 (0%) | 2 (4%) | 2 (3%) | .75 |
| Shot inside primary residence | 8 (53%) | 27 (47%) | 35 (49%) | .87 |
| Shooter Identification | | | | .35 |
| Unknown | 6 (40%) | 32 (56%) | 38 (53%) | |
| Friend | 3 (20%) | 5 (9%) | 8 (11%) | |
| Father | 1 (7%) | 4 (7%) | 5 (7%) | |
| Mother | 0 (0%) | 0 (0%) | 0 (0%) | |
| Sibling | 2 (13%) | 4 (7%) | 6 (8%) | |
| Self | 2 (13%) | 8 (14%) | 10 (14%) | |
| Other | 1 (7%) | 4 (7%) | 5 (7%) | |
| Gun type | | | | .14 |
| Shotgun | 1 (7%) | 0 (0%) | 1 (1%) | |
| Handgun | 5 (33%) | 33 (58%) | 38 (53%) | |
| Long gun | 3 (20%) | 7 (12%) | 10 (14%) | |
| Assault-style | 0 (0%) | 2 (4%) | 2 (3%) | |
| Unknown | 6 (40%) | 15 (26%) | 21 (29%) | |

**Table 1.** Continued

| | 2001-2010 (n=15) | 2011-2020 (n=57) | Total (N=72) | P-value |
|---|---|---|---|---|
| Intentional | 8 (53%) | 27 (47%) | 35 (49%) | .87 |
| Weapon unlocked at time of injury | 3 (21%) | 20 (35%) | 23 (32%) | .58 |
| Classification of injury encounter | | | | .36 |
| Bystander | 1 (7%) | 12 (21%) | 13 (18%) | |
| Intruder | 1 (7%) | 0 (0%) | 1 (1%) | |
| Cleaning gun | 0 (0%) | 1 (2%) | 1 (1%) | |
| Drive-by | 2 (13%) | 8 (14%) | 10 (14%) | |
| Homicide | 4 (27%) | 12 (21%) | 16 (22%) | |
| Police involvement | 1 (7%) | 0 (0%) | 1 (1%) | |
| Play | 4 (27%) | 13 (23%) | 17 (24%) | |
| Suicide | 0 (0%) | 1 (2%) | 1 (1%) | |
| Unknown | 2 (13%) | 10 (18%) | 6 (8%) | |
| Discharged from ED | 0 (0%) | 19 (33%) | 19 (26%) | .01 |
| Observe < 24 hrs | 2 (13%) | 10 (18%) | 12 (17%) | .70 |
| Admit (> 24 hrs) | 13 (87%) | 27 (47%) | 40 (56%) | .01 |
| Admit PICU | 10 (67%) | 11 (19%) | 21 (29%) | <.001 |
| # Hospital days | 12.53 (10.52) | 4.48 (11.02) | 6.16 (11.34) | 0.01 |

*ED,* emergency department; *f/u*, follow-up; *PICU,* pediatric intensive care unit.

## DISCUSSION

Firearm injury among children and teenagers in the US remains an area of significant public health concern with the rate of firearm deaths in this population steadily increasing.[16] Children with non-fatal firearm injuries experience high operative and readmission rates and suffer long-term morbidity and mental health sequelae.[17-19] Despite the magnitude of this public health and surgical crisis the morbidity of firearm injuries remains understudied. Here we identified a dramatic shift and increased frequency of FRIs to the upper extremity in pediatric trauma patients: of the 72 total pediatric cases identified with upper extremity injuries over the 20-year study period, 79% patients presented after 2010, and they also presented with an increase in the number of bullet wounds sustained. That said, following 2010, patents were less likely to get admitted to the PICU or to any floor for > 24 hours, potentially indicating an overall shift to outpatient-based follow-up for these injuries.

As the only pediatric Level I trauma center in Alabama, our hospital has a large number of injured children transferred to us for care. However, one critique of this review, in our experience, is that some minor gunshot wounds sustained in patients who live in remote or distant areas may have been treated locally and remain unaccounted for. Neither did this study include the Jefferson County coroner's reports for those children who did not make it to the hospital ED during this 20-year period. Most patients in our study had Medicaid insurance, which supports recent evidence suggesting a higher frequency of pediatric firearm injuries in those with government-assisted payment, followed by private and uninsured patients. In this group, Black children and teenagers comprised 83% of the pediatric population affected by upper extremity firearm injuries. Considering that Blacks make up only 42% of the pediatric population in Jefferson County (and 44% in the state of Alabama), the large numbers of Black children and teenagers in our injured cohort represents a disparate level of exposure to gun violence among these youths.

While we were unable to characterize the societal cost of pediatric firearm injury in our study due to the retrospective nature of collection across two decades, several groups have estimated that the median cost of pediatric firearm-related hospitalizations is greater than $45,000 per patient event.[8,9] While only two patients lost a digit in our cohort, over 31% had some form of documented motor deficit and 16% had sensory deficits. This long-term follow-up is severely limited due to loss of follow-up with time as patients often live far away and were flown in by air for their initial treatment. Naturally, it is difficult to quantify the long-term social and emotional impact on patients, families, and communities of this compromised daily function. This is concordant with accepted incidences in the literature, which show that while most victims of firearm-related violence survive their injuries, about half of children remain with a functional deficit.

Our findings of primarily male and non-White victims of pediatric firearm injuries mirror recent studies in other high-volume centers.[20-23] These studies include those by Summers et al who looked at pediatric upper extremity injuries secondary to non-ballistic firearms; Nichols et al who analyzed demographics

**Table 2.** Patient characteristics and outcomes by the operative-intervention group vs bedside-procedure group.

| | OR group (n=38) | BP group (n=34) | Total (N=72) | P-value |
|---|---|---|---|---|
| Male sex | 22 (58%) | 28 (82%) | 50 (69%) | .07 |
| Race/ethnicity | | | | .71 |
| Black | 31 (82%) | 28 (85%) | 59 (83%) | |
| White | 7 (18%) | 5 (15%) | 12 (17%) | |
| Age at injury | 11.17 (5.67) | 12.22 (4.19) | 11.67 (5.02) | .38 |
| Insurance | | | | .54 |
| Medicaid | 22 (58%) | 17 (50%) | 39 (54%) | |
| Private | 6 (16%) | 9 (27%) | 15 (21%) | |
| None | 10 (26%) | 8 (24%) | 18 (25%) | |
| Number of gunshot wounds | 1.86 (2.36) | 1.76 (2.46) | 1.81 (2.39) | .86 |
| Non-upper extremity concomitant Injury | 14 (37%) | 8 (24%) | 22 (31%) | .27 |
| Injury location | | | | |
| Neck/plexus | 2 (5%) | 4 (12%) | 6 (8%) | .32 |
| Scapula/clavicle | 2 (5%) | 1 (3%) | 3 (4%) | .62 |
| Shoulder | 2 (5%) | 7 (21%) | 9 (13%) | .05 |
| Upper arm | 14 (37%) | 14 (41%) | 28 (39%) | .71 |
| Elbow | 7 (18%) | 2 (6%) | 9 (13%) | .11 |
| Lower arm | 8 (21%) | 3 (9%) | 11 (15%) | .15 |
| Wrist | 5 (13%) | 1 (3%) | 6 (8%) | .12 |
| Hand/digits | 11 (29%) | 7 (21%) | 18 (25%) | .41 |
| Nerve injury | 6 (16%) | 7 (21%) | 13 (18%) | .60 |
| Artery injury | 5 (13%) | 1 (3%) | 6 (8%) | .18 |
| Bone injury | 28 (74%) | 10 (26%) | 38 (53%) | <.001 |
| Tendon injury | 9 (24%) | 1 (3%) | 10 (14%) | .01 |
| Soft tissue injury | 26 (68%) | 12 (35%) | 38 (53%) | .01 |
| No bullet retained (In/out) | 5 (13%) | 15 (44%) | 20 (28%) | <.001 |
| Hand injury specific clinic f/u | 26 (68%) | 14 (41%) | 40 (56%) | .07 |
| Motor deficit | 17 (45%) | 5 (15%) | 22 (31%) | .02 |
| Sensory deficit | 5 (15%) | 6 (18%) | 11 (16%) | .86 |
| Loss of limb/digit | 2 (5%) | 0 (0%) | 2 (3%) | .40 |
| OT documented | 16 (42%) | 5 (15%) | 21 (30%) | .02 |
| Season shooting occurred | | | | .31 |
| Fall | 7 (18%) | 8 (24%) | 15 (21%) | |
| Spring | 6 (16%) | 5 (15%) | 11 (15%) | |
| Summer | 13 (34%) | 17 (50%) | 30 (42%) | |
| Winter | 12 (32%) | 4 (12%) | 16 (22%) | |
| Shot inside primary residence | 11 (29%) | 19 (56%) | 30 (42%) | .01 |
| Gun-owning home | 18 (47%) | 9 (27%) | 27 (38%) | .28 |
| Shooter Identification | | | | .67 |
| Unknown | 17 (45%) | 21 (62%) | 38 (53%) | |
| Friend | 4 (11%) | 4 (12%) | 8 (11%) | |
| Father | 4 (11%) | 1 (3%) | 5 (7%) | |
| Mother | 0 (0%) | 0 (0%) | 0 (0%) | |
| Sibling | 4 (11%) | 2 (6%) | 6 (8%) | |
| Self | 6 (16%) | 4 (12%) | 10 (14%) | |
| Other | 3 (8%) | 2 (6%) | 5 (7%) | |

**Table 2.** Continued.

| | OR group (n=38) | BP group (n=34) | Total (N=72) | P-value |
|---|---|---|---|---|
| Gun type | | | | .08 |
| Handgun | 18 (47%) | 20 (59%) | 38 (53%) | |
| Long gun | 7 (18%) | 3 (9%) | 10 (14%) | |
| Assault-style | 2 (5%) | 0 (0%) | 2 (3%) | |
| Unknown | 10 (26%) | 11 (32%) | 21 (29%) | |
| Intentional | 17 (45%) | 18 (53%) | 35 (49%) | .32 |
| Weapon unlocked at time of injury | 14 (37%) | 9 (27%) | 23 (32%) | .03 |
| Shooting classification | | | | .15 |
| Bystander | 4 (11%) | 9 (27%) | 13 (18%) | |
| Intruder | 1 (3%) | 0 (0%) | 1 (1%) | |
| Cleaning gun | 0 (0%) | 1 (3%) | 1 (1%) | |
| Drive-by | 5 (13%) | 5 (15%) | 10 (14%) | |
| Homicide | 9 (24%) | 7 (21%) | 16 (22%) | |
| Police involved | 0 (0%) | 1 (3%) | 1 (1%) | |
| Play | 10 (26%) | 7 (21%) | 17 (24%) | |
| Suicide | 1 (3%) | 0 (0%) | 1 (1%) | |
| Unknown | 8 (21%) | 4 (12%) | 12 (17%) | |
| Discharged from ED (Observed < 23 hrs.) | 3 (8%) | 16 (47%) | 19 (26%) | <.001 |
| Admit (> 24 hrs.) | 32 (84%) | 8 (24%) | 40 (56%) | <.001 |
| Admit PICU | 16 (42%) | 5 (15%) | 21 (29%) | 0.01 |
| # Hospital days | 9.66 (13.79) | 2.25 (5.77) | 6.16 (11.34) | 0.01 |

*OR,* operative procedure; *BP,* bedside procedure; *OT,* occupational therapy; *ED,* emergency department; *f/u*, follow-up; *PICU,* pediatric intensive care unit.

and mechanisms of injury for upper-extremity pediatric firearm injuries at one tertiary trauma center in Florida; Dabash et al who examined characteristics and outcomes of 10 pediatric upper-extremity FRIs cases at a trauma center on the US-Mexican border; and Tarkunde et al who looked at epidemiological factors and management of FRIs to the wrist and hand in 29 pediatric patients (and 220 adult patients) at a Level I trauma center. Dabash found males to be more affected than females and most injuries due to either violence (60%) or accidental discharge (40%). Of note, none of the patients analyzed by Dabash et al had lasting physical deficits as a result of their injury.[22] On the other hand, Nichols et al found the hand to be the most frequent location of Andinjury, with factors including male sex, White-not Hispanic or Latino race/ethnicity, and adolescent age contributing to an increased risk for an upper extremity injury.[21]

## LIMITATIONS

This study has several limitations that warrant consideration. This was a single-center study, thus limiting its external validity. The single hospital location, with exclusion of those patients treated at outside facilities, may have selectively biased the data to more severe injuries that required treatment at a Level I trauma center and limit the generalizability of this data to other communities. Similarly, the true frequency of pediatric upper-extremity firearm injuries is likely still under-reported. In cases of isolated hand or minor injury, many patients may have been treated in a local ED or transported across state lines to an adjacent pediatric hospital if it was closer. That said, because our center is a high-volume pediatric and academic-trauma center, we believe that these injuries are more often identified here than in other centers. However, based on our significant findings, prospective database-reporting studies would be informative for guiding additional recommendations for diagnosis and management of pediatric upper-extremity firearm injuries.

Despite its limitations, this study sheds light on the adverse outcomes sustained by children as a result of upper extremity injuries from firearms. The size of our patient population is significantly larger than that of previous studies examining firearm injuries in children. Our study's specific focus on firearm-related musculoskeletal injuries over a 20-year span provides a long timeframe for evaluation, and we were able to present data about adverse outcomes from these injuries with at least a minmum three-year follow-up from the last patient collected at the time of our study. Our finding of increased risk of adverse outcomes in Black males and Medicaid/uninsured presents a focused population for gun safety outreach and future community health interventions. Continued re-evaluation of firearm injury prevention strategies and targeted efforts at reducing gun violence in our communities may be beneficial in ensuring continued decline in firearm-related injuries among America's youth.

## CONCLUSION

In the decade 2011-2020, pediatric patients suffered increased morbidity from their sustained firearms-related injuries, representing a significantly increased frequency of firearm-related injuries to the upper extremity. Given the importance of initial patient management and long-term care, clinicians are encouraged to assess for, document, and manage upper-extremity firearms injuries in pediatric trauma patients and consult orthopedic surgeons and plastic surgeons when appropriate. Future prospective studies are necessary to better characterize upper extremity patient-injury patterns and outcomes to generate practice-guiding recommendations for this patient population.

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# Completeness and Audibility of Verbal Orders for Medications and Blood Products during Trauma Resuscitation

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**Introduction**: Resuscitation of critically injured patients requires effective team leadership. Poor communication is the leading cause of sentinel events. Closed-loop communication reduces error during trauma resuscitations. Nonetheless, previous studies show few verbal orders are audible. Verbal orders during trauma resuscitations have not been studied for completeness. In this project we aimed to assess whether verbal orders for medications and blood products during trauma resuscitations were complete, audible, and used closed-loop communication.

**Methods**: This was an observational assessment of a convenience sample of verbal orders that trauma captains gave for medications and blood products during the primary and secondary survey. It was conducted in an academic emergency department (ED) at an adult Level 1 trauma center. We assessed medication orders for the presence or absence of medication name, dose, and route. Blood orders were evaluated for the presence or absence of blood product (packed cells or whole blood) and type (O- or O+). We recorded orders as audible or inaudible. Closed-loop communication was recorded as present or absent. Orders were considered complete if they included all elements. We used descriptive statistics to analyze data.

**Results**: There were 186 verbal orders enrolled: 165 (88.7%) for medications and 21 (11.3% for blood products. For medication verbal orders, 77.9% (n=127) were audible, 73.6% (n=120) included the name, 62.0% (n=101) included the dose, 17.8% (n=29) included the route, and 73.5% (n=111) used closed-loop communication. Overall, 23 (14.1%) medication verbal orders were complete. Regarding verbal orders for blood, 16 (76.2%) were audible, three (14.3%) included the blood product, seven (33.3%) included the blood type, and 13 (61.9%) used closed-loop communication. Overall, 0% (n=0) of the blood product verbal orders were complete.

**Conclusion**: Audible, complete verbal orders, and closed-loop communication were underused during trauma resuscitations. Interventions to improve communication of verbal orders warrant evaluation in the ED. [West J Emerg Med. 2025;26(6)1710–1718.]

## INTRODUCTION

Resuscitation of critically injured patients requires effective communication. The Joint Commission names poor communication as the leading root cause of all sentinel events.[1] In one survey-based study of healthcare professionals, 14% of respondents reported observing a medication error occurring due to misunderstanding or mishearing a verbal order.[2] Closed-loop communication reduces errors during verbal ordering and decreases time to task completion.[1,3] In a 2005 study of verbal orders during trauma resuscitations, only 16% of verbal orders were audible and only 6% were understandable.[4] Despite studies indicating poor communication during trauma resuscitations, verbal orders during trauma resuscitations have not been studied for completeness.

Blood product verbal orders have become more complex in recent years due to the successful implementation of whole blood resuscitation algorithms in civilian trauma programs.[5] Research supports the use of whole blood as the resuscitation

product of choice in the treatment of hemorrhagic shock and has shown improved outcomes in military settings.[6-10] In addition to whole blood products, more traditional blood products such as O- or O+ packed red blood cells, plasma, and platelets are often administered to traumatically injured patients. In this ED, trauma patients are given uncrossed packed red blood cells (O+ for male and O- for female) or low titer O+ whole blood for resuscitation of hemorrhagic shock in all male patients with anticipated activation of massive transfusion.

The use of multiple blood products (packed red blood cells and whole blood) and blood types (O+ and O-) introduces the potential for error wherein an incorrect blood product or blood type could be administered. Blood administration errors should be avoided in all patients but are particularly worrisome for patients with Rh-negative blood who may become pregnant. This is due to the potential for late complications such as hydrops fetalis, thrombocytopenia, neutropenia, and hemolytic disease of the fetus and newborn.[11-13] A sentential event involving the administration of O+ blood to a Rh-negative female trauma patient was the catalyst for this study.

Medication verbal orders are similarly complex because resuscitation of critically ill trauma patients may require the use of numerous medications given via multiple routes and using different units. Tailoring doses of medications to physiologic parameters may be required, particularly for patients at extremes of age or with unstable vital signs. Simply put, a one-dose-fits-all strategy is inappropriate in this setting. Once a medication, dose, and route have been decided by the ordering physician, these must be specified clearly.[14]

Given the importance of clear communication during trauma resuscitation, our aim in this study was to assess medication and blood product verbal orders during trauma resuscitations in the ED for audibility, completeness, and closed-loop communication.

*Population Health Research Capsule*

What do we already know about this issue?
*Resuscitation of critically injured patients requires effective communication, yet studies show few verbal orders are audible and completeness has not been studied.*

What was the research question?
*This project assesses verbal orders during traumas for completeness, audibility and closed-loop communication.*

What was the major finding of the study?
*Complete verbal orders were utilized 14.1% of the time for medications and 0% of the time for blood administration during traumas.*

How does this improve population health?
*This project demonstrates that interventions to improve communication of verbal orders warrant evaluation in resuscitation settings.*

## METHODS

### Study Design

This was an observational study of a convenience sample of verbal orders for medications and blood products provided by the trauma captain or a supervising physician during the primary and secondary survey of trauma activations at this adult Level 1 academic trauma center. This study was reviewed by the institution's institutional review board (IRB) and was determined to be IRB exempt.

### Study Setting

We conducted this study in an academic emergency department (ED), an adult Level 1 trauma center that sees approximately 4,000 trauma activations per year. Trauma activations are divided into trauma alerts (higher acuity requiring immediate life-saving intervention) and trauma calls (mid-acuity with high likelihood of requiring additional resources). Activation criteria for trauma alerts and trauma calls are included in Table 1. The primary and secondary surveys of trauma patients take place in one of four ED resuscitation bays and follow Advanced Trauma Life Support guidelines. During trauma activations, medications, blood, and interventions are ordered verbally by the trauma captain. Orders are not placed into the electronic health record (EHR) until after the secondary survey when the physician team can step away from the patient bedside.

Postgraduate year (PGY)-3 emergency medicine (EM) residents in this three-year EM program and PGY 3-5 surgery residents serve as trauma captains with close faculty supervision. In addition to the trauma captain, other team members present at trauma activations and team roles are shown in Figure 1. Roles include the following: resident physicians; trauma surgery and emergency medicine faculty; ED nurses; ED techs; ED pharmacists; respiratory therapists; and social workers. The specific personnel and resources mobilized for a trauma alert and a trauma call are detailed in Table 1.

The most notable difference is that a trauma surgery faculty responds immediately to any trauma alert, but within six hours to a trauma call. Team composition does not change with time of day or day of week. Each trauma activation is a single resuscitation. A single trauma team is not expected to care for more than one trauma resuscitation at a time. Resuscitations are run in the trauma bay, a large area with four separate

**Table 1.** Trauma activation criteria and resources; trauma alerts are the highest level of activation in which the full team will respond.

| Trauma Activation Criteria | Trauma Activation Resources |
|---|---|
| Trauma Alert | |
| Glasgow Coma Score (GCS) < 9<br>Systolic blood pressure (SBP) < 90 at any time<br>Heart rate (HR) < 50 or > 130<br>Respiratory rate < 10 or > 29 breaths/minute<br>Intubated patients transported from the scene or transferred from another facility<br>Patients with respiratory compromise or obstruction<br>Transfer patients from other hospitals who require blood to maintain vital signs<br>Gunshot wound to the head, neck, chest, back, or abdomen<br>Gunshot wound to extremities with active bleeding or non-palpable pulses<br>Tourniquet on any extremity or wound-packing with continuous pressure<br>Transfer with known head bleed and GCS ≤ 13<br>Transfer with known multisystem trauma (≥ 2 systems)<br>Geriatric criteria ( > 65 years old):<br>SBP < 110 at any time, and<br>HR > 100 at any time<br>Hypothermia from immersion or suspected exposure with vital sign criteria as above<br>Clinician discretion | The trauma alert team will respond immediately to the trauma resuscitation bays to participate in resuscitation and therapeutic decision-making:<br><br>Trauma Surgery Faculty – within 15 minutes of patient arrival<br>Trauma Surgery Senior Resident<br>Emergency Medicine (EM) Faculty<br>EM Residents<br>Anesthesiology<br>Emergency Department (ED) Nurses (Recorder, Left, Right)<br>ED Technician<br>Respiratory Therapy<br>Radiology Technician<br>Social Services<br>Pharmacy |
| Trauma Call (mid-acuity) | |
| GCS 9-12 with mechanism attributed to trauma<br>Stab wound to the head, neck, chest, back, or abdomen<br>Any penetrating injury to the back<br>Penetrating injury proximal to the elbow or knee<br>Flail chest<br>Combination trauma and burns<br>≥ 2 proximal long bone fractures<br>Pelvic fracture<br>Open or depressed skull fracture<br>Transfer with known head bleed and GCS > 13<br>New-onset paralysis<br>Amputation above the wrist or ankle.<br>Rigid or distended abdomen related to trauma mechanism<br>Geriatric criteria ( > 65 years old):<br>Any fall greater than standing height<br>Motor vehicle collision > 25 mph<br>Pedestrian struck<br>Falls > 20 feet<br>High-risk auto collision:<br>Intrusion, including roof: > 12 inches occupant site, or > 18 inches any site<br>Ejection (partial or complete)<br>Death in same passenger compartment<br>Vehicle telemetry data consistent with high risk of injury<br>Pedestrian/bicyclist/motorcycle/recreational vehicle thrown, run over, or with significant impact (> 20 mph)<br>Injured, pregnant trauma patient > 22 weeks<br>Hanging – only with patient injury<br>Inter-hospital transfer of trauma (unless direct admission is arranged)<br>Clinician discretion | The trauma call team will respond immediately to the trauma resuscitation bays to participate in resuscitation and therapeutic decision-making.<br><br>EM Faculty<br>Trauma Surgery Senior Resident<br>EM Residents<br>ED Nurses (recorder, left, right)<br>ED Technician<br>Respiratory Therapy<br>Social Services<br>Trauma Surgery Faculty – within 6 hours of patient arrival |

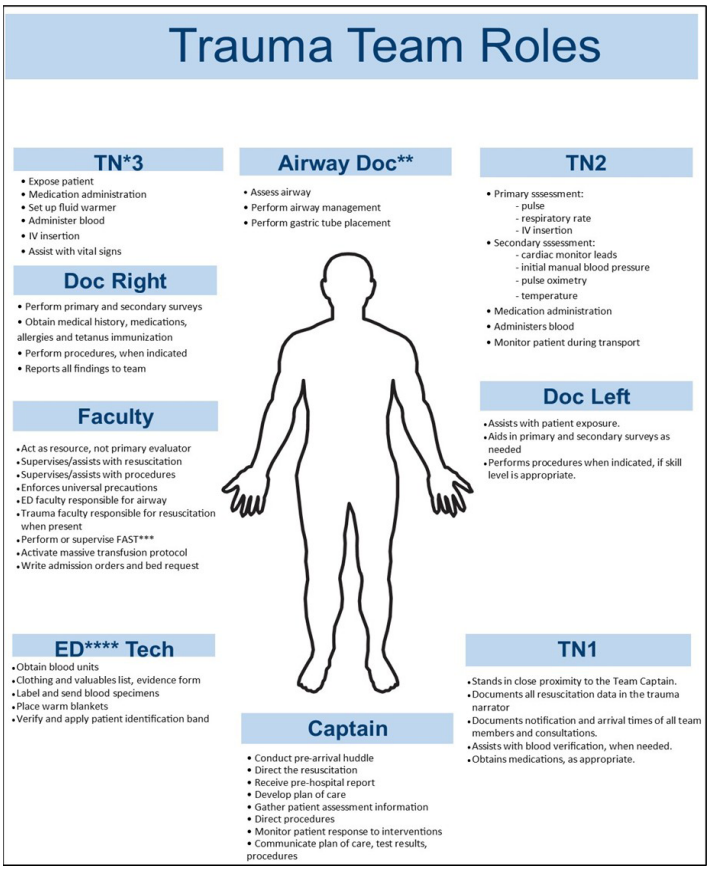


**Figure 1.** Trauma resuscitation team roles.
PGY-3 EM residents in this three-year EM program and PGY-3-5 surgery residents serve as trauma captains with close faculty supervision.
*DOC,* doctor (referring to a resident or attending physician); *ED,* emergency department; *FAST,* focused assessment with sonography in trauma; *PGY*, postgraduate year; *TN,* trauma nurse

**Table 2.** Characteristics of verbal orders, reported as absolute number and percentage.

| Characteristics | Number of verbal orders (N = 186) |
|---|---|
| Trauma activation | |
| Call | 72 (38.7%) |
| Alert | 114 (61.3%) |
| Role of captain | |
| EM resident | 138 (74.2%) |
| Surgery resident | 34 (18.3%) |
| Other physician | 14 (7.5%) |
| Patient sex | |
| Female | 54 (29.0%) |
| Male | 132 (71.0%) |
| Medication orders (n = 163) | |
| Audible | 127 (77.9%) |
| Name | 120 (73.6%) |
| Dose | 101 (62.0%) |
| Route | 29 (17.8%) |
| Closed-loop communication | 111 (73.5%) |
| Complete | 23 (14.1%) |
| Blood orders (n = 21) | |
| Audible | 16 (76.2%) |
| Blood product | 3 (14.3%) |
| Blood type | 7 (33.3%) |
| Closed-loop communication | 13 (61.9%) |
| Complete | 0 (0%) |

More trauma alerts than trauma calls were included. Emergency medicine residents gave most of the verbal orders, and male patients outnumbered female patients. There was < 100% compliance with verbal order audibility, completeness, and closed-loop communication.

resuscitation spaces separated by curtains. Anywhere from 0-4 patients are resuscitated in this space at the same time.

## Study Protocol

Trauma activations including both trauma alerts and trauma calls were observed by a member of the project team. We included a convenience sample of trauma activations, which were observed at all hours of the day and all days of the week over a 20-month period. Key measures were recorded on a password-protected tablet by a project team member in real time. The project team member collecting data was located near the recording nurse (TN1 [trauma nurse 1] in Figure 1), within five feet of the trauma captain, to ensure environmental noise did not impact data collection.

Data were collected by a medical student with prior experiences as an ED technician at a medium-sized urban ED, although without ATLS training. The data collector was not a member of the trauma team prior to or throughout the observation period. Given the dicohotomous nature of the variables observed, we decided that ATLS certficiation was not necessary to perform adequate data collection.

## Key Measures

Key measures were dichotomous variables including the presence or absence of the following: order audibility; medication name/dose/route; blood product and type; and closed-loop communication. Patient sex, acuity of trauma, and the training program of the captain were also recorded.

### *Order Audibility*

Verbal orders were considered audible if the project member collecting data could hear the order being given. We classified orders as inaudible in the following circumstances: an order was called but was indiscernible; closed-loop

communication was used but no initial order was heard, or when the ED pharmacist brought a medication to bedside following a verbal order that was not heard by the project team member. Because the project team member was closer to the captain than the bedside registered nurse (RN), the ED pharmacist, or the recording trauma RN, it is presumed that if the order was inaudible to our data collector, it was likely inaudible to other team members standing farther away.

*Order Content*

No clear standard or recommendation exists for contents of a verbal order in a resuscitation situation. Following the sentinel event that prompted this study, a multidisciplinary group including trauma surgery faculty, emergency medicine (EM) faculty, ED nursing, ED pharmacists, and a patient safety specialist determined expected verbal order contents during trauma resuscitations. As per the Institute for Safe Medication Practices, a complete medication order includes the drug name, dose/strength, frequency, route of administration, indication, type/frequency of assessment to monitor the effects of therapy, drug administration precautions, drugs to discontinue during therapy, and instructions to address known potential emergencies associated with the drug. Our approach to selecting the contents to define a complete verbal order was that a verbal order should contain the components suggested for a complete written order that are both relevant to the emergent bedside resuscitation of a critically injured patient and can be stated with a pace commensurate to the resuscitation itself. In this way, the content of medication verbal orders including name, dose, and route were selected by consensus of this multidisciplinary group and recorded as present or absent during data collection. If all three of these were present, the verbal order was considered complete (eg: "Give 100 mg of ketamine, IM" [intramuscular).

We did not include components such as frequency, monitoring effects of therapy, drug precautions, drugs to discontinue, or instructions to address potential emergencies. We decided that these components did not apply to a trauma resuscitation given that the physician and nursing team members are present at bedside continuously throughout the resuscitation, that the team is witnessing any effect of the medication in real time, and that the frequency is presumed to be "once, now" given the context of the verbal order. The content for blood verbal orders were selected based on input of our multidisciplinary trauma/EM team. Departmental recommendations were provided based on the availability of blood products in our ED and the necessary verbal components to distinguish between these blood products. The content of blood verbal orders including blood product (packed red blood cells or whole blood) and blood types (O+ or O- were recorded as present or absent). A blood order was considered complete if both component parts were present (eg: "Administer one unit of O negative packed red blood cells.")

**Closed-loop Communication**

We defined closed-loop communication as audible repetition of the verbal order and recorded as present or absent for all medication and blood orders. Repeat orders made by the trauma captain after another team member used closed-loop communication to clarify were not included in the study. We documented closed-loop communication for the original verbal order as being present.

**Data Analysis**

Data were housed in a secure Excel spreadsheet (Microsoft Corporation, Redmond, WA). We used descriptive statistics to analyze all data. Order content was analyzed for completeness, with subgroup analysis of component parts. Additionally, we performed subgroup analyses based on the sex of the patient, the acuity of trauma, and the training program of the ordering physician. Specifically, we sub-analyzed high-acuity (trauma alerts) and mid-acuity (trauma calls due to differing degrees of critical injury contributing to different numbers of team members involved, different medication and blood products administered, and the level of urgency of resuscitation.

## RESULTS

There were 186 verbal orders enrolled over 23 months between February 2020–December 2021. Medication orders comprised 88.7% (n=165/186) of enrolled orders, and blood orders comprised the remaining 11.3% (n=21/186). Types of medications ordered and recorded included analgesics, anxiolytics/anti-psychotics, sedatives and paralytics for rapid sequence intubation, intravenous fluids, antibiotics, and tetanus vaccines. Of the trauma resuscitations, 38.7% (n=72/186) were trauma calls and 61.3% (n=114/186) were trauma alerts. Trauma captains gave 92.4% (n=172/186) of verbal orders, and the remaining 7.5% (n=14/186) were provided by another supervising physician. Of orders given by trauma captains, 80.2% (n=138/172) were given by an EM resident and 19.8% (n=34/172) were given by a surgery resident. We documented that 71.0% (n=132/186) of the verbal orders were given during resuscitation of male patients with the remaining 29.0% (n=54/186) of verbal orders during the resuscitation of female patients.

**Order Audibility**

Of all verbal orders given for medications, 77.9% (n=127/163) were audible. Subgroup analysis based on acuity of trauma revealed that 77.9% (n=53/68) of orders given during trauma calls (mid-acuity with high likelihood of requiring additional resources) were audible, and 77.9% (n=74/95) of orders given during trauma alerts (higher acuity requiring immediate life-saving intervention) were audible. Subgroup analysis based on trauma captain residency program demonstrated that 80.2% (n=93/116) of orders given by an EM resident were audible, 67.6% (n=23/34) of orders given

by a surgery resident were audible, and 80% (n=8/10) of orders given by a supervising physician were audible.

Similar to medication verbal orders, 76.2% (n=16/21) of orders for blood were audible. Subgroup analysis based on acuity of trauma revealed that 75% (n=3/4) of orders during trauma calls were audible and 76.5% (n=13/17) of orders during trauma alerts were audible. Subgroup analysis based on trauma captain residency program revealed that 75% (n=15/20) of orders given by an EM resident were audible and 100% (n=1/1) of orders given by a supervising physician were audible. No verbal orders for blood were given by a surgery resident.

### Order Content

Only 14.1% (n=23/163) of medication verbal orders were complete, with 73.6% (n=120/163) including the name, 62.0% (n=101/163) including the dose, and 17.8% (n=29/163) including the route. Subgroup analysis based on acuity of trauma revealed that 14.7% (n=10/68) of medication verbal orders during trauma calls were complete, and 13.7% (n=13/95) of medication verbal orders during trauma alerts were complete. Subgroup analysis based on trauma captain residency program revealed 17.2% (n=20/116) of medication verbal orders given by an EM resident were complete, 8.8% (n=3/34) of orders given by a surgery resident were complete, and 0% (n=0/10) given by a supervising physician were complete.

Throughout the course of data collection, we noted that the unit of a dose of medication was frequently not included in the verbal order. Unit was not initially included in the data collection template, although after recognizing the frequent absence of the unit in the medication verbal order, the presence or absence of a unit was subsequently recorded. There were 100 medication verbal orders where unit was included in our assessment. Of these 100 verbal orders, it is evident that similar to other parts of the verbal order, unit was underused, while 4% (n=4/100) of verbal orders included the unit. If including units as a component of completeness, the number of complete verbal orders is much fewer. Only 1.0% (n=1/100) of verbal orders included the name, dose, unit of dose, and route.

Regarding verbal orders for blood, 14.3% (n=3/21) included the blood product and 33.3% (n=7/21) included the blood type. Over half (52.4%; n=11/21) of orders for blood omitted both blood product and blood type (eg, "Hang a unit of blood.") No verbal orders for blood were complete (0%; n=0/21). Of note, 28.6% (n=6/21) of blood verbal orders were given during resuscitation of a female patient, and only 50% (n=3/6) of those orders included the blood type.

### Closed-loop Communication

Closed-loop communication was used for 73.5% (n=111/151) of orders for medication and in 61.9% (n=13/21) of orders for blood.

## DISCUSSION

Verbal orders for both medications and blood products were not universally audible or complete, and closed-loop communication was inconsistently used. This lack of audible, complete verbal orders and closed-loop communication creates room for error. In fact, this study was inspired by a patient safety event in which an incomplete verbal order for blood resulted in a young adult female trauma patient with an O- blood type receiving O+ blood during her trauma resuscitation. This case exemplifies the impact that incomplete verbal orders can have on critically ill trauma patients during their initial resuscitation. None of the care team members observed participated in any education intervention following this sentinel event. No further high-harm safety events occurred during trauma resuscitations within the data collection period, and no root cause was determined to be related to verbal ordering practices.

### Order Audibility

Orders for medications and for blood products were inaudible, a finding consistent with prior research. El-Shafy et al found 97% of orders to be audible and 26% to be closed loop.[3] While these audibility results differ from the 78% reported in this adult ED study, the El-Shafy study was conducted in a pediatric setting, which may have impacted the ambient noise of concurrent trauma and medical resuscitations, team dynamics, and other factors. It is unclear where the enrolling study member stood in that study, which may have impacted results as well. A study by Bergs et al reported that 56% of observed orders were audible.[4] This study was done at an adult Level 1 trauma center, but data were collected via video recording. This data collection methodology may have impacted audibility of orders and resulted in a somewhat lower percentage of audible orders recorded as compared to this study. A study team member collecting data standing among the resuscitation team most closely approximates the experience and, therefore, the audibility of orders to team members.

The environment of the ED resuscitation bay can be loud and crowded. Thus, providing audible verbal orders can be challenging for trauma captains. Nonetheless, audible verbal orders are key to patient safety. With this demonstrated room for improvement, mitigation strategies are needed and may include environmental noise control, empowering care team members to clarify indiscernible orders, and educational simulation for physicians to recognize the audibility of their orders.

### Order Content

Complete verbal orders were inconsistently given. In fact, not providing a complete verbal order was the most frequently observed deviation from best practice of all the observed measures in this study. Only 14.1% of orders for medication were complete, and no orders for blood were complete.

**Orders for Medications**

Most often, a medication verbal order was incomplete because it did not include the route. In fact, 50.7% (n = 71/140) of orders for medication were incomplete due to the absence of route. Trauma captains may have omitted route as it is frequently assumed that patients were to take nothing by mouth and that medications are given intravenously (IV). If medication route were not required for order completeness, medication verbal order completeness would increase from 14.1% (n = 23/163) to 57.7% (n = 94/163). This demonstrates persistent room for improvement. Dose was absent in 38% of verbal orders. For example, a trauma captain may say, "Give some IV fentanyl." Further, 26.4% of orders lacked even the name of the medication. For example, a trauma captain may say "Give another 50 mcg" rather than "give 50 mcg of IV fentanyl." This certainly introduces the potential for medication error, making future QI interventions necessary. Trauma captains may deliver incomplete medication verbal orders due to relative lack of experience leading resuscitations, due to a medical knowledge deficit, or a host of other reasons. More research is necessary to evaluate the contributing factors to incomplete verbal order delivery

**Orders for Blood Products**

As previously defined, a complete blood verbal order includes the blood product and blood type. Despite the fact that multiple blood products and blood types are used in our ED, no observed blood orders were complete. The importance of this is highlighted when considering blood administration in patients who may be pregnant. Due to Rh incompatibility, incorrect blood administration may contribute to future patient and fetal harm.[11-13] Therefore, complete blood verbal orders are of great importance to patient safety. Given the total lack of complete blood verbal orders reflected in the data, and the high impact these orders have on patient safety, QI and safety improvement strategies are necessary.

**Closed-Loop Communication**

One benefit of closed-loop communication is to identify a potential error before it occurs. This is especially important considering the frequency with which verbal orders were inaudible or incomplete. Therefore, the key to effective closed-loop communication is stating the medication or blood product that is being administered prior to administration. Throughout observation of trauma resuscitations, it was noted that closed-loop communication was not always used correctly. Upon recognizing that closed-loop communication was often used after administration of a medication or blood product, the timing of closed-loop communication was recorded as before or after administration. We assessed 60 medication and blood verbal orders for timing of closed-loop communication. Of these, 56.7% (n = 34/60) of closed-loop communication occurred after the medication or blood was already administered. Using closed-loop communication in this way limits error prevention. Further, in an ideal situation an ED nurse would use closed-loop communication both before completion of the order to ensure they heard the correct order details, and after the completion to confirm they completed the order. This practice was not observed during our data collection period. Regardless of timing, there is significant room for increased use of this best practice.

El-Shafy et al reported that 26% of orders included closed-loop communication.[3] This represents notably fewer instances of closed-loop communication than were observed in our study. This is likely due to the definitions used to rate closed-loop communication as present. El-Shafy defined closed-loop as "audible, directed to a team member, check-back by the team member, and acknowledgment by team leader."[3] For this study, closed-loop communication was recorded as present if the ED nurse completing the order repeated the order back. As discussed above, it was acknowledged that the presence of closed-loop communication is likely lower than our reported 73% if only optimal closed-loop communication was recorded rather than any closed-loop communication.

Data from this study demonstrate that there is a significant quality gap between optimal verbal ordering practices and the verbal ordering practices that were observed. Therefore, opportunity exists for quality improvement. Further research is needed to determine why verbal orders are often inaudible or incomplete. Possible etiologies may include medical knowledge deficit (eg, a dose was not included in the verbal order because the resident physician did not know the correct dose), environmental factors (eg, orders were inaudible secondary to environmental noise), or the relative inexperience of the trauma captain compared to an attending physician. This study suggests that efforts should be multidisciplinary, as physicians in multiple residency training programs and nursing care team members all demonstrated ideal verbal ordering practices inconsistently. One such improvement effort may include in-situ multidisciplinary trauma simulation, which has been implemented at our institution following the data collection period of this study. Simulation has been effective in similar situations such as cardiopulmonary resuscitation using Advanced Cardiac Life Support and should be evaluated for effectiveness in trauma resuscitation improvement efforts as well.[16] Further research is also necessary in similar situations where emergencies exist such as in medical codes and in clinical practice environments where verbal orders are used such as in operating rooms.

Of note, little has been published on recommended order content during emergent resuscitations. While best practice recommendations exist regarding the use of verbal orders, these primarily state that a physician or other healthcare professional may use a verbal order when necessary to avoid significant delay in emergent care.[14] They do not specify order-content recommendations specific to the unique practice environment of an emergent resuscitation of a critically injured patient. Verbal

orders may occur with increased frequency during emergent resuscitations; however, many recommendations for order content do not apply in this setting. Further expert opinion and society guidelines are necessary to standardize best practices for verbal ordering during trauma resuscitations and critical medical resuscitations.

## LIMITATIONS

Given the observational nature of this study in an environment that can be busy and loud, it is possible that the audibility of verbal orders is under-reported. Likewise, it is possible that certain component parts of an order were present but not heard by the study team member collecting data. However, the team member collecting data was physically located right next to the recording trauma nurse, within five feet of the trauma captain. Therefore, any inability to hear orders would mirror that of the clinical care team. In this way, data accurately reflect the communication experienced by the care team. The number of patients and staff varied throughout the observation period, thus impacting audibility. However, variability in the number of patients and staff is a clinical challenge in all emergency care settings.

We used a convenience sample of verbal orders. Many more orders were recorded for medications, during trauma alerts, and during the care of male patients. No comparative statistics were used. Nonetheless, data demonstrated the lack of audible and complete verbal orders with closed-loop communication regardless of trauma acuity, the residency training program of the captain, or the sex of the patient.

Because this was a non-blinded observational study, one might question the impact of the Hawthorne effect on verbal order practices. However, the study was not broadly discussed or announced among clinical teams. Furthermore, data were collected by a non-ATLS trained medical student who was unfamiliar to the clinical team.

This study was conducted at an academic medical center and most of the enrolled verbal orders were given by residents. Therefore, the ordering physician was most often still acquiring the skills necessary to expertly resuscitate trauma patients. Verbal-order audibility and completeness may be present more frequently in a non-academic setting, where ordering physicians have completed residency training. While this limits the generalizability of our data to settings where attending physician-only teams resuscitate trauma patients, many tertiary care and Level 1 trauma centers are at academic medical centers, and the data are, therefore, applicable to many EDs in which trauma resuscitations are performed.

## CONCLUSION

Audible, complete verbal orders and closed-loop communication are underused during the multidisciplinary resuscitation of trauma patients in our ED. Findings were consistent regardless of the severity of trauma activation or the training program of the trauma captain. This represents a multidisciplinary QI opportunity wherever verbal orders are used. Future research is needed in other clinical practice environments where verbal orders are used, and after QI initiatives have been implemented.

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# Triage Temperature and Timeliness of Sepsis Interventions in a Pediatric Emergency Department

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**Introduction:** Fever as an indicator of infection is frequently used as an aid in triggering concern for sepsis in the emergency department (ED). Adults with sepsis presenting to the ED with a normal temperature have been shown to have delays in treatment and greater mortality. The association between temperature and timeliness of sepsis-related care in the ED remains poorly characterized in children. Our objective in this study was to measure the association between body temperature at the physiologic onset of sepsis and the time to initiation of antibiotic treatment and fluid bolus among children with clinically defined sepsis.

**Methods:** We conducted a retrospective, cohort study of pediatric patients with sepsis presenting to the ED. Data collected from an existing quality improvement database were supplemented via chart extraction. We assessed body temperature at physiologic onset of sepsis (PO-S), the date and time when a patient first met clinical criteria for sepsis as defined by Goldstein et al.[1] Our primary outcomes were time from PO-S and administration of antibiotics and fluid bolus. Secondary outcomes included maximum vasoactive-inotropic scores, need for extracorporeal membrane oxygenation (ECMO) within 30 days of presentation, presence and type of organ dysfunction, 30-day hospital- and intensive care unit (ICU)-free days, and mortality. We summarized and compared data by temperature group. Multivariable quantile regression was used to evaluate adjusted associations between body temperature and time to initiation of antibiotic treatment and fluid bolus.

**Results:** Of 928 patients screened, 385 (41%) met inclusion criteria. Median time to antibiotic treatment did not differ between temperature groups at PO-S—≤ 36.0 °C: median (IQR) 48.5, (41.3-104.8); 36.1-37.9 °C: median, 95.5, (41.3-104.8;), and ≥ 38.0 °C: median 84, 45-151; ($P$ = .24). Median time to fluid bolus administration also did not differ between temperature groups at PO-S—≤ 36.0 °C: median 39, (20.8-65.8); 36.1-37.9 °C: median, 42.5 (21.3-86.3); and ≥ 38.0 °C: median, 54 (29-84); ($P$ =.07). In addition, mortality differed by temperature at PO-S (≤ 36.0 °C: 1/22 (4.5%); 36.1-37.9 °C: 4/80 (5.0%); and ≥. 38.0 °C: 3/283 (1.1%), ($P$ = .04); as did organ dysfunction at 72 hours: ≤. 36.0 °C: 15/22 (68.2%); 36.1-37.9 °C: 43/80 (53.8%), ≥ 38.0 °C: 74/283 (26.1%); ($P$ < .001) and median (IQR) 30-day ICU- and hospital-free days—≤ 36.0 °C: median, 24, (20,-26.8); 36.1-37.9 °C: median, 28 (24.8-30), ≥ 38.0 °C: median, 30 (27-30), ($P$ < .001); and at ≤. 36.0°C: median, 22, (17-25); 36.1-37.9 °C: median, 24 (17.8-27); ≥ 38.0 °C: median, 25 (20, 27), ($P$ = .04), respectively. We did not observe an association between temperature and median time to antibiotic administration (β: 2.5, 95% CI, -4.2 to 9.1, $P$ = .50) or first fluid bolus administration (β: 1.7, 95% CI, -1.4 to 4.8, $P$ = .30).

**Conclusion:** Time to fluid bolus administration and time to antibiotic administration did not differ statistically by temperature from physiological onset of sepsis. Children presenting with hypothermia (≤ 36.0 °C) had worse outcomes. [West J Emerg Med. 2025;26(6)1719–1728.]

## INTRODUCTION

Sepsis, defined as a dysregulated host response to an infecting pathogen associated with life- threatening organ dysfunction, accounts for approximately 4,500 pediatric mortalities annually in the United States.[2] Pediatric mortality rates attributable to sepsis range from 4-25%, with many of those deaths occurring within the initial 48-72 hours of presentation.[3,4] The emergency department (ED) often serves as the first point of contact for septic children.[5] Timely intervention with early fluid resuscitation and antibiotic administration in the ED improves sepsis-related morbidity and mortality by up to 50%.[6] Previous studies have demonstrated that delayed therapy is associated with increased mortality and prolonged organ failure.[2,7–10] Accordingly, early recognition of sepsis is essential to timely clinical intervention.

In the setting of systemic infection, a host immune-mediated response results in the rising of the body temperature set point via the hypothalamus.[11] Hypothermia has also been shown to be associated with serious bacterial infections.[12] Sepsis screening tools use clinical data, including body temperature, to recognize patients at risk for sepsis and can improve the timeliness of subsequent clinical intervention.[13] Although no universally accepted sepsis-screening tool exists, an important data element common to pediatric recognition tools is the history of an abnormal temperature.[13] Research in adults with severe sepsis and septic shock has shown that elevated body temperature greater than 37 °C in the ED is associated with reduced time to antibiotic, but not fluid bolus administration, likely due to a heightened awareness of potential infection.[14]

The impact of normal or low body temperatures on the timeliness of sepsis care in the ED is less understood. Park et al showed that in comparison to adult septic patients presenting with hyperthermia, patients presenting with normothermia (36-38 °C) had more than twice the risk of in-hospital mortality and lower compliance with sepsis bundles.[15] The association between temperature at the presentation of illness and the administration of timely antibiotics and fluid boluses within recommended time frames remains poorly characterized. Accordingly, we aimed to investigate the association between body temperature at the physiologic onset of sepsis (PO-S) and timeliness to initiation of antibiotics and fluid bolus in children presenting to the ED with clinically suspected sepsis. We hypothesized that body temperature is associated with both the time to initiation of antibiotics and administration of first fluid bolus.

*Population Health Research Capsule*

What do we already know about this issue?
*Fever triggers concern for sepsis. Adults with sepsis presenting with normothermia have been shown to have delays in treatment and greater mortality.*

What was the research question?
*Is there an association between body temperature and time to sepsis treatment for children presenting to the emergency department?*

What was the major finding of the study?
*There was no association between temperature and time to antibiotic (CI, -4.1 to 9.1, P =.50) or fluid bolus (CI, -1.4 to 4.8, P =.30).*

How does this improve population health?
*Body temperature should be used in conjunction with other clinical signs of sepsis to promptly treat children in the ED.*

## METHODS

### Study Population and Design

We conducted a single-center, retrospective cohort study of pediatric patients 0-21 years of age with clinically defined sepsis who presented to the ED from January 1, 2017–February 28, 2021. Our ED is located within a 259-bed quaternary-care, freestanding children's hospital with an annual volume of approximately 30,000 visits per year. We extracted data from an existing institutional quality improvement database of patients with sepsis who contributed data to the Children's Hospital Association Improving Pediatric Sepsis Outcomes (IPSO) Collaborative.[16] The IPSO Collaborative is a multi-institutional quality improvement initiative with the intent to reduce sepsis-related mortality and improve patient outcomes through early identification and intervention. Additional supplemental data specific to our study were extracted from our local electronic health record. We included patients meeting at least one operational definition of sepsis using the IPSO intention-to-treat algorithm in the institutional database.[17]

Patients were considered to have sepsis if the patient received an intravenous antibiotic, ≥ 2 fluid boluses (or one fluid bolus plus initiation of a pressor) within six hours of presentation and a blood culture was obtained within 72 hours of presentation, plus at least one of the following: documentation of *International Classification of Diseases, 10th Rev*, codes (ICD-10) for sepsis (R65.20/R65.21); positive institutional sepsis screen; use of institutional septic shock order set; intensive care unit (ICU) admission; or documentation of sepsis-related ICD-10 codes (A02.1, A20.7, A21.7, A22.7, A24.1, A26.7, A32.7, A39.2-4, A40.0-3,

A40.8-9, A41.01-2, A41.1-4, A41.50-3, A41.59, A41.81, A41.89, A41.9, A42.7, A54.86, B00.7, B37.7). We excluded patients who were originally treated at an outside facility or were not treated within the ED. Additional patients were excluded if they had missing data on body temperature at triage or timing of medical intervention (fluid bolus and/or antibiotic administration). This study was approved by our Institutional Review Board (IRB 00287405). We followed criteria 1-5, 9-12 from Methods of Medical Record Review Studies in Emergency Medicine Research. The abstractor was not blinded to the hypothesis but was blinded to the outcome.[18]

**Exposure Measurements**

The primary study exposure was body temperature in degrees Celsius at time of patient's PO-S. During this study, our organization was involved in the IPSO C-ollaborative where an alert occurred when a child met criteria for concern for sepsis if ≥ 3 physiologic criteria associated with sepsis occurred. The time the concern for sepsis occurred was consider the physiological onset of sepsis if the alert led to obtaining a blood culture and initiating intravenous antibiotics, and if at least two fluid boluses (or fluid bolus with initiation of vasopressor) were given.[1,16]

**Outcome Ascertainment**

The first primary outcome was the difference in minutes between PO-S and administration of antibiotics. The second primary outcome was the time to administration of first fluid bolus. Secondary outcomes included maximum vasoactive-inotropic scores,[19] need for extracorporeal membrane oxygenation (ECMO) within 30 days of presentation, presence and type of organ dysfunction, 30-day hospital and intensive care unit (ICU)-free days, and mortality. We defined 30-day ICU- and hospital-free days as the number of days within the first 30 days after admission that a patient was alive and not admitted to either the hospital or ICU. We calculated this composite measure of both mortality and duration of hospitalization, as opposed to length of stay, to eliminate bias of early mortality.

**Covariate Measurements**

Data on patient clinical characteristics included source of infection (as determined by positive culture or as described in the discharge summary), comorbidities that may place a child at a higher risk of infection (malignancy, asplenia, bone marrow or solid organ transplant, immunocompromise, technology dependent), presence of a central venous catheter, vasoactive agent initiation (where applicable), duration of hospitalization, and disposition. We calculated vasoactive-inotropic scores based on the medical administration record in the EHR. Additional data manually extracted from the EHR included patient demographics, medical comorbidities, and laboratory values (white blood cell count, C-reactive protein, erythrocyte sedimentation rate, and lactate).

**Statistical Analyses**

For descriptive purposes, we categorized temperature as ≤ 36.0 °C, 36.1-37.9 °C, and ≥ 38.0°C. Patient demographic and clinical characteristics were summarized across body temperature groups at PO-S with medians and interquartile ranges, and frequencies and percentages for quantitative and categorical variables, respectively. We compared data across temperature groups using Kruskal-Wallis tests for quantitative variables and chi-square or Fisher exact test for categorical variables, as appropriate. When significant differences (< .05) across groups were observed with the omnibus test, we performed post-hoc pairwise analyses with a Bonferroni correction. Density and Q-Q plots suggested skewedness and non-constant variance in the outcomes across body temperature. Given these considerations and the a priori hypothesis asserting an inverted "U"-shaped association between the primary exposure and outcomes, multivariable quantile linear regression models with robust standard errors were fitted to evaluate the adjusted relationship between body temperature at PO-S and time to treatment with either antibiotic and/or fluid bolus at the 10th, 25th, 50th, 75th and 90th percentiles. For multivariable modeling, we analyzed temperature as a continuous variable. Beta coefficients were calculated and reported along with corresponding robust standard errors.

We adjusted models for sex at birth, age, race and ethnicity, number of medical comorbidities (0, 1, ≥. 2), and sepsis screening score (< 3, ≥ 3). Sepsis scores ≥ 3 indicate the patient may be at risk for sepsis with triggering of sepsis-specific bundle care. Sepsis scores, although containing body temperature, were controlled for because clinician intervention may have been secondary to elevated scores even in the absence of fever. We considered two-sided *P*-values < .05 statistically significant. With a given sample size of 385 patients and an α level of .05, the study had 90% power to detect a medium effect size using multivariable quantile regression modeling the association between temperature and primary outcomes with adjustment for seven additional covariates. Analyses were performed with Stata/SE v17.1 (StataCorp, LLC, College Station, TX), and we calculated power estimates with PASS Power Analysis and Sample Size software v16 2018 (NCSS, LLC, Kaysville, UT).

## RESULTS

**Patient Population**

Of 928 patients we assessed for eligibility within the quality improvement database, 543 patients were ineligible or excluded. Overall, 385 patients were included in the final analysis (Figure 1). Demographic and clinical characteristics according to patient body temperature at PO-S are summarized in Table 1. Twenty-two patients (5.7%) had body temperatures ≤ 36.0 °C, while eight (20.8%) had temperatures 36.1-37.9 °C, and 283 (73.5%) had temperatures ≥ 38.0 °C. The distribution of oncologic comorbidities differed

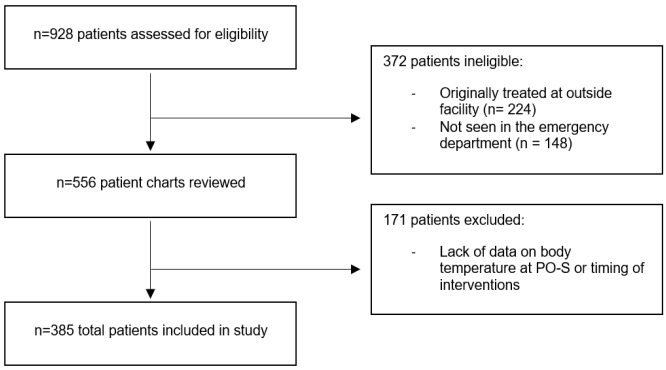


**Figure 1.** CONSORT diagram of patient inclusion in a study of the association of body temperature at physiologic onset of sepsis and timeliness of sepsis-related interventions.
*PO-S*, physiologic onset of sepsis.

statistically by temperature group ($P = .03$). Patients with body temperature of 36.1-37.9 °C had the highest proportion of oncologic comorbidities, whereas zero patients with lower body temperatures of ≤ 36.0 °C had an oncologic comorbidity. No statistical differences were observed in the distribution of sex, race, ethnicity, or high-risk conditions.

### Sepsis Treatment-related Outcomes

There were no statistical differences in time to antibiotic treatment or time to fluid bolus administration by temperature group as seen in Table 2. In comparison to patients with higher body temperatures, patients with temperature ≤ 36.0 °C had higher mortality rates ($P = .04$), fewer 30-day ICU-free days ($P <.001$), fewer 30- day hospital-free days ($P = .04$), higher proportions of organ dysfunction at 72 hours ($P < .001$), respiratory dysfunction ($P = < .01$), higher proportions of vasoactive agent use within 24 hours ($P = <.01$), and ECMO ($P = .02$) within 30 days of PO-S (Figure 2).

### Multivariable Analyses

In multivariable models measuring the association between body temperature at PO-S and time to antibiotic and time to fluid bolus, there was no detectable association between the temperature group and either outcome (Tables 3, 4). However, faster administration of both antibiotic and fluid bolus was seen with patients who had medical comorbidities and elevated sepsis scores. No other significant associations were observed for either primary outcome.

## DISCUSSION

In our study of children presenting to a pediatric ED receiving sepsis-specific care, body temperature at PO-S was not associated with time to initiation of antibiotic treatment or time to initiation of fluid resuscitation. Additionally, patients with triage temperature ≤ 36.0 ºC more often received vasoactive agents or ECMO and experienced more frequent end-organ dysfunction and mortality. The influence of temperature at PO-S and timeliness to intervention remains unclear.

Providing timely, bundled sepsis care inclusive of prompt fluid resuscitation, blood culture acquisition, and administration of antibiotics in the ED decreases sepsis-related morbidity and mortality.[20–22] Because provision of the entire bundle appears necessary for improvement in outcomes, there is a call for quality-based efforts that use targeted interventions focused on standardized recognition algorithms and team-based strategies to deliver life-saving care.[7,23] Many sepsis recognition algorithms focus on the presence of an abnormal temperature as a non-specific indicator for potential sepsis. Fever is a common presenting symptom for children in the ED (the vast majority of whom do not have clinical sepsis), and the absence of an abnormal temperature may influence the timeliness of delivery of bundled sepsis care.

We detected no clinically relevant differences between body temperature at PO-S and time to initiation of antibiotics or fluid bolus. This contrasts with previous studies that showed normothermia in the setting of sepsis within the adult population was associated with lower compliance with timely sepsis interventions and higher rates of mortality.[14,15] While fever is a common presenting symptom in EDs for pediatrics, it is far less common among adults.[24] This difference in populations, may, in part, contribute to the timeliness of interventions, as the clinical suspicion for serious infection may be greater among adults presenting with fever.

As opposed to temperature at PO-S, we identified several other factors associated with timeliness of sepsis care. An elevated institutional sepsis screening score or having medical comorbidities was associated with more timely administration for both antibiotics and fluid bolus. At our institution, a patient with a sepsis score ≥ 3 triggers a multidisciplinary, sepsis-specific response including physician notification through the electronic health record. This is intended to prompt timely management of sepsis using care bundles. Children with ≥ 1 comorbidity are at higher risk for mortality secondary to sepsis and may prompt physicians to intervene sooner.[25] In addition, our institution has a clinical practice guideline guiding antibiotic administration and acquisition of a blood culture within one hour for children presenting with fever and who have a history of bone marrow transplant without full engraftment and recovery or ongoing oncologic treatment. In these scenarios, it is likely that clinical context and institutional care pathways have a greater impact on timeliness of sepsis interventions than temperature alone.

In our study, we intentionally evaluated for disparities in timeliness of sepsis care between racial and ethnic groups. In other settings and conditions, Black patients are at higher risk of receiving a less urgent triage score, Black and Hispanic children are less likely to receive diagnostic imaging in the ED, and Black children are less likely to receive analgesia in the setting of appendicitis.[26-28] Prior studies have suggested

**Table 1.** Demographic and clinical characteristics of patients by body temperature at physiologic onset of sepsis presenting to a pediatric emergency department in a study of the association of temperature and timeliness of sepsis-related interventions.

| | ≤ 36.0 °C (n=22) | 36.1-37.9 °C (n=80) | ≥ 38.0 °C (n=283) | P- value |
|---|---|---|---|---|
| Sex at Birth, n (%) | | | | |
| Female | 9 (40.9) | 40 (50.0) | 130 (45.9) | .70 |
| Race, n (%) | | | | |
| White | 15 (68.2) | 49 (61.3) | 168 (59.4) | .97 |
| Black | 5 (22.7) | 16 (20.0) | 65 (23.0) | |
| Asian-American | 0 (0.0) | 1 (1.3) | 5 (1.8) | |
| American Indian/Alaska Native | 0 (0.0) | 0 (0.0) | 2 (0.7) | |
| Multiracial | 1 (4.5) | 1 (1.3) | 7 (2.5) | |
| Unknown | 1 (4.5) | 13 (16.3) | 36 (12.7) | |
| Ethnicity, n(%) | | | | |
| Hispanic/Latino | 19 (86.4) | 63 (78.8) | 222 (78.4) | .87 |
| Non-Hispanic/Latino | 3 (13.6) | 14 (17.5) | 54 (19.1) | |
| Unknown | 0 (0.0) | 3 (3.8) | 7 (2.5) | |
| High-risk Conditions Present, n (%) | | | | |
| Malignancy | 0 (0.0) | 14 (17.5) | 28 (9.9) | .03 |
| Asplenia | 0 (0.0) | 5 (6.3) | 14 (4.9) | .63 |
| BMT | 0 (0.0) | 4 (5.0) | 7 (2.5) | .35 |
| Indwelling line/catheter | 2 (9.1) | 15 (18.8) | 50 (17.7) | .62 |
| Solid organ transplant | 1 (4.5) | 7 (8.8) | 17 (6.0) | .70 |
| Severe intellectual disability | 7 (31.8) | 20 (25.0) | 77 (27.2) | .81 |
| Immunocompromised | 15 (68.2) | 54 (67.5) | 188 (66.4) | .97 |
| Technology dependent | 7 (31.8) | 26 (32.5) | 92 (32.5) | >.99 |
| ≥ 2 High-risk Conditions | 7 (31.8) | 39 (48.8) | 127 (44.9) | .37 |
| Severe Sepsis Selection Criteria, n (%) | | | | |
| Positive sepsis screen (with treatment) | 12 (54.5) | 19 (23.8) | 160 (56.5) | <.001 |
| Positive huddle for severe sepsis | 0 (0.0) | 0 (0.0) | 1 (0.4) | |
| Severe sepsis order set used (with treatment) | 3 (13.6) | 5 (6.3) | 7 (2.5) | |
| ICU admission (with treatment | 6 (27.3) | 20 (25.0) | 33 (11.7) | |
| Lactate (with treatment) | 0 (0.0) | 3 (3.8) | 15 (5.3) | |
| Standalone ICD codes | 1 (4.5) | 3 (3.8) | 5 (1.8) | |
| Other sepsis ICD-10 (with treatment) | 0 (0.0) | 30 (37.5) | 62 (21.9) | |
| Organ System with Known Comorbidity, n(%) | | | | |
| No comorbidities | 11 (50.0) | 24 (30.0) | 102 (36.0) | .21 |
| Neurologic | 9 (40.9) | 20 (25.0) | 77 (27.2) | .32 |
| Cardiovascular | 1 (4.5) | 7 (8.8) | 17 (6.0) | .70 |
| Pulmonary | 7 (31.8) | 17 (21.3) | 57 (20.1) | .44 |
| Gastrointestinal | 9 (40.9) | 25 (31.3) | 93 (32.9) | .74 |
| Nephrological | 2 (9.1) | 5 (6.3) | 27 (9.5) | .72 |
| Rheumatologic | 0 (0.0) | 1 (1.3) | 5 (1.8) | > .99 |
| Endocrinologic | 0 (0.0) | 4 (5.0) | 23 (8.1) | .36 |
| Other | 0 (0.0) | 7 (8.8) | 15 (5.3) | .30 |
| Multiple Comorbidities | 9 (40.9) | 34 (42.5) | 105 (37.1) | .83 |

**Table 1.** Continued

| | ≤ 36.0 °C (n=22) | 36.1-37.9 °C (n=80) | ≥ 38.0 °C (n=283) | P- value |
|---|---|---|---|---|
| Source of Infection, n (%) | | | | |
| No infection source identified | 19 (86.4) | 61 (76.3) | 224 (79.2) | .74 |
| Pulmonary | 13 (59.1) | 29 (36.3) | 120 (42.4) | .19 |
| Urinary | 2 (9.1) | 7 (8.8) | 38 (13.4) | .50 |
| Skin and soft tissue | 0 (0.0) | 6 (7.5) | 18 (6.4) | .52 |
| Catheter-associated | 1 (4.5) | 4 (5.0) | 20 (7.1) | .87 |
| Bacteremia without specific site | 1 (4.5) | 3 (3.8) | 3 (1.1) | .12 |
| Meningitis | 0 (0.0) | 1 (1.3) | 14 (4.9) | .25 |
| Other | 0 (0.0) | 3 (3.8) | 11 (3.9) | >.99 |

*Percentages may not add to exactly 100% due to rounding.*
*BMT, bone marrow transplant; ICD-10,* International Classification of Diseases, 10th Rev; *ICU*, intensive care unit.

**Table 2.** Sepsis treatment-related outcomes by body temperature at physiologic onset of sepsis of patients presenting to a pediatric emergency department in a study of the association of temperature and timeliness of sepsis-related interventions.

| | ≤36.0 °C n=22 | 36.1-37.9 °C n=80 | ≥ 38.0 °C n=283 | *P*-value | ≤ 36.0 °C vs 36.1-37.9 °C Adjusted *P*-value[2] | ≤36.0 °C vs ≥ 38.0 °C Adjusted *P*-value[2] | ≥ 38.0 °C vs 36.1-37.9 °C Adjusted *P*-value[2] |
|---|---|---|---|---|---|---|---|
| Time to antibiotic treatment (minutes), median [IQR] | 48.5 [41.3, 104.8] | 95.5 [41.3, 104.8] | 84 [46, 151] | .24 | .39 | .39 | >.99 |
| Time to first fluid bolus (minutes), median [IQR][1] | 39.0 [20.8, 65.8] | 42.5 [21.3, 86.3] | 54.0 [29, 84] | .07 | >.99 | .24 | .27 |
| Vasoactive agent within 24 hours, n (%) | 6 (27.3) | 12 (15.0) | 23 (8.1) | <.01 | .54 | .01 | .20 |
| ECMO within 30 days, n (%) | 1 (4.5) | 2 (2.5) | 0 (0) | .02 | >.99 | <.001 | .02 |
| Blood culture positive, n (%) | 4 (18.2) | 9 (11.3) | 41 (14.5) | .62 | >.99 | >.99 | >.99 |
| Urine culture positive, n (%) | 2 (9.1) | 8 (10.0) | 28 (9.9) | .95 | >.99 | >.99 | >.99 |
| CSF culture positive, n (%) | 0 (0) | 1 (1.3) | 8 (2.8) | >.99 | - | - | >.99 |
| Organ dysfunction within 72 hours, n (%) | 15 (68.2) | 43 (53.8) | 74 (26.1) | <.001 | .68 | <.001 | <.001 |
| Cardiovascular dysfunction | 5 (22.7) | 15 (18.8) | 31 (11.0) | .68 | >.99 | >.99 | >.99 |
| Respiratory dysfunction | 12 (54.5) | 19 (23.8) | 23 (8.1) | <.01 | .25 | <.01 | .48 |
| Neurological dysfunction | 0 (0) | 1 (1.3) | 4 (1.4) | .81 | - | - | >.99 |
| Hematologic dysfunction | 4 (18.2) | 10 (12.5) | 13 (4.6) | .57 | >.99 | >.99 | >.99 |
| Renal dysfunction | 5 (22.7) | 3 (3.8) | 12 (4.2) | .05 | >.99 | .72 | >.99 |
| Hepatic dysfunction | 8 (36.4) | 24 (30.0) | 36 (12.7) | .75 | >.99 | .32 | .29 |
| Multiple organ dysfunction | 9 (40.9) | 18 (22.5) | 24 (8.5) | .12 | .96 | .09 | .60 |
| Mortality, n (%) | 1 (4.5) | 4 (5.0) | 3 (1.1) | .04 | >.99 | .50 | .07 |
| ICU-free days, median [IQR][1] | 24.0 [20, 26.8] | 28.0 [24.8, 30] | 30.0 [27, 30.0] | <.001 | <.01 | <.001 | .02 |
| Hospital-free days, median [IQR][1] | 22.0 [17, 25] | 24.0 [17.8, 27] | 25.0 [20, 27] | .04 | >.99 | .12 | .27 |

[1] IQR is reported as [25th percentile, 75th percentile]
[2] A Bonferroni correction was applied to account for multiple comparisons between groups.
*CSF*, cerebrospinal fluid; *ECMO*, extracorporeal membrane oxygenation; *ICU*, intensive care unit.

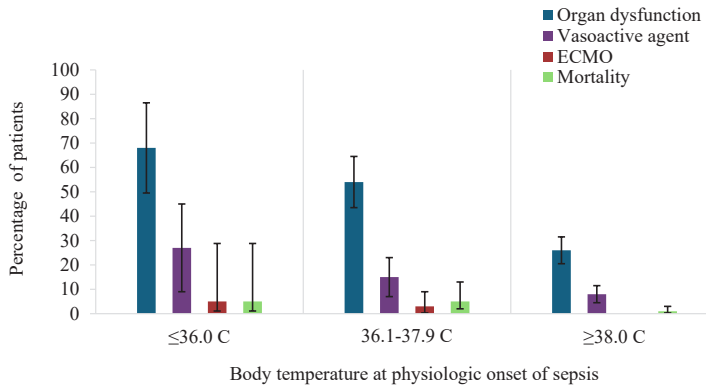


**Figure 2.** Sepsis-related outcomes stratified by body temperature categories of patients presenting to a pediatric emergency department in a study of the association of temperature and timeliness of sepsis-related interventions. The frequency of each outcome differed between temperature groups (*P* < .05 for all). *ECMO*, extracorporeal membrane oxygenation.

that implementation of electronic alerts and clinical pathways may reduce racial differences.[29,30] Although not a primary explanatory variable, we did not detect an association between race or ethnicity and timeliness to sepsis interventions. Nonetheless, future studies involving the careful and deliberate evaluation of the impact of systemic and implicit biases on the timeliness of sepsis-related care for under-represented and marginalized groups are essential.

We also investigated whether clinically relevant outcomes monitored by the IPSO Collaborative differed between temperature groups. The prevalence of patients requiring vasoactive agents within 24 hours, use of ECMO within 30 days, and development of end-organ dysfunction within 72 hours differed between temperature groups and were more common in those presenting with temperatures ≤ 36.0 °C. Similarly, 30-day ICU-free days and mortality differed between groups, with hypothermic patients having fewer ICU-free days and higher mortality compared to those with

**Table 3**. Adjusted association between temperature at physiologic onset of sepsis and time to antibiotic administration of patients presenting to a pediatric emergency department in a study of the association of temperature and timeliness of sepsis-related interventions.

| N = 385 | β Coefficient | 95% CI | *P*-value |
|---|---|---|---|
| Temperature at PO-S (◦C) | 2.5 | -4.2 to 9.1 | .50 |
| Sex at Birth | | | |
| Female | Ref. | | |
| Male | -15.3 | -34.6 to 3.9 | .10 |
| Age (years) | 0.1 | -1.4 to 1.7 | .90 |
| Ethnicity | | | |
| Hispanic/Latino | -17.1 | -46.3 to 12.1 | .30 |
| Non-Hispanic/Latino | Ref. | | |
| Unknown | -10.7 | -73.1 to 51.7 | .70 |
| Race | | | |
| AIAN/Asian/Native Hawaiian/Pacific Islander/Multiracial | -17.6 | -65.2 to 30.0 | .50 |
| Black | -12.0 | -36.5 to 12.6 | .30 |
| Unknown | -5.1 | -38.2 to 28.0 | .80 |
| White | Ref. | | |
| Sepsis Score | | | |
| < 3 | Ref. | | |
| ≥ 3 | -57.3 | -82.0 to -32.6 | <.001 |
| Not Reported | -28.8 | -56.4 to -1.3 | .04 |
| Hypotension | | | |
| Hypotension within 15 minutes of triage | -2.8 | -35.8 to 30.2 | .90 |
| Medical Comorbidities | | | |
| None | Ref. | | |
| 1 | -53.0 | -78.1 to -27.9 | <.001 |
| ≥ 2 | -26.7 | -51.5 to -1.9 | .04 |

*AIAN,* American Indian and Alaska Native*; PO-S,* physiologic onset of sepsis*; Ref,* reference variable

**Table** 4. Adjusted association between temperature at physiologic onset of sepsis and time to first fluid bolus of patients presenting to a pediatric emergency department in a study of the association of temperature and timeliness of sepsis-related interventions.

| N = 385 | β Coefficient | 95% CI | P-value |
|---|---|---|---|
| Temperature at PO-S (◦C) | 1.7 | -1.4 to 4.8 | .30 |
| Sex at Birth | | | |
| Female | Ref. | | |
| Male | -9.3 | -18.2 to -0.3 | .04 |
| Age (years) | -0.2 | -0.9 to 0.5 | .60 |
| Ethnicity | | | |
| Hispanic/Latino | -4.3 | -17.9 to 9.2 | .50 |
| Non-Hispanic/Latino | Ref. | | |
| Unknown | 4.6 | -24.4 to 33.6 | .80 |
| Race | | | |
| AIAN/Asian/Native Hawaiian/Pacific Islander/Multiracial | 3.9 | -18.2 to 26.0 | .70 |
| Black | 1.0 | -10.4 to 12.4 | .90 |
| Unknown | 2.5 | -12.9 to 18.0 | .70 |
| White | Ref. | | |
| Sepsis Score | | | |
| < 3 | Ref. | | |
| ≥ 3 | -13.5 | -25.0 to -2.0 | .02 |
| Not Reported | -18.9 | -31.7 to -6.1 | <.01 |
| Hypotension | | | |
| Hypotension within 15 minutes of triage | -15.3 | -30.7 to 0.03 | .05 |
| Medical Comorbidities | | | |
| None | Ref. | | |
| 1 | -22.9 | -34.6 to -11.3 | <.001 |
| ≥ 2 | -11.1 | -22.6 to 0.5 | .06 |

*AIAN,* American Indian and Alaska Native; *PO-S*, physiologic onset of sepsis; *Ref,* reference variable

normal or elevated temperatures. Our results are consistent with other studies suggesting association between hypothermia and worse outcomes in the setting of critical illness. Previously, hypothermia has been associated with increased mortality in both children and adults with sepsis.[31–35] In other studies, hypothermia within 24 hours of sepsis diagnosis was associated with immune dysfunction as well as increased incidence of organ failure and disseminated intravascular coagulation.[36-37]

## LIMITATIONS

This study had several limitations. Due to its retrospective nature, we were unable to establish a causal association between temperature at PO-S and sepsis intervention and clinical outcomes. During the time in which our data was collected, our institution was involved in QI initiatives to improve sepsis care and, therefore, results may be biased and not reflective of all centers caring for children presenting with possible sepsis. It is possible sepsis was more quickly recognized and with prompter initiation of treatment secondary to the initiative. Additionally, with the primary predictor as temperature category and with such a small number of hypothermic patients, the study is underpowered to attempt to understand why patients with hypothermia did not receive more timely care. One theory is that with aggressive sepsis management processes linked to fever, in the absence of fever, clinicians may be focused on managing hypothermia and less on achieving timely intervention with the concern for sepsis. In addition, we conducted a secondary analysis of an existing database and, therefore, we were limited to the definitions, including sepsis and PO-S, defined previously by its creators.

We were also limited to the information in the EHR for identification of PO-S, which may have resulted in misclassification of cases with sepsis or exclusion of patients that should have ultimately been included. All patients in this study were included based on an intention to treat sepsis; however, not all patients were ultimately found to have an

identifiable bacterial source. In our population, 14% of patients had a positive blood culture, 10% had a positive urine culture, and 2% had a positive cerebrospinal fluid culture. Because the data were collected from a single center with local institutional practices regarding bundled sepsis care, including the use of sepsis scoring triggering prompt action, the generalizability of our findings may be limited.

Furthermore, there may be additional confounders that would influence the timeliness of sepsis care such as ED patient volumes as well as individual clinician characteristics such as years of experience and tendencies to recognize and treat patients with suspected sepsis. As there is no validated severity of illness score for children in the ED, we could not reliably control for severity of illness that may have influenced both timeliness of care or secondary outcomes. However, we did include markers of severity such as hypotension on arrival that are a surrogate for shock and risk for greater severity of illness. Finally, body temperature was likely obtained via a variety of methods, and this was not standardized or recorded consistently, which may result in misclassification of patients regarding temperature at PO-S.

## CONCLUSION

No significant association between body temperature at PO-S and time to initiation of antibiotic treatment or fluid bolus was detected. Worse outcomes were observed among pediatric patients presenting with hypothermia (≤ 36.0 °C), but faster intervention among this group was not seen, highlighting a need for an improved clinical approach. Abnormal body temperature alone was not associated with faster intervention. However, patients with elevated sepsis scores, which include body temperature, received faster administration of both fluid bolus and antibiotics, suggesting that temperature is an important clinical factor that should be used in conjunction with other signs of sepsis. Further studies are needed to understand the influence of body temperature at time of triage on timeliness of sepsis related interventions.

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# Differences in Admission Rates of Children with Pneumonia Between Pediatric and Community Emergency Departments

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**Introduction**: Pneumonia is the most common cause of pediatric death worldwide. We sought to determine whether the rate of hospital admission of pediatric patients diagnosed with pneumonia at a dedicated pediatric -emergency department (PED) is different than the rate at a community emergency department (CED). This comparison may provide insight into decision-making and factors associated with admission.

**Methods**: In this retrospective cohort study we reviewed patient records from January 1, 2017–December 31, 2019 for pediatric patients diagnosed with pneumonia. We excluded patients who were not prescribed antibiotics, those who did not receive a chest radiograph or had no radiologic signs of pneumonia. In addition, we excluded patients with comorbid conditions such as tracheostomy, supplemental oxygen requirement at baseline, chronic lung disease other than asthma or reactive airway disease, any cancer diagnosis, cystic fibrosis, or congenital heart disease. The primary outcome was the proportion of pneumonia diagnoses that resulted in admission from the PED vs CED. We used logistic regression analyses to evaluate which clinical factors were associated with hospital admission. Significance levels were determined by chi-square test or the Fisher exact test and Cochran-Mantel-Haenszel statistic.

**Results**: We identified 400 pediatric patients with pneumonia, 182 from the PED and 218 from the CED. There was a significant difference in admission rates between the two hospitals: 53 of 182 patients in the PED were admitted (29.1%) vs 27 of 218 patients in the CED (12.4%, $P < .001$). Patients in the PED were, therefore, 2.35 times more likely to be admitted than those at the CED (odds ratio 5.1, 95% CI, 2.5-10.4). Patients presenting to the PED were more likely to arrive via ambulance (10.7% vs 3.1%, $P = .04$) and to be hypoxic upon arrival (13.2% vs 3.2%, $P < .001$). The median age of patients in the PED was significantly higher than the CED (6.0 years vs 2.0 years, $P < .001$). A significantly greater proportion of patients in the CED identified as Hispanic or Latino (68.6% vs 20.3%, $P < .001$). Patients in the CED were more likely to be insured (11.0% vs 19.9%, P = .01). There was no significant difference in immunization status between the two groups.

**Conclusion**: Patients presenting to a dedicated pediatric ED had a higher admission rate than did those at a community ED. Patients in the PED were more likely to arrive by ambulance and less likely to have active health insurance coverage. Patients at the PED were more likely to be hypoxic than patients at the CED. These findings highlight important practice differences between PEDs and CEDs that may inform strategies to improve patient outcomes, reduce costs, and promote more effective, evidence-based care. Future studies should further investigate the drivers of these variations and evaluate targeted interventions to optimize care across settings. [West J Emerg Med. 2025;26(6)1729–1737.]

## INTRODUCTION

Each year, over 100,000 children in the United States are hospitalized due to pneumonia.[1,2] This accounts for 1-4% of all emergency department (ED) visits.[3,4] The Pediatric Infectious Disease Society recommends that patients with moderate to severe community-acquired pneumonia (evidenced by tachypnea, clinical signs of dyspnea, altered mental statu,s or hypoxemia with pulse oximetry measurement < 90%) be admitted for inpatient treatment. Additional recommendations include that any patient < 3 months of age with suspected bacterial pneumonia, any child with suspected community-associated methicillin-resistant pneumonia, or children for whom there is concern about careful observation or therapy adherence at home be admitted.[5]

Various factors influence the risk of infection. Infants and children < 5 years of age are at heightened risk due to their developing immune systems and smaller airways, which are more susceptible to obstruction. Children with underlying health conditions such as chronic respiratory diseases, immunocompromised states, and cardiovascular or neuromuscular disorders are at increased risk as well. Exposure to second-hand smoke, air pollution, and crowded living conditions, such as in daycare settings, significantly raises the likelihood of pneumonia infection and subsequent hospital admission. Malnutrition and vitamin deficiencies can weaken immune function. Children who are not fully vaccinated against pathogens like *Streptococcus pneumoniae*, *Haemophilus influenzae*, and the influenza virus are particularly vulnerable.[6] The interaction between host factors and the pathogen, including genetic predispositions and the type of infecting organism, further influences the severity of pneumonia.

Socioeconomic factors also contribute, as children from lower income backgrounds may face barriers to healthcare and encounter poorer living conditions. Racial and ethnic disparities exist in pneumonia treatment and outcomes. Non-Hispanic Black children have been reported to experience higher rates of pneumonia-related complications compared to non-Hispanic White children.[7] Understanding these multifaceted risk factors impacting the disease process and likelihood of admission is crucial in guiding preventive strategies, such as vaccination, reducing environmental exposures, and improving healthcare access to mitigate the burden of pediatric pneumonia.

No previous studies have been performed comparing admission rates specifically for pediatric pneumonia between community EDs (CED) and pediatric EDs (PED), although previous researchers have compared pediatric cohorts in tertiary-care centers vs CEDs for conditions other than pneumonia (eg, migraines).[8] A CED primarily focuses on providing immediate medical care for a wide range of medical concerns for adults and children within a specific geographic area, while the PED specializes in treating children with acute illnesses and injuries, often within a larger academic medical center that emphasizes research and teaching. Bourgeois et al identified significant variation—up to threefold—in hospital-level admission rates for pediatric pneumonia at pediatric tertiary-care hospitals across the US, highlighting the need for greater standardization of admissions decisions.[9] If such wide differences were found to exist between tertiary-care centers, it is likely that similar gaps exist between community and tertiary-care centers.

*Population Health Research Capsule*

What do we already know about this issue?
*There is significant variation in hospital admission rates for pneumonia patients at pediatric tertiary-care hospitals.*

What was the research question?
*Is the rate of hospital admission of pediatric patients with pneumonia different at a pediatric emergency department (PED) vs a community emergency department (CED)?*

What was the major finding of the study?
*Among pediatric patients with pneumonia, admission rates were significantly higher in PEDs compared to CEDs (29.1% vs 12.4%; CI, 2.5-10.4).*

How does this improve population health?
*Understanding these dynamics can potentially reduce unnecessary hospitalizations at both PEDs and CEDs while ensuring that more severe cases receive the necessary care.*

## AIMS AND OBJECTIVES

In this study we sought to determine whether the rate of hospital admission of pediatric patients diagnosed with pneumonia at a dedicated PED was different than the rate at a CED. Emergency physicians at PEDs may be more comfortable with or experienced in managing pediatric pneumonia, due to increased volume and higher rates of pediatric fellowship-trained physicians relative to their CED counterparts. As a result, these pediatric emergency physicians may have greater confidence in discharging patients home rather than admitting. However, because of their status as a pediatric center, PEDs may receive

proportionally sicker patients, inflating the admission rate. We compared data from a PED and a CED to analyze differences in admission, excluding patients with pre-existing immunodeficiencies or lung diseases to control for selection bias of patients' families toward a tertiary-care center. We hypothesized that the proportion of pediatric patients with pneumonia admitted to the hospital would be significantly lower at the PED than at the CED.

## METHODS

The PED in this study is a Level I pediatric trauma center with a children's hospital offering specialized pediatric emergency care. The PED, which serves both rural and urban communities, is 15 minutes from a major city. This center is staffed by board-certified pediatric emergency physicians. In 2023, the PED managed 24,236 patient visits, while the adult ED in the same institution handled 55,319 visits. The CED is a 204-bed acute care hospital serving a suburban community. It is staffed by board-certified emergency physicians. The center, which does not have a dedicated pediatric ED or trauma center designation, sees approximately 36,170 adult and pediatric patients annually.

In conducting this study, we referenced the framework for retrospective chart review in emergency medicine research outlined by Worster and Bledsoe. We included the following elements: abstractor training; case selection criteria; variable definition; abstraction forms; medical record identification; and institutional review board approval.[10] Abstractors were not blinded to the study hypothesis, as the main data abstractor was also responsible for the study design. Additionally, we did not formally assess inter-rater reliability, as most of the data collection was performed by a single individual. In this retrospective cohort study we used patient charts over the period of January 1, 2017–December 31, 2019. This time frame was selected as it was the most current data available at the time of project initiation and was prior to the start of the COVID-19 pandemic, which would have introduced a variety of confounding factors for analysis.

To be included in the study, a patient must have been < 18 years of age at the time of the ED visit and diagnosed with pneumonia (*International Classification of Diseases, 10th Modification* codes J12-J18) by chest radiograph (CXR). The CXRs were interpreted by radiologists to be suggestive of pneumonia if they showed consolidation, patchy infiltrates, atelectasis, or were otherwise determined by the radiologist to be suggestive of pneumonia. We reviewed the finalized impression summary and extracted key words, which were a part of the analysis. We excluded patients who were not prescribed antibiotics, did not receive a CXR or if they received a CXR without radiographic signs of pneumonia. We also excluded any patient with pre-existing conditions impacting lung function or immune response to control for bias for patients who were likely to become more ill from a pneumonia infection to present to the higher acuity center and, subsequently, increase their admission rates. These conditions included chronic lung disease, heart failure, previous heart or lung surgery, tracheostomy placement, or use of supplemental oxygen at baseline. Asthma and reactive airway disease were not controlled for in this study because diagnosis of asthma has not been strongly correlated with pneumonia outcomes. Although there is a correlation between early pneumonia infection and subsequent development of asthma by the age of four,[11] patients with pre-existing asthma tend to have clinical outcomes similar to the general population.[12]

All patient encounters meeting inclusion criteria during the period of interest were identified by our institutions' enterprise information management, which then provided the researchers with medical record numbers and basic encounter information. Each encounter was considered separately. For example, if a patient was diagnosed with pneumonia, discharged, and returned days later with clinical worsening, they would be included as two separate encounters, as inititally the child did not meet the institution's criteria for admission but in the second encounters did meet the criteria. The primary outcome was the proportion of pneumonia diagnoses that results in admission from PEDs vs CEDs. Secondary outcomes included demographics, clinical characteristics, and comorbid conditions. Data abstractors were trained on the inclusion and exclusion criteria and data collection protocols.

Study data were collected and managed using REDCap electronic data capture tools hosted at Penn State University. REDCap (Research Electronic Data Capture) is a secure, web-based software platform designed to support data capture for research studies.[13,14] This study was approved by our institutional review board (STUDY 00018516).

We conducted a power analysis to determine the appropriate sample size, resulting in a selection of 400 participants to detect a 15% difference with adequate statistical power. Variables evaluated include age, sex, clinical severity (determined by hypoxemia, dyspnea, tachycardia, altered mental status, temperature, dehydration, decreased perfusion, hypotension, duration of symptoms), medical comorbidities, and CXR factors (unilateral, bilateral, focal infiltrate, atelectasis, presence of pleural effusion, etc). Descriptive statistics (means, medians, standard deviations) were generated for continuous variables. We used logistic regression analyses to evaluate criteria associated with hospital admission. Differences between cohorts were characterized using contingency table analysis; significance levels were determined by chi-square statistic, the Fisher exact test and Cochran-Mantel-Haenszel statistic. For this study, significant differences were determined at $P < .05$. We used appropriate non-parametric procedures in the cases of small sample sizes, and we used SAS v9.4 (SAS Institute, Inc, Cary, NC) for data analysis.

## RESULTS

To address our objective, we identified patient encounters that met our inclusion criteria and compared rates of admission, patient characteristics, and factors impacting illness severity between sites. Analysis was performed on 400 pediatric patients who met inclusion criteria and were logged into REDCap (Figure 1). We reviewed 182 PED encounters and 218 CED encounters between January 1, 2017–December 31, 2019. Of the 182 patients presenting to the PED, 129 (70.9%) were discharged and 53 (29.1%) required inpatient hospital admission. Of the 218 presenting to the CED, 191 (87.6%) were discharged and 27 (12.4%) admitted (Table 1). These data indicate a notably higher admission rate at the PED compared to the CED. Patient demographics, insurance type, and clinical risk factors for pneumonia, such as history of asthma, prematurity, and secondhand smoke exposure, are presented in Table 2. Overall, the cohorts were comparable in terms of age and sex distribution. We observed differences in insurance status and presence of certain risk factors, such as previous asthma diagnosis.

Clinical features on presentation, including initial vital signs, oxygen saturation, and other indicators of clinical severity, are summarized in Table 3. Patients presenting to the PED were more likely to exhibit abnormal vital signs, including tachypnea and hypoxia than those at the CED.To evaluate for differences in admission rates between the. PED and CED, we performed a chi-square test of independence, yielding a significant result ($\chi^2(1) = 22.2$, $P < .001$, $\varphi = -0.37$). This suggests a statistically significant result with moderate-to-large effect size. A logistic regression analysis comparing admission rates between systems likewise yielded a significant result ($\chi^2(1) = 20.6$, $P < .001$). Patients at the PED had a significantly higher likelihood of admission compared to those at the CED. The admission rate at the PED was 29.1%, whereas at the CED it was 12.4%. The odds of admission at the PED were 5.1 times higher than at the CED (odds ratio 5.1, 95% CI, 2.5-10.4), indicating a substantial difference in admission practices between the two hospitals.

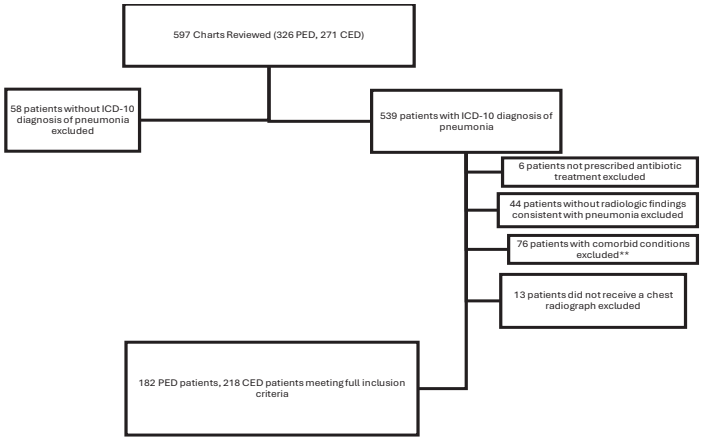


**Figure 1.** Flowchart of inclusion and exclusion criteria used to determined how pediatric patients with pneumonia at a pediatric emergency department and community emergency department were selected for inclusion in the study.
**Previous cancer diagnosis, chronic lung disease (not including asthma or reactive airway disease), heart failure, previous heart or lung surgery, tracheostomy placement, or use of supplemental oxygen at baseline.
*CED*, community emergency department; *PED*, pediatric emergency department; *ICD-10*, *International Classification of Diseases, 10th Mod*.

## DISCUSSION

In this study we aimed to answer whether there was a significant difference in pediatric pneumonia admission rates between CEDs and PEDs. The results demonstrate that the odds of admission to the PED for pneumonia were 2.35 times greater than to the CED. This denotes a significantly higher admission rate for pediatric patients with pneumonia at the PED compared to the CED, aligning with our objective to explore how the type of medical institution may influence clinical decision-making. Additionally, patients presenting to the PED were more likely to be admitted to the ED observation unit than those at the CED. The observation unit allows for extended monitoring and additional workup for patients who do not meet criteria for hospital admission but may be inappropriate for discharge. The rate of admission at the. PED was higher likely due to patients being sicker upon arrival. There were several key factors contributing to this, most notably the following statistically significant differences between the two sites including higher rates of hypoxia and more patients requiring fluid resuscitation for hemodynamic instability among PED patients. Patients presenting to the PED were also more likely to arrive via ambulance (10.7% vs 3.1%).

Dean and Florin noted in their systematic review that tachycardia may be associated with greater clinical severity of pneumonia.[15] There was no significant difference on the auscultation of wheezing on physician examination between the two sites. Wheezing is a component of the Novel Pneumonia Risk Score, a scoring tool developed to identify low-risk patients for whom radiography and antibiotics can be avoided. Its presence decreases the likelihood of a pneumonia that requires imaging and antibiotics.[16] We were unable to demonstrate the importance of this factor with our study population. We did, however, note that physicians auscultated crackles or rales more frequently in the PED cohort, which could have been associated with hospital admission. Nevertheless, auscultation is a subjective measure that can vary based on the examiner.

The findings of this study reveal a notable difference in admission rates between the PED and the CED, with the PED admitting 29.1% of pediatric pneumonia patients compared to 12.4% admitted at the CED. This negates the hypothesis that emergency physicians in the PED, who have more pediatric-

**Table 1.** Rate of admission to inpatient hospital status of children with pneumonia to a pediatric vs community emergency department.

| | Admission Status | | | | | |
|---|---|---|---|---|---|---|
| | | Admit | | | | |
| | Discharge | Inpatient | ICU | Total | Rate of Hospitalization | *P*-value* |
| PED | 129/182 (70.8%) | 46/182 (25.2%) | 7 (3.8%) | 182 | 29.1% | |
| CED | 191/218 (87.6%) | 27/218 (12.4%) | - | 218 | 12.4% | |
| Total | 320 | 73 | 7 | 400 | 20.0% | < .001 |

Emergency department disposition for pediatric patients presenting with pneumonia to a pediatric emergency department and a community emergency department.
* Corresponds to *t*-test for continuous variables and chi-square test for categorical variables.
*CED*, community emergency department; *ICU*, intensive care unit; *PED*, pediatric emergency department.

specific training and experience, may be more comfortable managing pneumonia cases on an outpatient basis. Our study contradicts previous research studies, which identified several factors as higher risk indicators for pneumonia and are often associated with higher rates of admission, including being **uninsured**, **Black/Non-Hispanic**, **age,** and **vaccination status**. Despite these well-known risk factors, we did not observe a higher admission rate at the PED among patients with these characteristics. This discrepancy raises questions about the impact of **socioeconomic factors** on admission decisions and suggests that other variables not controlled for—such as physician experience, institutional practices, or referral patterns—may play a more significant role in the admission process.

The median age of patients at the PED was significantly higher (6.0 vs 2.0 years, $P < .001$), suggesting that younger patients, who may be more vulnerable to severe pneumonia, were more likely to present to the CED. Patients presenting to the CED were more often infants and toddlers. Additionally, a significantly greater proportion of patients at the CED identified as Hispanic or Latino (68.6% vs 20.3%, $P < .001$). They were less likely to be uninsured (11.0% vs 19.9%, $P = 0.01$). These findings raise questions about potential socioeconomic factors influencing admission decisions. Clinical presentation also varied, with dyspnea reported more frequently at the PED (19.1% vs 6.6%, $P < .001$), which may have contributed to higher admission rates. These findings suggest that both physician experience and patient population characteristics play a role in admission decisions, warranting further investigation into the impact of physician training, institutional resources, and social determinants of health on pediatric pneumonia management.

## LIMITATIONS

Despite its valuable insights, this study has several limitations. First, the retrospective nature of the analysis introduces potential biases, including incomplete documentation and variability in clinical decision-making that cannot be fully accounted for. Additionally, the study does not assess clinician-level differences, such as variations in training, experience, or institutional admission protocols, which may have influenced admission rates independently of the hospital setting. The study was also limited in that it only compared one CED site to one PED site. Differences in institutional protocols, patient population, and clinician experience may limit the generalizability of our findings to other settings. Another limitation is the demographic and socioeconomic differences between patient populations at the two hospitals. The significantly higher proportion of Hispanic and uninsured patients at the CED suggests that healthcare access and social determinants may play a role in admission decisions, yet these factors were not directly analyzed. Furthermore, illness severity was not consistently measured across all patients, making it difficult to determine whether differences in admission rates reflected physician confidence or true differences in disease burden.

Data abstraction yielded nearly 400 patient encounters meeting inclusion criteria, with about 200 encounters per institution. As per the sample-size calculations, this sample size provided enough power to identify a difference of more than 15% in admission rates between the two institutions. To assess secondary outcomes more fully with more statistical power, larger sample sizes will be required.

Subsequent research should evaluate the treatment course and outcomes for admitted patients. Comparing length of stay, interventions required, and return to the ED following discharge would provide insight into the admission practices at each institution to evaluate which institution is most appropriately triaging pediatric patients with pneumonia. Future research should also aim to address these limitations by incorporating a prospective design with standardized severity scoring to better control for clinical presentation. A multicenter study including additional PED and CED settings would also help generalize findings and identify broader trends in pediatric pneumonia management. Additionally, qualitative research on physician decision-making, as well as an analysis of post-discharge outcomes, could provide further insights into the safety and effectiveness of outpatient management. Exploring the impact of social determinants, such as language barriers and healthcare access, on admission decisions could also inform strategies for equitable pediatric care.

**Table 2.** Demographics, insurance status, and pneumonia risk factors for children presenting to a pediatric vs community emergency department.

| | PED | CED | Overall | |
|---|---|---|---|---|
| N | 182 | 218 | 400 | *P*-value* |
| Biological sex | | | | .87 |
| Male | 105 (57.7%) | 124 (56.8%) | 229 | |
| Female | 77 (42.3%) | 94 (43.1%) | 171 | |
| Age, years | | | | < .001 |
| Median [IQR] | 6.0 [3.0-9.0] | 2.0 [1.0-5.0] | 4.0 [1.0-7.0] | |
| Ethnicity | | | | < .001 |
| Hispanic, Latino, and/or Spanish origin | 37 (20.3%) | 149 (68.6%) | 186 | |
| Not Hispanic, Latino, and/or Spanish origin | 141 (77.8%) | 64 (29.5%) | 205 | |
| Declined to answer or unknown | 4 (2.2%) | 4 (1.8%) | 8 | |
| Race | | | | |
| White | 111 (61.0%) | 49 (22.5%) | 160 | < .001 |
| Black | 8 (4.4%) | 15 (6.9%) | 23 | .28 |
| American Indian and/or Alaska Native | 1 (0.6%) | 0 (0.0%) | 1 | .27 |
| Asian | 8 (4.4%) | 0 (0.0%) | 8 | - |
| Native Hawaiian and/or Pacific Islander | 0 (0.0%) | 0 (0.0%) | | - |
| Other race | 29 (15.9%) | 141 (64.7%) | 170 | < .001 |
| Declined to answer or unknown | 7 (3.9%) | 6 (2.8%) | 13 | .54 |
| Insurance status | | | | .01 |
| Uninsured | 36 (19.9%) | 24 (11.0%) | 60 | |
| Insured | 145 (80.1%) | 194 (89.0%) | 339 | |
| Premature birth (< 36 weeks gestation) | | | | ** |
| Yes | 14 (9.5%) | 13 (6.3%) | 27 | |
| No | 20 (13.5%) | 58 (28.2%) | 78 | |
| Not documented | 114 (77.0%) | 135 (65.5%) | 249 | |
| Smoke exposure | | | | |
| No smoke exposure at home | 37 (20.3%) | 30 (13.8%) | 67 | .08 |
| Patient smokes | 2 (1.1%) | 0 (0.0%) | 2 | .12 |
| Other smoker in the home | 10 (5.5%) | 7 (3.2%) | 17 | .26 |
| Not documented | 123 (67.6%) | 175 (80.3%) | 298 | < .01 |
| Vaccination status | | | | .53 |
| Up to date | 98 (54.1%) | 113 (51.8%) | 211 | |
| Not up to date | 7 (3.9%) | 5 (2.3%) | 12 | |
| Not documented | 76 (42.0 %) | 100 (45.9%) | 176 | |
| History of Asthma | | | | .02 |
| Yes | 45 (24.7%) | 34 (15.6%) | 79 | |
| No | 137 (75.3%) | 184 (84.4%) | 321 | |

Demographic comparisons for pediatric patients presenting to the emergency department with diagnosis of pneumonia at a community emergency department and a pediatric emergency department.
* Corresponds to *t*-test for continuous variables and chi-square test for categorical variables.
- Not applicable or sample too small.
** Sample sizes are not representative of incidence/prevalence within a single institution due to incomplete data
*CED*, community emergency department; *IQR*, interquartile range; *PED*, pediatric emergency department.

## CONCLUSION

This study demonstrates that the admission rate for pediatric pneumonia patients was higher at a pediatric than at a community emergency department, contrary to the initial hypothesis. This study provides important insights into pediatric pneumonia management at two distinct EDs.

**Table 3.** Clinical features of children with pneumonia presenting to a pediatric vs community emergency department.

| | PED | CED | Overall | |
|---|---|---|---|---|
| N | 182 | 218 | 400 | *P*-value* |
| Arrival by ambulance | | | | < .01 |
| Yes | 17 (10.7%) | 6 (3.1%) | 23 | |
| No | 142 (89.3%) | 189 (96.9%) | 159 | |
| Chief complaint | | | | < .001 |
| Fever | 63 (37.5%) | 90 (42.5%) | 153 | |
| Chest Pain | 3 (1.8%) | 0 (0.0%) | 3 | |
| Cough | 42 (25.0%) | 98 (46.2%) | 140 | |
| Dyspnea | 32 (19.1%) | 14 (6.6%) | 46 | |
| Duration of symptoms before presentation | | | | .48 |
| ≤ 24 hours | 47 (25.8%) | 62 (29.0%) | 109 | |
| > 24 hours | 135 (74.2%) | 153 (71.0%) | 287 | |
| Lung sounds | | | | |
| Wheezes | 29 (15.9%) | 44 (20.2%) | 73 | .27 |
| Crackles/rales | 40 (22.0%) | 29 (13.3%) | 69 | .02 |
| No wheezes or crackles/rales documented | 107 (58.8%) | 152 (69.7%) | 259 | .02 |
| Clinical severity in the emergency department | | | | |
| Altered mental status† | 1 (0.6%) | 1 (0.5%) | 2 | .90 |
| Dehydration† | 18 (9.9%) | 11 (5.1%) | 29 | .06 |
| Dyspnea† or tachypnea | 50 (27.5%) | 58 (26.6%) | 108 | .85 |
| Fever (> 38 °C) | 82 (45.1%) | 105 (48.2%) | 187 | .53 |
| High-flow nasal cannula | 6 (3.3%) | 1 (0.5%) | 7 | .03 |
| Hypotension | 1 (0.6%) | 0 (0.0%) | 1 | .27 |
| Hypoxia ($SpO_2$ < 90%) | 24 (13.2%) | 7 (3.2%) | 31 | < .001 |
| Tachycardia | 93 (51.1%) | 99 (45.4%) | 192 | .26 |
| Sepsis† | | | | 0.89 |
| No | 178 (98.3%) | 214 (98.2%) | 392 | |
| Yes | 3 (1.7%) | 4 (1.8%) | 7 | |
| Fluid resuscitation for hemodynamic instability | | | | < .001 |
| Not required | 161 (88.5%) | 216 (99.1%) | 377 | |
| Required | 21 (11.5%) | 2 (0.9%) | 23 | |
| Intubation | | | | - |
| Not required | 182 (100.0%) | 218 (100.0%) | 400 | |
| Required | 0 (0.0%) | 0 (0.0%) | 0 | |
| Laboratory studies | | | | < .001 |
| Not obtained | 101 (56.1%) | 170 (78.0%) | 271 | |
| Obtained | 79 (43.9%) | 48 (22.0%) | 127 | |
| Chest radiograph findings^ | | | | |
| Unilateral | 155 (85.2%) | 132 (60.1%) | 287 | < .001 |

Features of clinical diagnostic and treatment course for pediatric patients presenting to the emergency department who are diagnosed with pneumonia. Table denotes data extracted from individual patient chart review; it includes factors that may contribute to pneumonia severity and reason for admission.
*Corresponds to *t*-test for continuous variables and chi-square test or Fisher exact test (two-tailed; noted if used) for categorical variables.
-Not applicable or sample is too small.
†Marked as positive if the clinician documented such in their note.
*CED*, community emergency department; *PED*, pediatric emergency department; $SpO_2$, oxygen saturation of peripheral blood.

**Table 3.** Continued.

| | PED | CED | Overall | *P*-value* |
|---|---|---|---|---|
| N | 182 | 218 | 400 | |
| Bilateral | 21 (11.5%) | 81 (37.2%) | 102 | < .001 |
| Focal infiltrate | 120 (65.9%) | 134 (61.5%) | 254 | .36 |
| Atelectasis | 41 (22.5%) | 20 (9.2%) | 61 | < .001 |
| Pleural effusion | 7 (3.9%) | 5 (2.3%) | 13 | .36 |
| Multifocal | 43 (23.6%) | 78 (35.8%) | 121 | .01 |
| Aspiration | 3 (1.7%) | 0 (0.0%) | 3 | .06 |
| Other indications for admission | | | | |
| Dehydration | 10 (5.5%) | 11 (5.1%) | 21 | .84 |
| Inability to tolerate oral intake | 7 (3.9%) | 5 (2.3%) | 12 | .36 |
| Hypoxia ($SpO_2$ <90%) | 27 (14.8%) | 12 (5.5%) | 39 | < .01 |
| Respiratory distress | 20 (11.0%) | 19 (8.7%) | 39 | .46 |
| Failure of outpatient antibiotics[&] | 13 (7.1%) | 6 (2.8%) | 19 | .04 |
| Clinical worsening[#] | 15 (8.2%) | 4 (1.8%) | 19 | < .01 |
| Family preference | 1 (0.6%) | 0 (0.0%) | 1 | .27 |
| Comorbid presentation[%] | 10 (5.5%) | 4 (1.8%) | 14 | .05 |
| Emergency department observation unit | | | | < .001 |
| No | 154 (84.6%) | 206 (94.5%) | 360 | |
| Yes | 28 (15.4%) | 12 (5.5%) | 40 | |

^Multiple descriptors extracted from radiologist report.
[&]Patient presents for clinical worsening or symptoms that persist longer than the original outpatient antibiotic course.
[#]Failure to improve clinical condition despite antibiotic and supportive therapies in the ED or marked decline in vital signs or laboratory values.
[%]Patient has pneumonia in addition to another acute medical problem such as appendicitis, seizure, gastroenteritis.
*CED*, community emergency department; *PED*, pediatric emergency department; *$SpO_2$*, oxygen saturation of peripheral blood.

Although we found a higher admission rate at the PED, the results were influenced by the sicker patient population, as evidenced by factors like hypoxia, the need for intravenous fluids, and arrival by ambulance. Further analysis, controlling for these severity factors, is necessary to determine whether the observed differences are due to institutional practices or differences in patient severity.

The results of this study could provide insight in the variability in clinical practice between PEDs and CEDs and have implications for differences in healthcare costs, antibiotic stewardship, and hospital-acquired infection rates. This insight could impact future patient care in these settings and help lead to better and more cost-effective care. Understanding these dynamics could help improve decision-making and clinical practices in both CED and PED settings, potentially reducing unnecessary hospitalizations while ensuring that more severe cases receive the necessary care.

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# A Geriatric Nurse-led Callback System to Reduce Emergency Department Revisits in Older Adults

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**Introduction:** Emergency departments (ED) present unique challenges for elderly patients who often experience higher revisit rates, increased number of complications, and worse health outcomes. This study examines the impact of implementing a combined automated screening callback and Geriatric Emergency Nurse Initiative Expert (GENIE)-led callback system on reducing ED revisit rates among elderly patients.

**Methods:** We conducted a retrospective analysis that compared revisit rates before and after the implementation of a GENIE callback system in the ED of a large, Level 1 trauma academic center. The study cohort included 23,664 patients, and the primary outcome was revisits at three, seven, and 30 days post-discharge from the ED. Data were adjusted for the Emergency Severity Index (ESI), age group, and sex. The cost of this initiative came from a three-year grant of $650,000 from the Gary and Mary West Foundation, which included the salary for a GENIE nurse.

**Results:** Revisit ratios in the pre-intervention period were 4.8%, 8.9%, and 17.2% at three, seven, and 30 days after discharge, respectively. Following implementation of the callback system, those ratios decreased to 3.9%, 7.6%, and 15.2% at the corresponding time points. All reductions were statistically significant ($P < .001$) and remained significant after adjusting for ESI, age group, and sex.

**Conclusion:** The GENIE callback system effectively reduced ED revisits among elderly patients, highlighting the importance of structured follow-up communication and care. These findings support the expansion of such programs to improve patient outcomes and reduce healthcare costs. [West J Emerg Med. 2025;26(6)1738–1743.]

## INTRODUCTION

Emergency departments (ED) are critical access points for healthcare; however, the environment, system, and overall experience can be particularly challenging for elderly patients. Elderly patients often have complex health needs, leading to longer stays, increased number of complications, and higher revisit rates. These repeat visits not only burden the healthcare system but also indicate potential gaps in patient care and follow-up. In response, a large, academic medical center partnered with a company that created a customized callback system using prerecorded voice actors speaking the patient's native language, as well as a phone tree including a Geriatric Emergency Nurse Initiative Expert (GENIE) to follow up with all elderly patients post-discharge from the ED. In this study

we aimed to evaluate the impact of this system on reducing all-cause ED revisit rates among elderly patients.

Current data indicate that older adults, defined as those ≥ 65 years of age, represent approximately 19.4% of all ED visits in the United States, amounting to approximately 27 million annual visits.[1] As demographic trends continue to shift toward an aging population, it is projected that by 2060, one in four Americans will be an older adult, with the population of those ≥ 65 years of age expected to double from 2016 figures, and those ≥ 85 projected to triple.[2]

Older adults present unique challenges for EDs, as they tend to use emergency services more frequently than younger demographics, have higher urgency levels during visits, stay longer in the ED, are more likely to be admitted or to revisit the ED, and experience higher rates of adverse health outcomes post-discharge.[3] A review of patient comments from before and after the COVID-19 pandemic highlighted that negative feedback regarding ED visits primarily centered on communication issues between healthcare practitioners across the care continuum and the professionalism of ED personnel.[4]

To optimize care for older adults in the ED, we implemented a multidisciplinary group of nursing and ancillary staff services following the geriatric emergency department initiative of the American College of Emergency Physicians. A similar program has demonstrated success in increasing the likelihood of older adults being discharged from the ED without increasing the risk of returning to the ED for the same reason, or mortality.[5] We aimed to further minimize revisits among this demographic with a combination callback program, focusing on personalized post-discharge interventions.

Research conducted by Fruhan et al showed that employing an automated telephone call two days post-discharge significantly decreased revisits within a seven-day period.[6] Despite the promising results, this study was limited by a relatively small enrollment of 8,110 patients and a focus on a seven-day revisit period. We aimed to build on these findings by investigating the relationship between an automated callback system, enhanced by a dedicated emergency nurse with specialized geriatric training and education, and revisit rates at three, seven, and 30 days post-discharge.

*Population Health Research Capsule*

What do we already know about this issue?
*Older adults experience high emergency department revisit rates due to complex needs; post-discharge follow-up may reduce these visits.*

What was the research question?
*Can a technology-supported, nurse-led callback system reduce ED revisit rates among discharged older adults?*

What was the major finding of the study?
*Emergency department revisits dropped at 3, 7, and 30 days (4.8→3.9%, 8.9→7.6%, 17.2→15.2%; all P < .001).*

How does this improve population health?
*Targeted follow-up for older adults reduces the number of preventable ED revisits, easing system strain and improving continuity of care.*

## METHODS

The GENIE callback system was implemented on June 14, 2021. We included patients ≥ 65 years of age who visited the ED between January 2019–June 2021 (pre-intervention) and September 2021–May 2023 (post intervention), covering a period of 30 months prior to and 20 months following the implementation of the GENIE callback system (the intervention). All ED patients ≥ 65 of age who were discharged home from the ED and had not been admitted to the hospital received an automated telephone follow-up call within 24 hours of discharge. The automated system used a standardized structured script to assess the patient's post-discharge status and identify potential concerns requiring further intervention. Patients received calls in their preferred language (English, Spanish, Vietnamese, Mandarin, or Korean) via prerecorded voice actors reading from a script.

The call included three primary questions regarding symptoms, discharge instructions, and medication access. If patients were satisfied with their care and had no questions, no referral for an additional follow-up call was created. If the patient stated that their symptoms were worse, that response triggered a prompt advising the patient to call 9-1-1 if needed and generated a referral to the GENIE callback queue for a follow-up call if the patient had questions regarding their discharge instructions or had multiple questions. If the patient only had a medication-related concern those calls were routed to an ED pharmacist. However, if the patient responded that they had a medication question and additional questions, their case was also referred to the GENIE callback que for a follow-up call. The GENIE nurse reviewed the callback queue and returned patients' calls to address their questions. The GENIE callbacks were conducted without a prescriptive script, allowing for personalized follow-up care based on the patient's reported issues.

The GENIE performed these callbacks during her ED shifts, Monday through Thursday 8 AM-5 PM and Friday 8 AM-noon. We extracted data from retrospective review of the electronic health records. Revisits were defined as a return visit to the ED within three, seven, and 30 days post-discharge. We excluded from analysis records with missing

data, and no imputation was performed. The following elements of optimal chart review as defined by Woster and Bledsoe were followed for this study: case selection criteria; variable definition; medical record identification; sampling method missing data management; and obtaining institutional review board approval.[8]

Patients were stratified into two age groups: 65-74; and ≥ 75 years of age. We compared the proportion of revisits at three, seven, and 30 days post-discharge before and after the intervention using the Pearson chi-square test. We subsequently used a generalized linear model to compare revisit rates pre- and post-intervention, adjusting for age group, sex, and Emergency Severity Index (ESI). Data were analyzed using SPSS Statistics for Windows v29.0.2.0 (IBM Corporation, Armonk, NY), with a type I error level set at 5%.

The callback system was part of a much larger initiative to develop an accredited comprehensive geriatric ED program, which was grant-funded by the West Health Institute (Gary and Mary West Foundation, La Jolla, CA). The total amount of grant funding for this project was $647,167. The GENIE nurse's salary was covered by the grant for three years (approximately $87,516 per year), and the hospital covered her benefits (total salary was approximately $132,870 per year). The hospital funded subscription to an automated callback system (Cipherhealth, New York, NY). Thus, most grant funding for the callback project went toward the GENIE nurse's salary. (Of note, the GENIE nurse had multiple other functions in addition to the callback program.) The GENIE role was eventually approved to be a full-time role in the ED, and the ED funded her position in full after the grant ended. During the study period, other experienced nurses would fill the GENIE callback role in the absence of the GENIE nurse.

The GENIE nurse documented a range of follow-up interventions during patient callbacks, which were categorized into five main themes. The most frequent intervention involved general status assessments, including checking on the patient's condition, providing education or clarification, and assessing pain or other symptoms. A significant portion of follow-up efforts involved assisting patients with follow-up appointments by coordinating care with appropriate clinics or clinicians. A third intervention included clarification of discharge instructions—reviewing written information, lab results, and actions to take if symptoms worsened. The GENIE also addressed issues related to obtaining prescriptions, including contacting pharmacies or helping patients overcome access barriers. Finally, a smaller subset of interactions involved answering medication-related questions, such as how to take medications or understanding potential side effects. These themes highlight the GENIE's role in bridging care transitions and addressing common gaps in post-discharge understanding and support.

The total number of calls initiated by the automated system was 9,824. Of those calls, 8,842 patients were reached by the automated callback system, and 5,738 (65.0%) responded to at least one callback question. Among these, 1,416 (24.7%) patients identified an issue requiring follow-up. The GENIE nurse followed up on and closed 1,149 of these issues, representing 81.2% of all issues flagged by patients. This accounts for 20.0% of all patients who engaged with the system and 13.0% of all patients reached by the automated calls. Of the 1,149 issues closed by the GENIE, 648 (56.4%) included detailed documentation of the resolution in the medical record.

## RESULTS

The study included a total of 23,664 patients, comprising 12,173 patients in the pre-intervention group and 11,491 patients in the post-intervention group (Table 1). The proportion of revisits observed during the pre-intervention period was 4.8%, 8.9%, and 17.2% at three, seven, and 30 days post-discharge, respectively. In the post-intervention period, these proportions were 3.9%, 7.6%, and 15.2% at the corresponding time points. The differences observed between the pre- and post-intervention periods were statistically significant across all three timeframes ($P < .001$) (Table 2).

**Table 1.** Themes and queries of callback issues addressed by the Geriatric Emergency Nurse Initiative Expert.

| Post-discharge issues addressed by the GENIE | Subcategory/description |
|---|---|
| General status checks | Giving encouragement or general patient check-in |
| | Assessing pain |
| | Providing reassurance |
| Follow-up appointment assistance | Helping schedule follow-up care |
| | Directing transfer to the correct department or clinic |
| | Coordinating with primary care physicians |
| Clarification of discharge instructions | Reviewing written instructions |
| | Reviewing lab results |
| | Discussing next steps if symptoms worsened |
| Obtaining prescriptions | Ensuring prescriptions were filled |
| | Contacting pharmacies |
| | Addressing access barriers |
| Medication-related questions | Explaining how and when to take medications |
| | Discussing side effects or drug interactions |

*GENIE,* Geriatric Emergency Nurse Initiative Expert.

**Table 2.** Comparison of patient population and revisit ratios before and after implementing a geriatric callback program.

| | | Study period | | | |
|---|---|---|---|---|---|
| | | Pre-intervention | | Post-intervention | |
| | | Count | Column % | Count | Column % |
| Age group at the index ED visit | > 75 | 5,759 | 47.3% | 5,544 | 48.2% |
| | 65-74 | 6,414 | 52.7% | 5,947 | 51.8% |
| Sex | Female | 6,537 | 53.7% | 6,148 | 53.5% |
| | Male | 5,636 | 46.3% | 5,343 | 46.5% |
| Patient returned to the ED within 3 days | No | 11,583 | 95.2% | 11,047 | 96.1% |
| | Yes | 590 | 4.8% | 444 | 3.9% |
| Patient returned to the ED within 7 days | No | 11,093 | 91.1% | 10,617 | 92.4% |
| | Yes | 1,080 | 8.9% | 874 | 7.6% |
| Patient returned to the ED within 30 days | No | 10,079 | 82.8% | 9,749 | 84.8% |
| | Yes | 2,094 | 17.2% | 1,742 | 15.2% |

*ED,* emergency department.

Figure 1 illustrates revisits within three days by Emergency Severity Index (ESI) before and after the intervention. The number of revisits increased by higher ESI in both the pre- and post-intervention periods. Furthermore, the disparity in revisits between the pre- and post-intervention periods was more pronounced at higher ESI levels.

In the multivariable analysis, revisits within three days post-discharge (Table 2) were higher during the pre-intervention period ($P < .001$). It was also associated with male sex ($P < .001$), younger age ($P = .05$), and a higher ESI ($P < .001$).

Similarly, revisits rates at seven and 30 days post-discharge were significantly higher during the pre-intervention period ($P < .001$) and were associated with male sex ($P < .001$), younger age ($P < .05$), and higher ESI scores ($P < .001$) in multivariable analysis.

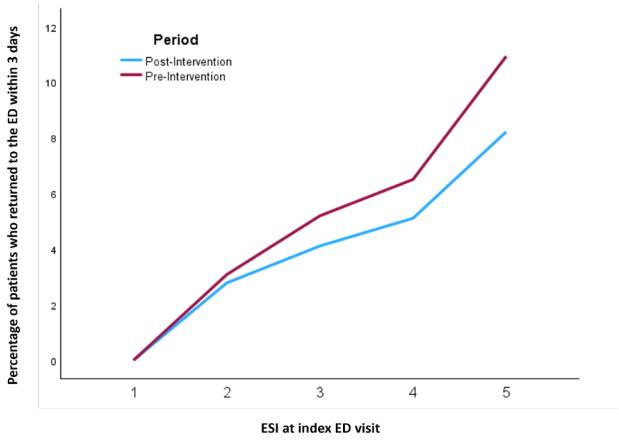


**Figure 1.** Revisits at 72 hours before and after the geriatric call-back intervention, per Emergency Severity Index.
*ED,* emergency department; *ESI,* Emergency Severity Index.

## DISCUSSION

The findings of this study demonstrate that the GENIE callback system significantly reduced revisit rates among elderly patients at three, seven, and 30 days post-discharge. Importantly, this reduction remained significant even after adjusting for several confounding variables, including ESI, age group, and sex. Elderly patients are disproportionately affected by high revisit rates, a multifactorial issue often driven by chronic comorbidities, polypharmacy, and insufficient social support. The GENIE callback system addresses these challenges by providing structured, personalized, follow-up care post-discharge. This approach ensures timely identification and resolution of potential complications, enhances adherence to discharge instructions and medication regimens, and offers direct access to a dedicated expert for addressing patient concerns.

A key strength of the system lies in its unique design, which designates a specialized geriatric nurse to lead the follow-up process. This proactive and targeted approach likely accounts for the intervention's success. While specialized ED geriatric nurses have been used in other contexts with positive outcomes,[5] this study is the first to evaluate their impact specifically on post-discharge revisits in elderly ED patients. The results emphasize the critical role of the GENIE in bridging gaps in care and reducing avoidable ED visits. Our findings also highlight the broader implications of follow-up interventions for healthcare systems. By reducing revisits, the GENIE callback system aids in alleviating the burden on emergency services. This is particularly significant given the increasing demand for emergency care and the associated strain on healthcare resources. Programs like the GENIE callback system could play a pivotal role in addressing these systemic challenges while enhancing the quality of care for an aging population.

**Table 3.** Generalized linear model analysis of variables associated with 3-, 7-, and 30-day post-discharge revisits.

| Post-discharge Interval | Independent variable (predictor) | B | SE | Hypothesis test | | |
|---|---|---|---|---|---|---|
| | | | | Wald $\chi^2$ | df | P-value |
| 3 days | Intercept | -4.31 | .161 | 720.60 | | |
| | Post- vs pre-intervention period | -.23 | .065 | 12.24 | 1 | < .001 |
| | Age group: (65-74 vs ≥ 75) | .13 | .065 | 4.03 | 1 | .05 |
| | Sex: male vs female | .44 | .065 | 45.41 | 1 | < .001 |
| | ESI | .35 | .050 | 49.49 | 1 | < .001 |
| 7 days | Intercept | -3.49 | .119 | 862.25 | | |
| | Post- vs pre-intervention period | -.16 | .048 | 11.06 | 1 | < .001 |
| | Age group: (65-74 vs ≥ 75) | .10 | .048 | 862.25 | 1 | < .001 |
| | Sex: male vs. female | .36 | .048 | 58.02 | 1 | < .001 |
| | ESI | .32 | .038 | 71.20 | 1 | < .001 |
| 30 days | Intercept | -2.62 | .089 | 870.77 | | |
| | Post- vs pre-intervention period | -.14 | .038 | 16.24 | 1 | < .001 |
| | Age group: (6574 vs ≥ 75) | .11 | .036 | 8.95 | 1 | < .001 |
| | Sex: male vs female | .32 | .036 | 79.03 | 1 | < .001 |
| | ESI | .29 | .028 | 102.32 | 1 | < .001 |

*SE,* standard error; *df,* degrees of freedom; *ESI,* Emergency Severity Index.

## LIMITATIONS

The most significant limitation of this study is its before-and-after design, which meant that we were unable to account for factors such as the COVID-19 pandemic. Additionally, although we adjusted for several confounders, residual confounding variables such as socioeconomic status, caregiver support, non-ED or external healthcare system access, and specific comorbidities may have influenced the observed outcomes. Additionally, this study was conducted in a single academic healthcare setting, potentially limiting the generalizability of the findings to other healthcare systems or community hospitals.

Another possible confounding factor was that our institution established a geriatric ED program in 2019 and achieved Level 1 Geriatric Emergency Department Accreditation (GEDA) on March 7, 2022. Although during that period the GENIE nurse did not formally call back patients in a systematic way, the GENIE nurse worked in the ED and the GEDA program was in effect prior to the implementation of the callback system June 14, 2021. To our knowledge, no significant number of callbacks were made by the GENIE. Additionally, there was no formal system in place to follow up with ED patients beyond the usual clinical care provided by physicians and advanced practice clinicians, which included answering questions if patients initiated calls to the ED after their initial visit. A final study limitation is that our GENIE nurse worked Monday through Thursday 8 AM-5 PM and Friday 8 AM-noon. Patients who were discharged on Friday and over the weekend were called back on Monday. This gap in callbacks could potentially have led to increased revisits on days when callbacks were not occurring.

Future research should explore the cost-effectiveness of the GENIE callback system, as the financial feasibility of scaling such programs is a critical consideration. In addition, it would be helpful if future studies evaluated the impact on revisits if GENIE coverage was seven days a week instead of five. Furthermore, qualitative studies capturing patient and caregiver experiences with the system could provide nuanced insights into its strengths and areas for improvement. Subgroup analyses examining the system's impact on patients with specific conditions, such as dementia or heart failure, could also help tailor interventions for maximum effectiveness. Additional studies could also investigate specific impacts on patient health outcomes and patient satisfaction related to curated callbacks post initial ED visits.

## CONCLUSION

The implementation of the Geriatric Emergency Nurse Initiative Expert callback system significantly reduced revisits rates among elderly patients post-ED discharge, highlighting its potential as an effective follow-up intervention. This study provides evidence supporting the broader adoption of specialized, nurse-led and technology-supported programs to enhance care quality, improve patient outcomes, and mitigate pressures on overburdened emergency departments. Future work focusing on long-term benefits, sustainability, and cost-effectiveness will be essential in guiding the integration of such initiatives into comprehensive care strategies for older patients.

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*Conflicts of Interest*: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. No author has professional or financial relationships with any companies that are relevant to this study. There are no conflicts of interest or sources of funding to declare.

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# Trends in Proportion of Delirium Among Older Emergency Department Patients in South Korea, 2017-2022

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**Introduction:** Delirium is a critical neuropsychiatric condition that surged among older adults during the coronavirus disease 2019 (COVID-19) pandemic, likely due to social isolation resulting from distancing measures. In this study we examined trends in delirium-related emergency department (ED) visits before and during the pandemic using nationwide data from South Korea, with a focus on different phases of social distancing, to inform healthcare strategies for older adults during public health crises.

**Methods:** We obtained data from the National Emergency Department Information System (2017-2022). Changes in ED visits were assessed across pre-pandemic (January 2017–January 2020), early pandemic (February 2020–March 2022), and late pandemic (April 2022–December 2022) phases using interrupted time series analysis.

**Results:** A total of 80,442 delirium-related ED visits among adults ≥ 65 years of age were recorded. The interrupted time series analysis showed a significant step increase in ED visits during the early pandemic phase (relative risk [RR] 1.290, 95% CI 1.201-1.386; 29.0% increase), followed by a decrease in the late pandemic phase (RR 0.922, 95% CI 0.868-0.981; 7.8% decrease). The most substantial increase was for individuals 65-74 year of age during the early pandemic period (RR 1.406, 95% CI 1.264-1.564) reflecting a 40.6% increase in visits to the ED. Indirect ED visits, such as institutional referrals, also notably increased (RR 1.275, 95% CI 1.184-1.373) reflecting a 27.5% increase.

**Conclusion:** Delirium-related ED visits among older adults showed a notable 7.8% decrease during the late pandemic period, with key risk groups identified, particularly adults 65-74 of age (40.6% increase) and those referred from institutions (27.5% increase) during the early pandemic period. These findings may help inform targeted interventions and public health responses in similar healthcare settings. Despite limitations including reliance on diagnostic codes, lack of subgroup analysis by COVID-19 status, potential duplicate visit counts, and limited regional granularity this study offers important insight into delirium care needs during crisis periods. Further research should further explore causal mechanisms and the specific impact of COVID-19 infection on delirium incidence. [West J Emerg Med. 2025;26(6)1744–1754.]

## INTRODUCTION

Delirium is a critical neuropsychiatric condition marked by disruptions in attention and consciousness, leading to a rapid decline in cognitive function.[1] It often results from underlying medical issues such as infections, metabolic imbalances, or medication effects.[2] If not promptly recognized and managed, delirium can lead to significant morbidity and mortality. Delirium occurs in approximately 7-10% of older emergency department (ED) patients,[3] with research indicating rates as high as 10-30%.[2] Furthermore, delirium affects up to 50% of hospitalized older adults, particularly among those who initially presented to the ED, underscoring the importance of addressing this issue in both hospital and community settings.[4]

The coronavirus disease 2019 (COVID-19) pandemic has drawn increased attention to the incidence of delirium among older patients, particularly in emergency and inpatient settings. A systematic review and meta-analysis demonstrated that delirium was highly prevalent among older adults with COVID-19, significantly elevating their risk of mortality.[5] Several factors contributed to the rising incidence of delirium during the pandemic, including overwhelmed healthcare systems, staff shortages, and stringent infection-control measures. The multifactorial nature of COVID-19-associated delirium, which may result from severe respiratory distress, systemic inflammation, and the effects of prolonged social isolation, further complicates its management.[6-8] Studies conducted in Japan and Germany highlighted how visitation restrictions and patient isolation during the pandemic escalated delirium rates among hospitalized COVID-19 patients, particularly among older adults.[9,10] Analyzing factors such as age, housing, and hospitalization is crucial for both healthcare and public policy.

The pandemic exacerbated the vulnerabilities of older patients, revealing significant gaps in the ability of healthcare systems to effectively manage and prevent delirium.[11] These challenges encountered during the COVID-19 crisis underscore the need for improved protocols, increased staffing, and heightened awareness of delirium as a critical condition, particularly in emergency settings.[12] However, because most research has focused on Western countries, comprehensive studies on the impact of COVID-19 on delirium in South Korea are lacking. During the COVID-19 pandemic, the government of South Korea implemented stringent public health interventions, including centralized triage protocols, nationwide social distancing, and restricted hospital visitation policies, which likely influenced patterns of ED use among older adults.[13]

Notably, a South Korean study examining the effects of intensive care unit (ICU) visitation policies during the pandemic found no difference in overall delirium incidence between the restricted and non-visitation groups. However, significant differences in delirium subtypes and anxiety levels were observed. Patients without visitors were more likely to experience hyperactive and mixed delirium and had significantly higher anxiety levels, underscoring the potential role of family presence in the management of delirium during crisis situations.[14] Cultural differences, such as family involvement in older adult care, improvement in healthcare infrastructure, and implementation of various public health strategies, may significantly reduce the incidence and promote better management of delirium among older patients.[15,16]

In this study we aimed to examine temporal trends in delirium presentations to EDs before and during the COVID-19 pandemic, with the goal of understanding how the pandemic and associated public health measures may have affected delirium incidence and healthcare use among older adults. By identifying changes in delirium patterns, we sought to inform future preparedness and response strategies for vulnerable populations in times of public health emergencies. Rather than examining delirium occurrence among confirmed COVID-19 patients, we sought to explore how broader pandemic-related societal measures, including social distancing and restricted healthcare access, influenced temporal trends in delirium presentations in EDs. This approach was intended to capture the wider public health impact on older adults beyond the effects of direct infection.

*Population Health Research Capsule*

What do we already know about this issue?
*Delirium is common in older ED (emergency department) patients and may worsen during public health crises due to social isolation and disrupted healthcare access.*

What was the research question?
*How did delirium-related ED visits among older adults change before and during COVID-19 in South Korea?*

What was the major finding of the study?
*Delirium ED visits rose 29.0% early in the pandemic (RR 1.290, 95% CI 1.201-1.386) and fell 7.8% later (RR 0.922, CI 0.868-0.981).*

How does this improve population health?
*Findings highlight the need for targeted delirium monitoring and support strategies for older adults during health crises to reduce ED burden.*

## METHODS

### Data Source

We constructed a cross-sectional study using data from the National Emergency Department Information System (NEDIS). This observational study follows the Strengthening the Reporting of Observational Studies in Epidemiology reporting guidelines. The NEDIS compiles real-time patient information from more than 400 EDs across South Korea.[17] It is a government-operated emergency information network managed by the Ministry of Health and Welfare and the National Emergency Medical Center. Emergency centers across the country undergo annual evaluations to maintain their status as emergency service institutions. As part of this process, they are required to digitize all NEDIS data and submit the information for assessment. The NEDIS database encompasses a range of demographic and clinical information for all patients who visited EDs. Detailed information has been presented in previous studies.[18-20]

### Study Population

Patients ≥ 65 years of age who visited EDs between January 1, 2017–December 31, 2022 were included in the study. Variables considered included age, sex, region, and insurance status, along with detailed clinical data related to ED visits, such as arrival and departure times and dates, mode of arrival, transport method, chief complaints, and Korean Triage Acuity Scale (KTAS) scores. We also recorded patient disposition and diagnosis codes based on the *International Classification of Diseases*, *10th Ed*, (ICD-10). We categorized EDs into three levels based on hospital function and capacity, with data collection protocols varying by ED category.

### Study Outcomes and Variables

The selection of study outcomes and variables was guided by a review of established literature on delirium risk factors in older adults. In particular, Inouye et al (2014) provided a comprehensive framework for identifying key risk factors such as infections, metabolic disturbances, and medication use, which informed the classification of comorbid conditions included in our analysis.[4] The primary outcome was delirium, as defined using ICD-10 codes (F05.0-F05.1, F05.8-F05.9). The ICD-10 codes were more frequently recorded for hyperactive or mixed delirium (42.9%) than for hypoactive delirium (14.3%) or normoactive delirium (5.9%).[21] The other outcomes of interest were predisposing factors for delirium, defined as diagnoses or treatment codes based on ICD-10 or Unified Medical Language System codes, detailed in Supplementary Table 1, with their categorization based on previous studies.[1,9,20,22,23] We grouped and analyzed these diagnosis categories to evaluate changes in the distribution of predisposing medical conditions for delirium across the pandemic phases.

Demographic variables considered included sex, age (65-74, 75-84, and 85+ years), and insurance status. We analyzed ED characteristics and classified EDs according to hospital type and urbanity. Other relevant factors were also assessed, including ambulance use, KTAS score, arrival time, length of stay, route of arrival, and final disposition in the ED. The KTAS levels are 1-5, with 1 representing the highest and 5 indicating the lowest acuity. Route of arrival was included as it may reflect differences in care access, institutionalization, and illness severity at presentation.

### Statistical Analysis

We first conducted descriptive analyses based on patient demographics and ED visit information. We used the 2020 mid-year census population data from the Korean Statistical Information Service, provided by Statistics Korea, to calculate the annual age-standardized incidence rate of ED visits per 1,000,000 person-days. Interrupted time series analysis was applied to assess step and slope changes in monthly delirium-related ED visits from 2017–2022. The interrupted time series models incorporated the following: a dummy variable to indicate the pandemic period; an interaction term to enable step and slope changes; a covariate to capture monthly trends; and a harmonic term to adjust for seasonal effects.[24] The total number of ED visits per month was used as the offset for the monthly estimated ED visit rate.

We stratified these analyses according to the COVID-19 pandemic period, patient age, and ED arrival route. Although COVID-19 diagnostic data were not available at the patient level, the study period was divided into three phases based on previous studies[25,26]: pre-pandemic (January 2017–January 2020); early pandemic (February 2020–March 2022); and late pandemic (April–December 2022). The pandemic phases (pre-, early-, and late-pandemic) were defined based on national-level changes in COVID-19 mitigation policies, particularly social distancing regulations, rather than on patient-level COVID-19 incidence or diagnoses. No direct COVID-19-confirmed case data were used in the analysis. We based temporal classification of the pandemic period on nationally recognized epidemiological turning points, beginning with the first confirmed case on January 19, 2020, and the subsequent lifting of most social isolation measures in mid-April 2022. Arrival routes were divided into two categories: direct and indirect (transferred from other hospitals). We performed all statistical analyses using SAS v9.4 (SAS Institute Inc., Cary, NC) and R statistical software v4.3.3 (The R Foundation for Statistical Computing, Vienna, Austria).

## RESULTS

The total number of older adults who visited the ED between 2017–2022 was 11,639,534. Delirium patients numbered 35,069 (43.6%) pre-pandemic, 31,898 (39.7%) during the early pandemic phase, and 13,475 (16.8%) during the late pandemic phase (Figure 1).

The number of ED patients 65-74 years of age increased steadily from 2,371 in 2017 to 3,438 in 2022. The age-

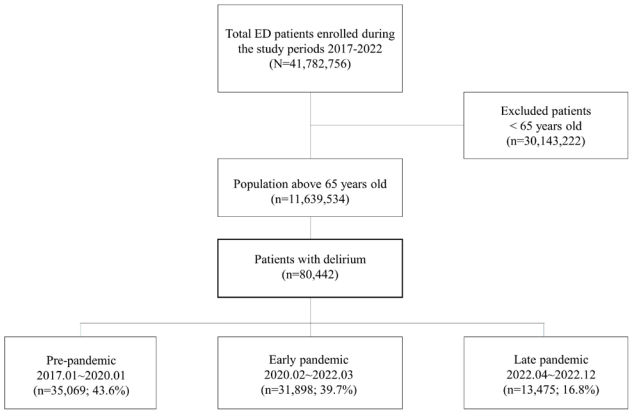


**Figure 1.** Flowchart of the study population, representing older adults with delirium.
This flowchart illustrates the selection of patients ≥ 65 years of age who visited EDs in South Korea from 2017– 2022. Inclusion and exclusion criteria are detailed to define the final analytic sample used to examine trends in delirium-related ED visits during the pre-pandemic, early pandemic, and late pandemic phases.
*ED*, emergency department.

standardized rate showed that there were more male than female patients with delirium (Supplementary Table 2). In general, the proportion of patients with delirium during the pandemic periods remained low compared to that during the pre-pandemic phase. The demographics showed a higher proportion of females (51.5%), 75-84 years years of age (48.3%), and National Health Insurance Service-covered patients (85.2%) who presented to the ED with delirium. Between the pre-pandemic and late pandemic phases, the proportion of KTAS level 3 patients increased (55.6% vs 57.6%), as did the length of stay (3.7 hours vs 4.9 hours) and the proportion of direct arrivals (64.5% vs 71.6%). Most patients visited the ED in the morning (31.8%). The ED disposition differed by period; the proportion of discharged patients dropped in the late pandemic phase compared to that in the pre-pandemic phase (8.4% and 5.4%, respectively). In contrast, the proportion of hospitalized patients steadily increased from 71.9% to 73.1% (Table 1).Diseases of the circulatory and respiratory systems were the main predisposing factors (Figure 2 and Supplementary Table 3) for pre-pandemic ED visits (50.3% and 38.1%, respectively).

In the early and late pandemic phases, diseases of the circulatory and genitourinary systems were the most frequent presentations (49.3% and 37.8% in the early phase, and 48.2% and 38.7% in the late phase, respectively). Overall, the incidences of infectious, hematological, metabolic, digestive system, and genitourinary system diseases, fever/respiratory symptoms, and general anesthesia surgery increased between the pre-pandemic and late-pandemic phases. Similar patterns were also observed for patients transferred from other hospitals by ambulance (Supplementary Table 4).

The monthly proportion of delirium among ED patients increased from 0.58% pre-pandemic to 0.83% during the early pandemic phase (reflecting a 43.1% relative increase) and then remained stable at 0.82% in the late pandemic phase. There were differences between the early pandemic (step change: relative risk (RR) 1.290, 95% CI 1.201-1.386) reflecting a 29.0% increase; slope change: RR 0.996, 95% CI 0.992-1.000); and late-pandemic phases (step change: RR 0.922, 95% CI 0.868-0.981; reflecting a 7.8% decrease; slope change: RR 0.995, 95% CI 0.978-1.013) (Figure 3).

All age groups showed a significant increase in delirium incidence during the early pandemic phase; however, only the 75+ age group showed a significant decrease during the late pandemic phase (Table 2). Both direct and indirect routes of arrival increased significantly during the early pandemic phase. In contrast, direct arrival decreased in the late pandemic phase (Tables 3).

## DISCUSSION

The number of delirium patients ≥ 65 years of age among ED visitors increased during the early phase of the COVID-19 pandemic, followed by a slight decline during the late pandemic phase. The 85+ age group showed the highest proportion of cases, whereas the 65-74 age group had the highest rate of increase. Arrivals to the ED from other facilities were significantly higher than direct arrivals, particularly of patients with surgical conditions suffering from fever and genitourinary and digestive diseases.

Prior research indicates that the overall number of ED visits with delirium has been steadily increasing for several reasons. First, the aging population is rising, leading to a higher prevalence of age-related health issues, including cognitive disorders like delirium.[27] Second, the COVID-19 pandemic and associated isolation measures have exacerbated risk factors for delirium, especially in older adults who experience increased social isolation,[28] reduced physical activity,[29] and restricted access to routine mental health services, particularly those living in long-term care facilities or nursing homes.[30] Additionally, the increased demand for medical services due to COVID-19 patient care restricted healthcare access for older adults, which may have led to an increase in patients who have not received adequate medical attention for temporary cognitive deterioration disorders, such as delirium.[31,32] Lastly, heightened awareness and improved diagnostic practices may promote more frequent identification and treatment of delirium cases in emergency settings.[33] In addition to these factors, the pandemic influenced delirium presentations through indirect mechanisms, including hospital-level constraints such as staff shortages and care delays that may have contributed to longer ED stays and more advanced disease on arrival.[34]

Several hypotheses can explain the decrease in ED visits with delirium in the late-pandemic phase. Firstly, the incidence of delirium might have decreased due to rigorous medical intervention both in community and nursing home

**Table 1.** Demographics of visits to emergency departments by older adults with delirium before and during the COVID-19 pandemic.

| Variable | Category | Total N (%) | Pre-pandemic n (%) | Early pandemic n (%) | Late Pandemic n (%) |
|---|---|---|---|---|---|
| Total | | 80,442 (100.0) | 35,069 (43.6) | 31,898 (39.7) | 13,475 (16.8) |
| Sex | Male | 39,011 (48.5) | 16,974 (48.4) | 15,502 (48.6) | 6,535 (48.0) |
| | Female | 41,431 (51.5) | 18,095 (51.6) | 16,396 (51.4) | 6,940 (51.5) |
| Age group | 65-74 | 16,791 (20.87) | 7,457 (21.26) | 6,623 (20.76) | 2,711 (20.1) |
| | 75-84 | 38,842 (48.3) | 17,569 (50.1) | 15,120 (47.4) | 6,153 (45.66) |
| | 85+ | 24,809 (30.8) | 10,043 (28.6) | 10,155 (31.8) | 4,611 (34.2) |
| Insurance | NHI | 68,522 (85.2) | 29,588 (84.4) | 27,309 (85.6) | 11,625 (86.3) |
| | Medical aid | 9,679 (12.0) | 4,344 (12.4) | 3,766 (11.8) | 1,569 (11.6) |
| | No insurance | 412 (0.5) | 207 (0.6) | 153 (0.5) | 52 (0.4) |
| | Other or UK | 1,829 (2.3) | 930 (2.7) | 670 (2.1) | 229 (1.7) |
| Ambulance use | Yes | 54,467 (67.7) | 23,323 (66.5) | 22,001 (69.0) | 9,143 (67.9) |
| Length of Stay | Median (IQR) | 4.28 (5.4) | 3.73 (4.6) | 4.75 (6.2) | 4.85 (5.3) |
| | < 6 hours | 52,206 (64.9) | 24,839 (70.8) | 19,161 (60.1) | 8,206 (60.9) |
| | > 6 hours | 28,236 (35.1) | 10,230 (29.2) | 12,737 (39.9) | 5,269 (39.1) |
| Hospital | Regional emergency medical center | 19,519 (24.3) | 8,129 (23.2) | 7,880 (24.7) | 3,510 (26.1) |
| | Local emergency medical center | 43,850 (54.5) | 18,069 (51.5) | 18,427 (57.8) | 7,354 (54.6) |
| | Local emergency medical institution | 17,073 (21.2) | 8,871 (25.3) | 5,591 (17.5) | 2,611 (19.4) |
| KTAS[a] | 1 (resuscitation) | 1,964 (3.1) | 788 (3.0) | 842 (3.2) | 334 (3.1) |
| | 2 (emergent) | 10,784 (17.0) | 4,487 (17.1) | 4,391 (16.7) | 1,906 (17.5) |
| | 3 (urgent) | 35,576 (56.2) | 14,563 (55.6) | 14,756 (56.1) | 6,257 (57.6) |
| | 4 (less urgent) | 13,354 (21.1) | 5,615 (21.5) | 5,619 (21.4) | 2,120 (19.5) |
| | 5 (non-urgent) | 1,661 (2.6) | 715 (2.7) | 699 (2.7) | 247 (2.3) |
| | UK | 5 (0.0) | 5 (0.0) | 0 (0.0) | 0 (0.0) |
| Urbanity | Urban | 78,183 (97.2) | 34,036 (97.1) | 31,020 (97.3) | 13,127 (97.4) |
| | Rural | 2,259 (2.8) | 1,033 (3.0) | 878 (2.8) | 348 (2.6) |
| Time of Presentation | Morning (6AM-12PM) | 25,587 (31.8) | 10,857 (31.0) | 10,382 (32.6) | 4,348 (32.3) |
| | Afternoon(12PM-6 PM) | 32,397 (40.3) | 14,315 (40.8) | 12,714 (39.9) | 5,368 (39.8) |
| | Nighttime (6PM-1AM) | 17,965 (22.33) | 7,909 (22.6) | 7,045 (22.1) | 3,011 (22.4) |
| | Dawn (1AM-6AM) | 4,493 (5.6) | 1,988 (5.7) | 1,757 (5.5) | 748 (5.6) |
| Route of arrival | Direct | 56,696 (70.5) | 23,958 (68.32) | 22,837 (71.59) | 9,901 (73.48) |
| | Indirect[b] | 21,269 (26.4) | 10,216 (29.1) | 7,942 (24.9) | 3,111 (23.1) |
| | Other[c] or UK | 2,477 (3.1) | 895 (2.6) | 1,119 (3.51 | 463 (3.4) |
| ED disposition | Discharged | 5,371 (6.7) | 2,949 (8.4) | 1,696 (5.32) | 726 (5.39) |
| | Transferred | 776 (0.96) | 469 (1.34) | 224 (0.7) | 83 (0.6) |
| | Hospitalization | 58,213 (72.4) | 25,204 (71.9) | 23,160 (72.6) | 9,849 (73.1) |
| | ICU admission | 16,028 (20.0) | 6,422 (18.3) | 6,798 (21.3) | 2,808 (20.8) |
| | Died | 27 (0.0) | 14 (0.0) | 7 (0.0) | 6 (0.0) |
| | Other or UK | 27 (0.0) | 11 (0.0) | 13 (0.0) | 3 (0.0) |

[a]Only Level 1 (regional emergency medical center) and Level 2 (local emergency medical center) EDs were included due to their low rate of missing data.
[b]Indirect includes transfer from other hospital.
[c]Other includes refer from outpatient clinics.
This table presents the demographic and clinical characteristics of older adults with delirium-related emergency department visits in South Korea, stratified by pandemic phase to assess trends before and during the COVID-19 pandemic.
*UK*, unknown; *ICU*, intensive care unit; *ED*, emergency department; *IQR*, interquartile range; *NHI*, National Health Insurance.

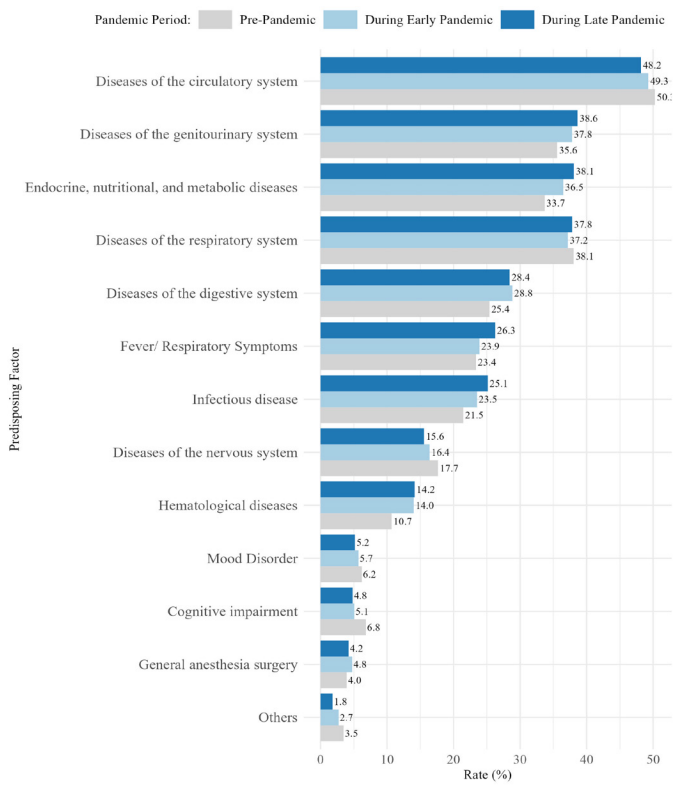


**Figure 2.** The proportion of predisposing factors in emergency department visits among older patients with delirium.
This figure displays the distribution of predisposing medical conditions among older adults (≥ 65 years) who presented to EDs with delirium in South Korea. The data are stratified by pandemic phase (pre-pandemic, early pandemic, and late pandemic) to illustrate shifts in the prevalence of key contributing factors over time. *ED*, emergency department.

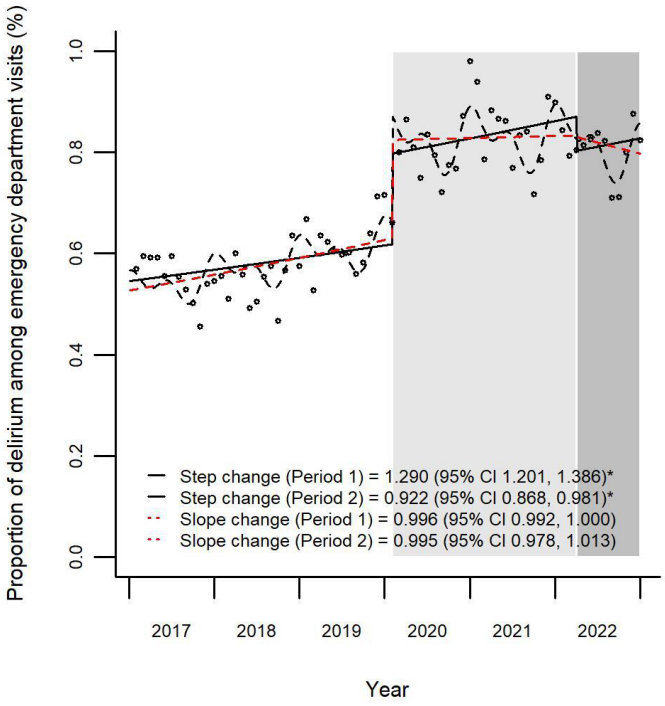


**Figure 3.** Proportion of delirium among emergency department visits before and during the COVID-19 pandemic.
This figure illustrates the monthly proportion of delirium-related emergency department visits among older adults (≥65 years) in South Korea from 2017–2022. The time series is stratified into three phases: pre-pandemic (January 2017–January 2020), early pandemic (February 2020–March 2022; Period 1), and late pandemic (April 2022–December 2022; Period 2). Solid black line indicates the predicted de-seasonalized trend from a step-change regression model. Dashed black line represents the trend from a step- and slope-change model adjusted for seasonality. Dashed red line shows the de-seasonalized trend based on the full step- and slope-change regression model. Shaded bands indicate 95% CIs. *CI*, confidence intervals.

care, although our study did not directly evaluate care quality.[35] In South Korea, enhanced infection control protocols and increased attention to vulnerable populations during the pandemic may have contributed to more structured monitoring and prevention efforts, particularly in long-term care facilities.[36] Secondly, families or nursing care staff living with delirium patients may have been desensitized to medical symptoms or too lethargic to let older adults visit EDs or outpatient departments; this is known as emotional exhaustion due to long-lasting COVID-19.[37] In Korean households, where family caregivers often play a central role in elder care, prolonged caregiving burden during the pandemic may have exacerbated such emotional fatigue.[38] This interpretation is supported by previous studies documenting increased psychological distress among caregivers during the COVID-19 pandemic. Thirdly, prolonged financial difficulties resulting from COVID-19 may have discouraged patients from seeing doctors or visiting hospitals.[39] This trend was also observed in South Korea, where studies reported decreased healthcare use among older adults due to economic strain and fear of infection.[40]

Lastly, the incidence of social alcohol use or substance use disorder behaviors may have decreased due to the isolation/distancing strategy against COVID-19, although this hypothesis was not directly tested in our study.[41] Post-pandemic trends need to be studied to identify the origin and context of delirium and thereby confirm these hypotheses within the Korean healthcare and social environment.[42] While these hypotheses provide potential explanations, the current dataset did not allow for direct testing of all these mechanisms. Future studies are needed to explore these unresolved questions in greater depth.

Our finding of decreased delirium-related ED visits during the later phase of the COVID-19 pandemic in South Korea contrasts with patterns reported in other countries. For instance, a multicenter study in the United States found that

**Table 2.** Association between the COVID-19 pandemic and changes in emergency department visits for delirium by age group: a comparison of pre-pandemic, early, and late pandemic periods.

| Age group | Period (Ref. Pre-pandemic) | Mean Monthly proportion of Delirium to the total ED visit | | Relative risk (95% CI) | |
|---|---|---|---|---|---|
| | | Before | During | Step change | Slope change |
| 65-74 | Period 1 | 0.28% | 0.38% | 1.406 (1.264, 1.564)* | 1.001 (0.995, 1.007) |
| | Period 2 | | 0.37% | 0.957 (0.873, 1.049) | 1.000 (0.973, 1.028) |
| 75-84 | Period 1 | 0.71% | 0.99% | 1.289 (1.196, 1.389)* | 0.996 (0.992, 1.000) |
| | Period 2 | | 0.96% | 0.912 (0.855, 0.972)* | 0.987 (0.969, 1.006) |
| 85+ | Period 1 | 1.13% | 1.57% | 1.232 (1.132, 1.342)* | 0.995 (0.990, 0.999)* |
| | Period 2 | | 1.54% | 0.900 (0.837, 0.968)* | 1.001 (0.981, 1.023) |

This table presents the mean monthly proportion of delirium-related emergency department visits and corresponding relative risks (RR) for each age group (65-74, 75-84, and ≥ 85 years), comparing the pre-pandemic, early pandemic (Period 1: February 2020–March 2022), and late pandemic (Period 2: April 2022–December 2022) periods in South Korea. Step and slope changes were estimated using interrupted time series analysis with the pre-pandemic period as the reference. An asterisk (*) indicates stasignificance at P < .05.
*Ref*, reference category; *ED*, emergency department; *RR*, relative risk.

28% of older adults with COVID-19 presented to EDs with delirium, even when respiratory symptoms were absent.[43] This discrepancy may reflect differences in healthcare access, triage protocols, hospital visitation policies, and the role of informal caregiving across systems. These international contrasts underscore the need for context-sensitive interpretation of delirium-related trends during public health emergencies.

We specifically examined the incidence of delirium, particularly among community-dwelling older adults, in this study. Delirium is characterized by a fluctuating state of confusion in which patients struggle to focus on or maintain awareness of themselves and their surroundings. Stays in the ICU and hospitalization can trigger or exacerbate delirium.[44,45]

In South Korea, many healthcare facilities postponed or canceled outpatient visits for patients vulnerable to the SARS-CoV-2 virus, leaving older adults defenseless against chronic illnesses. The pandemic isolation measures made it challenging to manage emergencies and maintain access to essential medical services. Routine care practices, including long-term treatment services, were interrupted by social distancing mandates.[46] These disruptions may have contributed to the observed increase in KTAS level 1 and 2 patients and ICU admissions during the early pandemic phase, reflecting higher acuity and delayed care among older adults. While individual COVID-19 diagnosis status could not be assessed, time trends in delirium and associated variables were interpreted in the context of pandemic-related system disruptions rather than infection-related effects alone.[34]

After these restrictions were gradually lifted in the later stages of the pandemic, most delirium patients could be transferred to EDs with fewer obstacles. Interrupted time series analysis in the present study confirmed this time gap in the proportion of ED visits by patients with delirium. Behavioral restrictions, such as confinement to rooms and limited visitation, can worsen disorientation and harm cognitive function.[7] The isolation of older adults in communities and lack of in-person care by skilled nursing facilities might have increased their risk of delirium.[11] Government regulation or restriction regarding visits by family and acquaintances hindered the recovery of hospitalized patients.[7] Social isolation due to distancing strategies has also been identified as a potential factor contributing to ICU delirium during the COVID-19 outbreak,[6] with stringent isolation measures having a negative impact on the mental health of older adults, potentially exacerbating or triggering neuropsychiatric symptoms.[14,47]

Our results indicate that the proportion of indirect visits for delirium increased more significantly than that of direct visits during the early pandemic phase. A previous study has shown that the incidence of delirium is notably higher among long-term care residents, with these patients facing an elevated risk of functional decline, worsening dementia, and mortality. Delirium in long-term care settings also increases the likelihood of hospital admissions and contributes significantly to long-term morbidity and healthcare costs.[30] Increased ED boarding times and constrained ICU capacity during the early pandemic may have further influenced patient disposition patterns, particularly among high-acuity cases.[48] Our study further emphasizes that residents in long-term care facilities represent a group particularly vulnerable to delirium.

Given these challenges, establishing proper referral systems during a pandemic is required, especially to manage an increase in ED visits by older delirium patients. Social isolation and aging can exacerbate mental symptoms; therefore, proactive community-based strategies are essential. Firstly, enhancing accessible mental health support and regular check-ins for older adults during a pandemic can mitigate the negative impacts of isolation and reduce the risk of delirium.[49] Community health programs as preventive measures should be implemented to promote physical activity, social engagement, and cognitive

**Table 3.** Association between the COVID-19 pandemic and changes in emergency department visits for delirium by route of arrival: a comparison of pre-pandemic, early-, and late-pandemic periods.

| Route of arrival | Period (Ref. Pre-pandemic) | Mean monthly proportion of delirium to the total ED visit (%) | | Relative risk (95% CI) | |
|---|---|---|---|---|---|
| | | Before | During | Step change | Slope change |
| Direct | Period 1 | 0.47% | 0.70% | 1.275 (1.184, 1.373)* | 0.996 (0.992, 1.001) |
| | Period 2 | | 0.69% | 0.910 (0.855, 0.969)* | 0.994 (0.976, 1.012) |
| Indirect | Period 1 | 1.18% | 1.61% | 1.334 (1.238, 1.438)* | 0.996 (0.992, 1.000) |
| | Period 2 | | 1.62% | 0.995 (0.933, 1.060) | 0.989 (0.971, 1.008) |

This table shows the mean monthly proportion of delirium-related emergency department visits and corresponding relative risks for patients categorized by route of arrival: direct (eg, self-transport, public ambulance) and indirect (eg, transfer from another hospital via private ambulance). The data compare the pre-pandemic, early pandemic (Period 1: February 2020–March 2022), and late pandemic (Period 2: April 2022–December 2022) phases. Step and slope changes were estimated using interrupted time series analysis, with the pre-pandemic period as the reference. An asterisk (*) indicates statistical significance at $P < .05$.
*Ref*, reference category; *ED*, emergency department; *RR*, relative risk.

stimulation, all of which have been shown to lower delirium risk.[50] Additionally, establishing telehealth services and expanding home healthcare resources for older adults, including those in long-term care facilities, would allow timely intervention and reduce unnecessary ED visits.[51] Adequate training of healthcare workers, family members, and caregivers to recognize early delirium symptoms is also essential. Early detection and proper management can significantly alleviate the symptoms of delirium and reduce ED reliance.[52] A well-coordinated response within communities will be critical for proactively addressing delirium in older adults and building resilience for future pandemics.

The proportion of delirium identified in this study was lower than prevalence estimates reported in prior studies, which have ranged from 7-30% among older ED patients based on structured screening tools.[2,3] This discrepancy is likely attributable to the use of diagnostic codes from administrative data rather than prospective clinical assessments. Delirium is frequently under-recognized in emergency care, particularly in patients with hypoactive symptoms, and is often undercoded in discharge summaries and hospital records. Nonetheless, the observed demographic and clinical characteristics of this study, such as predominance among individuals aged 75-84 years, females, and patients with circulatory or respiratory conditions, are consistent with previous papers.[53,54]

Internationally, the prevalence and documentation of delirium vary widely depending on healthcare infrastructure, assessment practices, and clinical priorities. A recent meta-analysis reported that delirium prevalence in COVID-19 patients ranged from 11-80% across countries,[55] suggesting substantial variability in recognition and reporting. In addition, a global survey across 44 countries revealed that only two-thirds of hospital units used validated delirium assessment tools, and the presence of formal delirium protocols varied considerably by region.[56] These findings underscore that the patterns observed in South Korea, such as a decrease in delirium-related ED visits during the pandemic may be shaped by country-specific factors such as triage protocols, long-term care capacity, family caregiving roles, and cultural attitudes toward emergency care. Thus, international comparisons must be interpreted in the context of these systemic and cultural differences.

## LIMITATIONS

Our study had several limitations. Firstly, delirium was defined solely based on diagnostic codes, which may have decreased the precision in accurately identifying delirium cases. Additionally, although COVID-19 is associated with an increased incidence of delirium symptoms, this trend was not specifically analyzed among COVID-19-positive patients. Although the study period was categorized into pandemic phases, individual-level COVID-19 diagnosis data or incidence rates were not incorporated into the analysis. This may have limited the precision in attributing observed trends directly to the pandemic's clinical impact. Our phase classification was instead based on broad policy timelines (eg, implementation of social distancing), which may not fully reflect the epidemiological burden of COVID-19 during each period. Our use of visit-level data also introduced the potential for duplicate visits, which may not accurately reflect the actual incidence of delirium.

Furthermore, social distancing measures varied slightly by region, but a detailed regional analysis was not conducted. Lastly, although the group of patients from nursing homes was not directly investigated, an indirect assessment of nursing facility transfers was conducted, defining indirect arrivals as those involving private ambulances. Another key limitation of this study is the absence of patient-level, COVID-19 diagnostic information in the NEDIS dataset. As a result, we were unable to directly assess delirium cases attributable to

confirmed infection. Instead, we analyzed temporal trends in the context of broader system-level disruptions, such as social distancing policies and ED utilization patterns.

In addition, several contextual factors related to the pandemic itself could not be fully captured in our data. Operational changes in hospitals such as staffing shortages, resource reallocation, and increased length of ED stay may have influenced the detection and documentation of delirium, as well as patterns of ED use. Furthermore, due to the limitations of administrative data, our variable selection did not include important psychosocial or clinical factors such as baseline cognitive status, caregiver stress, or social isolation. These unmeasured variables may have affected not only the incidence of delirium, but also patient or caregiver decision-making regarding ED visits. As a result, while our findings offer meaningful insights into national-level trends, their utility and generalizability may be limited by these data constraints.

Despite these limitations, this study is the first in South Korea to investigate the trend in ED visits for delirium among community-dwelling older adults, and provides critical insights into delirium occurrence during the pandemic at a national level. A comprehensive picture of delirium trends across diverse populations during the pandemic was obtained using nationwide data. Additionally, our study examined the importance of a time-framed strategy for medical intervention. More precise and categorical interventions are required to deal with psychiatric emergencies, such as delirium and other mental and physical conditions, especially during pandemics.

## CONCLUSION

We analyzed trends in delirium-related ED visits among older adults in South Korea before and during the COVID-19 pandemic, with a focus on the phases of social distancing. A notable 7.8% decrease in visits was identified during the late pandemic period, and key risk factors were highlighted, particularly among adults aged 65-74 (40.6% increase during the early pandemic) and those referred from institutions (27.5% increase during the early pandemic). These findings help elucidate the pandemic's impact on mental health and may inform targeted interventions and public health responses in similar healthcare systems or settings. While this study was based on national data from South Korea, the observed trends may offer preliminary insights for emergency care systems in other settings, particularly those with aging populations or facing similar healthcare disruptions during public health emergencies. Further research is needed to evaluate whether these patterns are consistent across different healthcare environments and to better understand their implications for emergency medicine practice globally.

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# Factors Associated with Survival to Hospital Discharge in Cardiac Arrest by Poisoning: WAIVOR Score

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**Introduction:** Poisoning-induced out-of-hospital cardiac arrest (P-OHCA) is a leading mortality cause; however, no specific prognostic model exists for P-OHCA. In this study we aimed to develop and validate a novel scoring system, the WAIVOR score, which identifies factors associated with survival to hospital discharge in patients with P-OHCA, including the nature of the toxic agent.

**Methods:** In this retrospective nationwide observational study we analyzed 4,252 South Korean adult P-OHCA cases from 2013–2023. The study population was randomly stratified into derivation (n = 2,834) and validation (n = 1,418) cohorts. Independent factors associated with survival to hospital discharge were identified through multivariable logistic regression analysis, yielding adjusted odds ratios (aOR) and 95% confidence intervals (CI). We assessed the scoring system's discriminative performance using the receiver operating characteristic curve and area under the curve (AUC) analysis, with optimal threshold determination via the Youden index.

**Results:** Among all patients, 291 (6.8%) survived to hospital discharge. The most frequent poisoning substances were gases/vapors (45.3%), pesticides (31.5%), and medically prescribed drugs (12.0%). Six independent factors associated with survival to hospital discharge were incorporated into the WAIVOR score (maximum 11 points): pre-hospital return of spontaneous circulation, four points (aOR 16.11, 95% CI 10.16-25.64); witnessed arrest, two points (aOR 3.86, 95% CI 2.61-5.71); age < 65 years, two points (aOR 3.34, 95% CI 2.20-5.15); female sex, one point (aOR 1.54, 95% CI 1.09-2.16); and arrest-to-emergency department intervals ≤ 30 minutes, two points (aOR 3.44, 95% CI 2.00-6.09; 31-60 minutes, one point (aOR 1.77, 95% CI 1.08-3.02); and poisoning by non-gas/non-vapor substances, one point (aOR 0.54, 95% CI 0.33-0.89). The WAIVOR score demonstrated robust discriminative performance (AUC: 0.823 and 0.739 in derivation and validation cohorts, respectively). At the optimal threshold of five points, the score demonstrated 53.6% sensitivity, 84.4% specificity, 19.8% positive predictive value, and 96.2% negative predictive value (NPV).

**Conclusion:** The WAIVOR score represents a practical tool whose associated factors may help assess potential for survival to hospital discharge in patients with P-OHCA. Its high NPV renders it valuable for identifying poor prognostic outcomes. However, further external validation studies are required before this score can be broadly used in decisions regarding resuscitation termination in clinical practice. [West J Emerg Med. 2025;26(6)1755–1763.]

## INTRODUCTION

Out-of-hospital cardiac arrest (OHCA) remains a leading cause of global mortality, associated with poor overall prognosis and neurological outcomes.[1] The etiology of OHCA can be categorized into medical and non-medical causes, including trauma, drowning, asphyxia, and poisoning.[2] In 2023, 105,007 drug overdose deaths occurred in the United States, resulting in an age-adjusted rate of 31.3

deaths per 100,000 standard population, of which opioid overdoses accounted for approximately 24.0 deaths per 100,000.[3] Poisoning-induced OHCA (P-OHCA) accounts for approximately 6% of non-traumatic OHCAs, resulting in substantial societal and economic burdens.[4]

Patients with P-OHCA are younger, experience fewer witnessed events, and present with lower rates of shockable rhythms than do those with non-poisoning OHCA.[5] The clinical outcomes for patients with P-OHCA vary across studies; however, recent studies have reported generally better outcomes than those of patients with non-poisoning OHCA, with survival rates with good neurological outcome of 15.2% vs 8.8% ($P < .001$), and an adjusted odds ratio (aOR) of 2.47.[6,7] Given the reported favorable clinical outcomes of P-OHCA compared to other OHCA etiologies, elucidating its specific prognostic factors is essential for optimizing patient outcomes.

Various prediction models have been developed to assess clinical outcomes in OHCA.[8] However, the unique pathophysiology and diverse toxic agents involved in P-OHCA make it challenging to accurately predict outcomes using existing prediction models. This underscores the need for a prognostic model tailored to P-OHCA cases, which can serve as an essential clinical tool for improving resource allocation and patient outcomes.

Considering the low prevalence but generally favorable clinical outcomes in patients with P-OHCA, a risk-stratification system specific to P-OHCA for predicting clinical outcomes is critical. However, previous tools have not fully considered the distinct characteristics of patients with P-OHCA. Therefore, our goal in this study was to develop a novel scoring system for identifying survival to hospital discharge specific to patients with P-OHCA.

*Population Health Research Capsule*

What do we already know about this issue?
*Poisoning-induced out-of-hospital cardiac arrest (P-OHCA) has unique prognostic factors but lacks a risk-stratification system for predicting clinical outcomes.*

What was the research question?
*Can we develop and internally validate a risk-stratification model for P-OHCA?*

What was the major finding of the study?
*The WAIVOR score demonstrated an area under the curve of 0.739 and a negative predictive value of 96.2%.*

How does this improve population health?
*The WAIVOR score is a valuable tool for guiding clinical decision-making and optimizing resource allocation in P-OHCA, including decisions on termination or prolonged resuscitation.*

## METHODS

### Study Design and Data Collection

In this retrospective observational study we used the Out-of-Hospital Cardiac Arrest Surveillance (OHCAS) database maintained by the Korea Disease Control and Prevention Agency (KDCA). The OHCAS is a nationwide registry and represents the largest and most comprehensive source of standardized data on OHCA in South Korea, annually capturing detailed information on approximately 30,000 patients with cardiac arrest who receive emergency medical service (EMS) care and subsequent transportation to medical facilities.

The OHCAS database integrates information from the National Fire Agency database and hospital medical records validated by the KDCA. The initial dataset originates from EMS documentation, encompassing clinical information, such as cardiac arrest circumstances, resuscitation timing, and prehospital interventions. This information is systematically recorded by EMS responders during prehospital care and transport. The second component involves a comprehensive hospital medical record review. Trained KDCA investigators conduct on-site visits to healthcare facilities to collect detailed information about in-hospital care, interventions, toxic exposures, and patient outcomes. The review process follows standardized protocols aligned with the Utstein-style guidelines and Resuscitation Outcomes Consortium Project parameters. Additionally, this retrospective chart review complied with recommended methodological criteria by Worster et al (2005), including clearly defined inclusion and exclusion criteria, abstractor training prior to data collection, explicit variable definitions, clear identification of the medical record databases, systematic assessment of interobserver reliability, defined management plans for missing data, and obtaining institutional review board approval.[9]

### Study Setting and Emergency Medical Services in South Korea

This study was conducted within the context of South Korea's national EMS infrastructure. The EMS system operates on a 24/7 basis under a government-operated model. Upon identification of OHCA, EMS personnel initiate an immediate response following standardized protocols. Under medical direction, EMS responders are authorized to perform clinical interventions, including advanced airway management and the administration of intravenous (IV) fluids (isotonic or dextrose), supplementary oxygen, bronchodilator

nebulizer, sublingual nitroglycerin, and IV or intramuscular epinephrine under specific clinical situations. However, administration of antidote medications for poisoning or envenomation (eg, naloxone, flumazenil, glucagon, ethanol, N-acetylcysteine, atropine, pralidoxime, and anti-venom) and gastric decontamination interventions are not permitted in the prehospital phase.

The EMS responders transport all patients with OHCA to the nearest emergency department (ED). As per South Korean EMS protocols, field pronouncement of death by EMS personnel is not permitted. Consequently, all patients with EMS-attended OHCA are transported to healthcare facilities and subsequently included in the OHCAS database. However, in cases where resuscitation is deemed futile due to obvious signs of death (including rigor mortis, livor mortis, or decapitation), EMS responders may withhold resuscitative efforts following online medical consultation. These cases are subsequently managed via private ambulance transport and are excluded from the OHCAS database.

**Study Participant Selection**

In the OHCAS database (2013–2023), we excluded cases in which the cause of OHCA was not poisoning, pediatric patients (< 19 years of age), patients with do-not-resuscitate (DNR) orders, and those with incomplete clinical outcome data. Given the large-scale clinical data and the rarity of survival to hospital discharge in P-OHCA, we performed internal validation using a split-sample method.[10] Accordingly, the study population was randomly stratified into a derivation cohort, comprising two-thirds of it, and a validation cohort, comprising the remaining one-third.

**Variables and Measurements**

We examined various variables encompassing patient demographics, cardiac arrest circumstances, and emergency response metrics. Demographic variables included age, sex, and residence (metropolitan vs non-metropolitan/rural). Cardiac arrest characteristics were systematically documented through the following parameters: location of arrest (public vs non-public); witnessed cardiac arrest; bystander cardiopulmonary resuscitation (CPR); first monitored rhythm (shockable vs non-shockable); and achievement of prehospital return of spontaneous circulation (ROSC). The arrest-to-ED interval time was defined as the temporal duration from cardiac arrest onset to ED arrival. Determination of arrest time was based on direct witness accounts or information obtained from emergency callers or caregivers. In cases where precise arrest timing could not be established, the last documented time of normal health status was designated as the reference point. To enhance scoring system simplicity, we transformed continuous variables into categorical variables: age was dichotomized at 65 years; and the arrest-to-ED interval was stratified using 30- and 60-minute thresholds.

Cardiac arrest etiologies in the OHCAS database are classified into predefined categories, including "poisoning." We included only cases coded as "poisoning" to ensure consistent exclusion of non-poisoning etiologies. As per the OHCAS data collection protocol, not all ingested or exposed agents are routinely recorded. While it is possible to document multiple poisoning substances, trained investigators systematically review both EMS records and hospital medical charts to identify and record the substances responsible for triggering the cardiac arrest. Based on a previously described classification method, poisoning substances were categorized into five groups:[5,11] medically prescribed drugs, including non-opioid analgesics, antipyretics, antirheumatics, antiepileptic sedative-hypnotics, and other unspecified medicinal and biological substances; gases and vapors; pesticides, including insecticides and herbicides; alcohol-based substances, including ethanol, methanol, organic solvents, and halogenated hydrocarbons; and unspecified chemicals and biological toxins. A detailed list of poisoning substances belonging to each group is provided in Appendix 1.

**Outcome Measurement**

The primary endpoint was survival to hospital discharge, defined as either discharge to home or transfer to another healthcare facility following completion of acute medical management. We ascertained discharge status through a comprehensive review of hospital discharge documentation, which was initially documented by the attending physicians.

**Statistical Analysis**

We performed statistical analyses using R software v4.4.2 (The R Foundation for Statistical Computing, Vienna, Austria). Descriptive statistics are presented as medians with interquartile ranges for continuous variables and as numbers with percentages for categorical variables. Baseline characteristics were compared using the Mann–Whitney U test for non-parametric continuous variables and the chi-square test for categorical variables. We identified predictors of survival to hospital discharge through multivariable logistic regression analysis, with adjustment for potential confounders identified in univariate analysis. The regression model generated adjusted odds ratios (aOR) with corresponding 95% confidence intervals (CIs). Based on these regression coefficients, we developed a clinical prediction scoring system. The scoring system's discriminative performance was assessed using receiver operating characteristic (ROC) curve analysis with the calculation of the area under the curve (AUC). We determined the optimal cutoff value for the scoring system using the Youden index. Statistical significance was set at $P < .05$.

## RESULTS

**Study Participants**

Between 2013–2023, 338,169 OHCA cases were registered in the OHCAS database. We first excluded 333,800

cases that were unrelated to poisoning. In the remaining poisoning-related cases, we excluded 81 pediatric cases (< 19 years of age), 24 cases with DNR orders, and 12 cases with incomplete clinical outcome data. The final study cohort comprised 4,252 eligible participants. The study population was randomly stratified into a derivation cohort (n = 2,834) and a validation cohort (n = 1,418) (Figure 1).

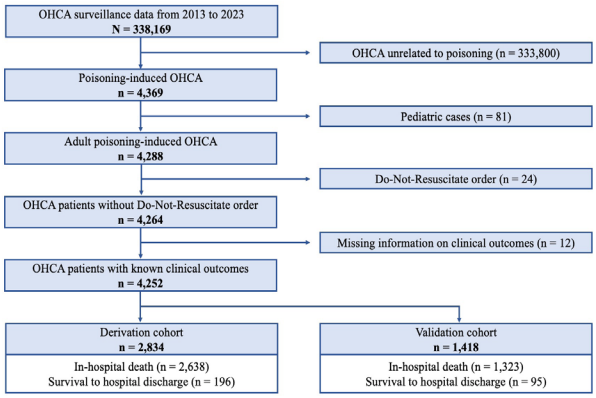


**Figure 1.** Flowchart illustrating participant selection process for the development and validation of the WAIVOR score. *OHCA,* out-of-hospital cardiac arrest.

The median age of the total study population (n = 4,252) was 56 years, with 64.1% of patients younger than 65 years of age. Male patients accounted for 65.7% of the overall cohort. Most cases occurred in non-metropolitan and rural areas (70.7%), and cardiac arrests predominantly took place in non-public locations (87.0%). Overall, 15.4% of arrests were witnessed, bystander response occurred in 23.4%, shockable initial rhythms were documented in 1.5%, and prehospital ROSC was achieved in 3.8%. The most frequently identified poisoning substances were gases and vapors (45.3%), followed by pesticides (31.5%). The median arrest-to-ED interval was 46 minutes, with most cases (57.0%) presenting within 31-60 minutes. Survival to hospital discharge was observed in 6.8% of the total cohort. All demographic and clinical characteristics were comparable between the derivation and validation cohorts. Detailed baseline characteristics of the total population, derivation cohort (n = 2,834), and validation cohort (n = 1,418) are presented in Table 1.

### Predictors of Survival to Hospital Discharge

Table 2 summarizes the univariate and multivariable analyses of factors associated with survival to hospital discharge in the derivation cohort. Univariate analysis revealed age < 65 years of age (77.0% vs 63.3%, $P < .001$), female sex (43.8% vs 34.1%, $P < .01$), witness (50.0% vs 12.9%, $P < .001$), bystander response (39.7% vs 22.6%, $P < .001$), shockable rhythm (6.6% vs 1.0%, $P < .001$), and achievement of prehospital ROSC (29.5% vs 2.1%, $P < .001$) to be significantly associated with survival to hospital discharge. Additionally, both the type of poisoning agent and the arrest-to-ED interval time demonstrated significant associations with survival to discharge (both $P < .001$).

Multivariable logistic regression analysis identified six independent predictors of survival to hospital discharge. Achievement of prehospital ROSC demonstrated the strongest association (aOR 16.11, 95% CI 10.16-25.64, $P < .001$), followed by witnessed cardiac arrest (aOR 3.86, 95% CI 2.61-5.71, $P < .001$) and age < 65 years (aOR 3.34, 95% CI 2.20-5.15, $P < .001$). Female sex maintained statistical significance (aOR 1.54, 95% CI 1.09-2.16, $P = .01$). Regarding time intervals, shorter arrest-to-ED interval was associated with improved survival: interval time ≤ 30 minutes (aOR 3.44, 95% CI 2.00-6.09, $P < .001$) and 31-60 minutes (aOR 1.77, 95% CI 1.08-3.02, $P = .02$) demonstrated better outcomes than did interval time ≥ 61 minutes. Among poisoning substances, only gases and vapors exhibited significantly reduced survival probability compared to medically prescribed drugs (aOR 0.54, 95% CI 0.33-0.89, $P = .01$).

### Development of the WAIVOR Score

Based on the multivariable analysis results, we developed a novel scoring system for predicting survival to hospital discharge in P-OHCA. The scoring system incorporates six independent predictors that demonstrated significant associations with survival to hospital discharge in the multivariable model: women, young age (< 65 years), arrest-to-ED interval time, poisoning substance (other than gas or vapor), witness, and prehospital ROSC. The weights for each variable were derived from the regression coefficients in the multivariable logistic regression model, yielding a maximum possible score of 11 points (Figure 2).

**WAIVOR score**

| Mnemonics | Variables | Score |
|---|---|---|
| W | Women | + 1 |
| A | Age < 65 | + 2 |
| I | Arrest to ED Interval Time<br>• 31 – 60 minutes<br>• ≤ 30 minutes | <br>+ 1<br>+ 2 |
| V | Other than Gas / Vapor | + 1 |
| O | Observe / Witness | + 1 |
| R | Prehospital ROSC | + 4 |

**Figure 2.** Components of the WAIVOR score, including weighted points assigned based on multivariable logistic regression analysis. *ED,* emergency department; *ROSC,* return of spontaneous circulation.

**Table 1.** Baseline demographic and clinical characteristics of patients with poisoning-induced out-of-hospital cardiac arrest.

| Variables | Total population (N = 4,252) | Derivation cohort (n = 2,834) | Validation cohort (n = 1,418) | P-value |
|---|---|---|---|---|
| Age (years) | 56 (41-72) | 55 (41-72) | 56 (41-71) | .78 |
| Young age (≤ 65 years) | 2,725 (64.1) | 1,822 (64.2) | 903 (63.6) | .72 |
| Female sex | 1,460 (34.3) | 987 (34.8) | 473 (33.3) | .35 |
| Residence | | | | .50 |
| Metropolitan | 1,245 (29.3) | 820 (28.9) | 425 (29.9) | |
| Non-metropolitan / rural | 3,007 (70.7) | 2,014 (71.0) | 993 (70.0) | |
| Witnessed | 656 (15.4) | 439 (15.4) | 217 (15.3) | .90 |
| Bystander response | 995 (23.4) | 676 (23.8) | 319 (22.4) | .34 |
| Shockable rhythm | 62 (1.5) | 41 (1.4) | 21 (1.4) | 1 |
| Arrest in public place | 554 (13.0) | 378 (13.3) | 176 (12.4) | .42 |
| Prehospital ROSC | 162 (3.8) | 116 (4.0) | 46 (3.2) | .20 |
| Poisoning substance | | | | .28 |
| Medically prescribed drugs | 509 (12.0) | 338 (11.9) | 171 (12.0) | |
| Gases and vapors | 1,926 (45.3) | 1,315 (46.4) | 611 (43.0) | |
| Pesticides | 1,338 (31.5) | 876 (30.9) | 462 (32.5) | |
| Alcohol-based substances | 82 (1.9) | 52 (1.8) | 30 (2.1) | |
| Unspecified and biological toxins | 397 (9.3) | 253 (8.9) | 144 (10.1) | |
| Multiple substances poisoning | 35 (0.8) | 26 (0.9) | 9 (0.6) | .43 |
| Arrest-to-ED interval time (minutes) | 46 (27-105) | 46 (27-103) | 47 (29-112) | .29 |
| Arrest-to-ED interval time | | | | .21 |
| ≥ 61 minutes | 1,022 (24.0) | 674 (23.7) | 348 (24.5) | |
| 31-60 minutes | 2,423 (57.0) | 1,601 (56.4) | 822 (57.9) | |
| ≤ 30 minutes | 807 (19.0) | 559 (19.7) | 248 (17.4) | |
| Survival to hospital discharge | 291 (6.8) | 196 (6.9) | 95 (6.6) | .84 |

Continuous variables are presented as medians (interquartile ranges).Categorical variables are presented as numbers (percentages).
*ED,* emergency department; *ROSC,* return of spontaneous circulation.

**Predictive Performance of the WAIVOR Score**

The WAIVOR score demonstrated favorable predictive accuracy with AUCs of 0.823 and 0.739 in the derivation and validation cohorts, respectively (Figure 3). Using the Youden index, we identified a WAIVOR score threshold of five points as the optimal cutoff for predicting survival to hospital discharge, yielding a sensitivity of 66.3% and specificity of 84.6% in the derivation cohort.

Regarding clinical outcomes, survival to hospital discharge was observed in 291 patients (6.8%) of the total cohort (N = 4,252). Specifically, 196 (6.9%) of the derivation cohort (n = 2,834) and 95 (6.6%) of the validation cohort (n = 1,418) survived to hospital discharge. Application of the optimal cutoff (WAIVOR score of 5) in the validation cohort demonstrated a sensitivity of 53.6% and specificity of 84.4%. Within the validation cohort, patients with WAIVOR scores ≤ 4 constituted 66.2% of in-hospital deaths and 2.1% of survivors, whereas those with scores ≥ 5 represented 27.0% of in-hospital deaths and 4.5% of survivors (Table 3). These findings corresponded to a positive predictive value (PPV) of 19.8% and a negative predictive value (NPV) of 96.2%.

## DISCUSSION

To our knowledge, this study presents the first clinical outcome prediction model specifically developed for P-OHCA. The WAIVOR score incorporates six independent predictors: women; age < 65 years; arrest-to-ED interval time; poisoning substance (other than gas or vapor); witnessed cardiac event; and prehospital ROSC. The scoring system demonstrated good predictive performance, with a maximum attainable score of 11 points and an optimal cutoff of five points. The model's utilization of readily available clinical parameters will facilitate rapid implementation in emergency settings.

The WAIVOR score demonstrated a notably high NPV of 96.2%, indicating its potential utility in identifying patients with P-OHCA with unfavorable prognostic outcomes

**Table 2.** Results of univariate and multivariable logistic regression analyses identifying factors associated with survival to hospital discharge among patients with poisoning-induced out-of-hospital cardiac arrest in the derivation cohort.

| | Univariate analysis | | | Multivariable logistic regression analysis | | |
|---|---|---|---|---|---|---|
| Variables | In-hospital death (n = 2,638) | Survival to discharge (n = 196) | P-value | aOR | 95% CI | P-value |
| Young age (≤ 65 years) | 1,671 (63.3) | 151 (77.0) | < .001 | 3.34 | 2.20-5.15 | < .001 |
| Female sex | 901 (34.1) | 86 (43.8) | < .01 | 1.54 | 1.09-2.16 | .01 |
| Residence | | | .34 | | | |
| Metropolitan | 757 (28.6) | 63 (32.1) | | | | |
| Non-metropolitan / rural | 1,881 (71.3) | 133 (67.8) | | | | |
| Witnessed cardiac arrest | 341 (12.9) | 98 (50.0) | < .001 | 3.86 | 2.61-5.71 | < .001 |
| Bystander response | 598 (22.6) | 78 (39.7) | < .001 | 0.83 | 0.58-1.21 | .34 |
| Shockable rhythm | 28 (1.0) | 13 (6.6) | < .001 | 1.56 | 0.63-3.70 | .31 |
| Arrest in public place | 352 (13.3) | 26 (13.2) | 1 | | | |
| Prehospital ROSC | 58 (2.1) | 58 (29.5) | < .001 | 16.11 | 10.16-25.64 | < .001 |
| Poisoning substance | | | < .001 | | | |
| Medically prescribed drugs | 289 (10.9) | 49 (25.0) | | Reference | - | - |
| Gases and vapors | 1,262 (47.8) | 53 (27.0) | | 0.54 | 0.33-0.89 | .01 |
| Pesticides | 816 (30.9) | 60 (30.6) | | 0.79 | 0.48-1.30 | .35 |
| Alcohol-based substances | 49 (1.8) | 3 (1.5) | | 0.39 | 0.06-1.51 | .23 |
| Unspecified and biological toxins | 222 (8.4) | 31 (15.8) | | 1.21 | 0.69-2.12 | .49 |
| Multiple substances poisoning | 23 (0.8) | 3 (1.5) | .58 | | | |
| Arrest-to-ED interval time | | | < .001 | | | |
| ≥ 61 minutes | 650 (24.6) | 24 (12.2) | | Reference | - | - |
| 31-60 minutes | 1,513 (57.3) | 88 (44.8) | | 1.77 | 1.08-3.02 | .02 |
| ≤ 30 minutes | 475 (18.0) | 84 (42.8) | | 3.44 | 2.00-6.09 | < .001 |

Continuous variables are presented as medians (interquartile ranges). Categorical variables are presented as numbers (percentages). *aOR,* adjusted odds ratio; *ED,* emergency department; *ROSC,* return of spontaneous circulation.

**Table 3.** Distribution of clinical outcomes (survival to discharge or in-hospital death) based on WAIVOR score cutoff among patients with poisoning-induced out-of-hospital cardiac arrest in both derivation and validation cohorts.

| | Derivation cohort (n = 2,834) | | Validation cohort (n = 1,418) | |
|---|---|---|---|---|
| | In-hospital death (n = 2,638) | Survival to discharge (n = 196) | In-hospital death (n = 1,323) | Survival to discharge (n = 95) |
| WAIVOR score ≤ 4 | 1,924 (67.8%) | 44 (1.5%) | 939 (66.2%) | 31 (2.1 %) |
| WAIVOR score ≥ 5 | 714 (25.1%) | 152 (5.3%) | 384 (27.0%) | 64 (4.5%) |

*WAIVOR,* a scoring system to aid in identifying prognostic outcome of survival to hospital discharge in cases of poisoning-related cardiac arrest.

(in-hospital death) and making decisions regarding the continuation of resuscitation efforts. Although the universal termination of resuscitation (TOR) guideline has demonstrated excellent predictive performance, it possesses significant limitations for P-OHCA cases.[12,13] The universal TOR guideline was primarily validated in cardiac-origin arrests, excluding non-cardiac etiologies; it was designed for pre-transport decision-making by EMS personnel, limiting its applicability to ED-based decisions in P-OHCA cases. Subsequent studies have developed and validated ED-based TOR criteria in the Japanese population, achieving high PPV for unfavorable neurological outcomes and one-month mortality.[14,15] However, these studies predominantly comprised cardiac-origin arrests (48.2-55.7% of study populations),

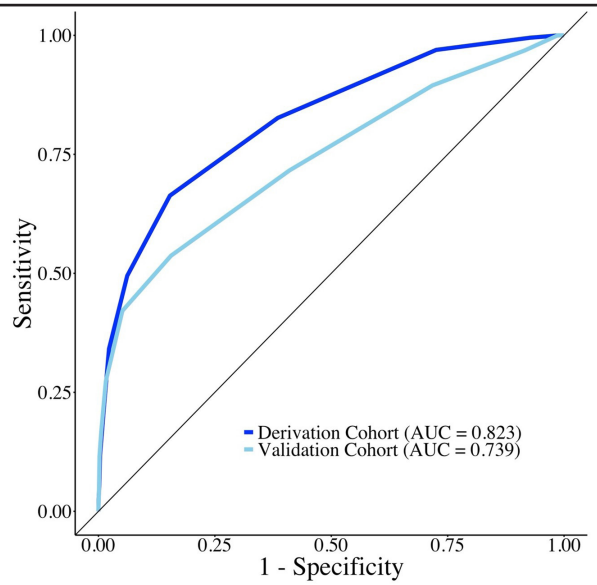


**Figure 3.** Receiver operating characteristic curves demonstrating the predictive performance of the WAIVOR score for survival to hospital discharge among patients with poisoning-induced out-of-hospital cardiac arrest in both derivation and validation cohorts. *AUC,* area under the receiver operating characteristic curve.

potentially limiting their generalizability to P-OHCA cases.

Emergency physicians currently face significant challenges due to the absence of objective, evidence-based prognostic tools specifically tailored for patients with P-OHCA. The primary contribution of our study lies in addressing this critical clinical gap by proposing the first systematic approach to stratifying prognosis in this unique patient population. While we emphasize that clinical decisions regarding TOR should not rely solely on the WAIVOR score, this tool offers an initial evidence-based framework to support structured prognostic discussions and informed decision-making. Ultimately, our study serves as a foundational step toward establishing more robust, evidence-driven prognostication strategies for P-OHCA and is intended to encourage further external validation and clinical application research in this challenging domain.

According to the current guidelines of the European Resuscitation Council, clinicians are encouraged to prepare for prolonged resuscitation efforts and consider the use of extracorporeal cardiopulmonary resuscitation (ECPR) in cases of cardiac arrest due to poisoning.[16] In this context, the WAIVOR score, particularly when below the defined threshold, may serve as a helpful tool to support clinical decision-making regarding the appropriateness of conventional vs prolonged resuscitation strategies or the potential candidacy for ECPR. However, further prospective research is needed to validate its utility in such applications.

The relatively low PPV of 19.8% at the optimal cutoff of five points can be attributed to the low baseline prevalence of survival to hospital discharge in P-OHCA cases. In low-prevalence conditions, such as survival in P-OHCA, PPV is inherently low, whereas NPV remains high, which is a known statistical phenomenon.[17] Given the prevalence-dependent nature of predictive values, the low frequency of survival outcomes inherently constrains the proportion of true positives among predicted positives. These findings underscore the importance of interpreting PPV within the context of low-prevalence conditions and emphasize the clinical utility of the WAIVOR score in identifying poor prognostic outcomes, as evidenced by its high NPV.

The AUC demonstrated excellent discriminative performance in the derivation cohort (AUC = 0.823) and good performance in the validation cohort (AUC = 0.739). The AUC observed in the derivation cohort may be inflated due to inherent overfitting of the prediction model to the derivation dataset.[18] Additionally, the smaller size of the validation cohort may have increased statistical variability in AUC estimation.

Although numerous prognostic scoring systems have been developed for OHCA, their direct comparison with the WAIVOR score was precluded in this study for the following reasons. First, existing prediction models have been developed largely for patients with OHCA and cardiac or medical etiologies, which differ from the patient population in this study. Second, various prediction models target different clinical outcomes. A recent review identified 16 prediction models for OHCA, with 10 models predicting different clinical outcomes (ROSC, neurological outcomes, and long-term outcomes).[8] Third, the OHCAS database lacks several variables used in other prediction models. The prognostic scores predicting survival to hospital discharge (NULL-PLEASE score, PCAC score, CREST score, PEA score, and GCS) require specific clinical parameters: laboratory (serum pH and lactate); imaging (cardiac ejection fraction); and physical examination (neurological motor and brainstem responses) results.[8] These parameters are unavailable in the OHCAS dataset. However, such detailed clinical information is often unavailable during the initial ED presentation of patients with cardiac arrest. The WAIVOR score uses readily available parameters derived from EMS personnel or patient caregivers. Although future external validation studies comparing the WAIVOR score with existing prediction models are warranted, its simplicity and real-time applicability may confer superior clinical utility in emergency settings, even if other prediction models exhibit higher predictive performance.

Regarding poisoning substances, P-OHCA caused by gases and vapors demonstrated significantly lower survival to discharge compared to P-OHCA caused by medically prescribed drugs, aligning with two previous studies.[5,11] However, while two prior studies reported significantly reduced survival in pesticide-related P-OHCA, our study did not demonstrate such an association. This discrepancy may be attributed to temporal changes, as our study encompassed more recent data (2013–2023). Pesticide self-poisoning has shown a global declining trend.[19] In South Korea, specifically,

regulatory interventions have substantially altered P-OHCA patterns. The 2012 paraquat ban, implemented in response to its frequent use in self-poisoning, has contributed to annual reductions in pesticide ingestion cases and a 10% decrease in national suicide rates.[20-22] Consequently, the use of more contemporary data in our study may explain the attenuated impact of pesticides on survival to hospital discharge.

In this study, the survival to hospital discharge rate among patients with P-OHCA was 6.8% (n = 291), which is relatively lower than the 9% pooled rate of survival to hospital discharge reported in a prior meta-analysis.[6] This discrepancy may be explained by differences in the distribution of causative agents. While opioids were the most common etiology in the previous study, the most frequently identified poisoning substances in our cohort were gases and vapors (45.3%), followed by pesticides (31.5%). These two categories together account for 76.8% of cases and are generally associated with high lethality, which may have contributed to the poorer outcomes observed in our study.

Notably, the five remaining variables included in the WAIVOR score, aside from the "gas or vapor" component, are commonly used predictors in previously published general OHCA scoring systems.[8,23] However, unlike cardiac-origin OHCAs, outcomes in P-OHCA are significantly influenced by the nature of the toxic agent. Therefore, even if similar variables are used, the relative prognostic contribution of each factor may vary depending on the underlying etiology of cardiac arrest. In this study, we quantitatively assessed the prognostic impact of each variable specifically within the P-OHCA population using multivariable logistic regression analysis. As a result, we believe that the WAIVOR score offers improved predictive accuracy tailored to P-OHCA. Nonetheless, further prospective multicenter studies are warranted to externally validate these findings.

Our analysis showed that two key predictors, bystander response and shockable rhythm, which are typically associated with favorable outcomes in general OHCA populations, were not independently significant predictors in our P-OHCA cohort. The low prevalence of shockable rhythms and the strong association between prehospital ROSC and clinical outcome may have overshadowed the predictive value of other variables, thereby limiting the statistical power to detect significant associations in the multivariable model.

## LIMITATIONS

This study has some limitations. First, our findings may not be generalizable to pediatric P-OHCA cases or global populations, as our study focused on adult patients in South Korea. Second, the possibility of selection bias cannot be entirely ruled out. Some cases may have been misclassified as P-OHCA despite having non-poisoning etiologies. Additionally, the OHCAS database excludes patients who were not resuscitated due to obvious signs of irreversible death, such as rigor mortis or decapitation. This raises the possibility that acute poisonings involving highly lethal substances with rapid onset, such as cyanide, may have been excluded from our analysis. However, case classification in the OHCAS registry is based on a comprehensive national survey conducted by trained experts, integrating EMS records and hospital data, which likely minimizes the risk of significant misclassification. Third, we did not take into account the quantities of the poisoning agents ingested or exposed to. However, accurate dose estimation is often infeasible in real-world settings due to the unconscious state of patients, absence of reliable witness accounts, and the inherent difficulty in quantifying exposure, particularly for gaseous substances. Although exposure dose could not be incorporated, this was a necessary trade-off to preserve the clinical applicability and practicality of the WAIVOR score in acute care environments. Lastly, this study lacks external validation; however, internal validation was performed to maintain objectivity. Additionally, the OHCAS data represent the largest OHCA database in South Korea, providing a sufficiently representative sample of patients with OHCA.

## CONCLUSION

We developed and validated a simple scoring system, the WAIVOR score, whose elements are associated with the probability of survival to hospital discharge in cases of poisoning-induced out-of-hospital cardiac arrest. This score incorporates key factors, including sex, age < 65 years, arrest-to-ED interval time, poisoning substance (other than gas or vapor), witnessed cardiac arrest, and prehospital ROSC. The WAIVOR score demonstrated robust predictive performance, with high negative predictive value, making it a valuable tool for guiding clinical decision-making and optimizing resource allocation. However, due to the limitations of this study, these findings should be considered preliminary rather than conclusive. Further research is warranted before the WAIVOR score can be established as a guideline and applied in clinical decision-making for patients with P-OHCA. The study's findings could help establish strategies for enhancing the management and treatment of P-OHCA.

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# Emergency Medicine Residents' Performance with National Institutes of Health Stroke Scale and Its Impact on Key Stroke-care Metrics

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**Background:** Emergency medicine (EM) physicians commonly use the National Institutes of Health Stroke Scale (NIHSS) to assess acute ischemic strokes in community settings. However, this assessment is often led by neurology residents in academic teaching hospitals. We implemented a quality improvement intervention to improve EM resident comfort with the NIHSS and to assess if EM resident-led NIHSS evaluation prolonged key stroke metrics, such as door-to-CT (DTCT), door-to-needle (DTN), or door-to-groin puncture (DTGP) times, which may affect stroke outcomes.

**Methods:** This prospective observational comparison analyzed all patients with acute ischemic strokes at the Zuckerberg San Francisco General Hospital, a Level I trauma center from April 2021–October 2022. We implemented the intervention from April 2022 –October 2022 which included NIHSS certification for all residents and attendings. Both EM and neurology residents recorded NIHSS scores separately for each patient and scores were revealed to each resident during patient care once completed. We then compared stroke metrics between pre- and post-intervention periods.

**Results:** There were 247 and 122 strokes included in our analysis, pre- and post-intervention, respectively. Overall, 58% (n=213) of all patients were female, 33% were Asian (n=123), and Cantonese was the second most common language after English (15%, n=54). Mean overall NIHSS scores were similar between EM and neurology residents, 6.6 (IQR = 2, 10) and 6.7 (IQR = 1, 10), ($p < 0.001$), respectively, with substantial agreement between groups (84.4%, $\kappa = 0.63$). Median DTCT times were 25 and 28 minutes (p=0.2), DTN times were 38 and 35 minutes (p=0.7), and DTGP times were 94 and 110 minutes (p=0.1) for pre- and post-intervention groups, respectively.

**Conclusion:** The NIHSS is one element of stroke evaluation and management that can impact stroke metrics. Our intervention found that EM resident-led NIHSS assessment did not prolong DTCT, DTN, and DTGP times and met nationally established goals. [West J Emerg Med. 2025;26(6)1764–1768.]

## INTRODUCTION

Stroke remains one of the leading causes of death and disability in the United States, affecting nearly 800,000 people annually, 87% of which are ischemic.[1] The National Institutes of Health Stroke Scale (NIHSS) is a 15-item neurologic assessment used in the evaluation of acute ischemic strokes[2]

and is strongly predictive of outcome after stroke.[3–5] This survey is used to assess severity, with higher scores correlating with more severe strokes evidenced by more profound neurologic deficits.[6] The NIHSS score aids in treatment decisions, either with intravenous tissue plasminogen activator (tPA) or endovascular thrombectomy (EVT). Key metrics in stroke management include time from hospital presentation to computed tomography (CT) imaging (door-to-CT time), thrombolytic therapy (door-to-needle time), and EVT (door-to-groin puncture time), as improvement in these measures correlates with decreased in-hospital mortality, improved clinical outcomes, and reduced one-year mortality.[7–9] The literature is sparse on NIHSS training among emergency medicine residents as it relates to the management and outcomes of acute ischemic strokes. The American Heart Association (AHA) updated its Stroke Phase III guidelines to establish national goals of door-to-needle times <60 minutes and door-to-groin puncture times <90 minutes for patients arriving directly to a stroke center.[10]

While the NIHSS is used in community emergency departments (ED) across the US, it is not uncommon for the NIHSS is to be conducted by neurology residents at academic hospitals. This poses a potential area of improvement in emergency medicine (EM) training, especially for graduates who plan to practice in community settings. We sought to determine whether a stroke quality improvement (QI) intervention could improve EM residents' comfort with the NIHSS and stroke management. (We analyzed these surveys of resident comfort levels and will discuss them in a separate paper.) We also aimed to see whether this intervention would influence acute stroke metrics, including door-to-CT, door-to-needle, and door-to-groin puncture times before and after our intervention.

*Population Health Research Capsule*

What do we already know about this issue?
*Data are limited comparing key stroke metrics between emergency medicine and neurology residents.*

What was the research question?
*Do NIHSS-trained EM residents prolong key stroke metrics compared to neurology residents?*

What was the major finding of the study?
*There was no significant difference in door-to-CT, door-to-needle, or door-to-groin puncture times.*

How does this improve population health?
*Establishing NIHSS training for EM residency programs allows for more competent evaluation and management of ischemic strokes.*

## METHODS

Our group sought oversight from our local Institutional Review Board (IRB) who determined our project to be a quality improvement initiative and not research. We analyzed all data with R Version 4.1 (R Foundation, Vienna, Austria), using Chi-square or Fisher's exact tests for categorical data and using Wilcoxon rank-sum tests for continuous data.

This prospective observational comparison included all patients with ischemic strokes presenting to the Emergency Department at Zuckerberg San Francisco General Hospital, a public safety net hospital and Level I trauma center, from April 2021–October 2022. We implemented our intervention in April 2022 and included NIHSS certification for all EM residents in their second through fourth post-graduate years (PGY 2-4) and attending physicians. This accreditation process involved a 6-part 8 hour online module through the American Heart Association11. During this six-month pilot, EM and neurology residents separately collected and calculated the NIHSS via a REDCap survey form which can be viewed in the supplementary section. NIHSS was used as the main clinical decision making tool for stroke management. Other tools, such as the modified Rankin scale, were not used. The examination itself was performed in tandem by both the neurology and EM residents. The survey results themselves were blinded to each other until both scores were submitted. The results subsequently displayed a side-by-side comparison of NIHSS scoring by both EM and neurology teams allowing for discussion of similarities and differences in scoring. Both EM and neurology were involved in scoring and deciding if the patient would be imaged in the post intervention group. The mean overall NIHSS scores of approximately 30 matched surveys were similar between the two groups which was discussed in a separate paper12. There was no designated time for score revelation, however, most would happen during patient care (e.g. while patient was in CT scan).

As primary outcomes, we compared DTCT, DTN, and DTGP times for all ischemic strokes occurring before and after the intervention periods. We excluded 6 patients with DTCT times greater than 8 hours and 2 patients with DTN and DTGP times greater than 6 hours from the analysis from all ischemic strokes. There were no other exclusion criteria. Our study had 80% power at a two-tailed alpha to detect absolute differences in DTCT times less than 30 minutes greater than or equal to 15%.

## RESULTS

Our analysis included 369 ischemic stroke patients presenting to the ED, with 247 (67%) strokes analyzed prior to intervention and 122 (33%) analyzed after intervention. 9.76% of all patients in our analysis had groin puncture

**Table.** Emergency department stroke metrics in a study of National Institutes of Health Stroke Scale performance by emergency medicine residents compared with neurology residents.

| | | Overall N=369 | Pre n=247 | Post n=122 | *P*-value |
|---|---|---|---|---|---|
| Age | 18-44 | 24 (6.5%) | 17 (6.9%) | 7 (5.7%) | |
| | 45-54 | 29 (7.9%) | 16 (6.5%) | 13 (11%) | |
| | 55-64 | 82 (%) | 52 (21%) | 30 (25%) | .7 |
| | 65-74 | 95 (%) | 65 (26%) | 30 (25%) | |
| | 75-84 | 72 (%) | 51 (21%) | 21 (17%) | |
| | 85+ | 67 (%) | 46 (19%) | 21 (17%) | |
| Sex | Female | 156 (42%) | 106 (43%) | 50 (41%) | .7 |
| | Male | 213 (58%) | 141 57%) | 72 (59%) | |
| Race | Asian | 123 (33%) | 90 (36%) | 33 (27%) | |
| | Black | 77 (21%) | 46 (19%) | 31 (25%) | .2 |
| | White | 76 (21%) | 48 (19%) | 28 (23%) | |
| | Other | 93 (25%) | 63 (26%) | 30 (25%) | |
| Language | Mandarin/ Cantonese | 54 (15%) | 41 (17%) | 13 (11%) | |
| | English | 217 (59%) | 142 (57%) | 75 (61%) | .5 |
| | Spanish | 53 (14%) | 34 (14%) | 19 (16%) | |
| | Other | 45 (12%) | 30 (12%) | 15 (12%) | |

(n=36). The table describes baseline demographics and characteristics of patients with ischemic strokes. Overall, 213 patients (58%) were female, and 123 (33%) were Asian, with Cantonese the second most common language spoken after English (54, 15%). There was no statistically significant difference between the pre- and post-intervention group demographics and characteristics with regard to sex, race, and language. Median door-to-CT times were 25 minutes (interquartile range [IQR] 8-74) during the pre-intervention period and 28 minutes (IQR 20-65) for the post-intervention period (*P*=.2). Median door-to-needle times were 38 minutes (IQR 26-56) and 35 minutes (IQR 30-48) pre- and post-intervention, respectively (*P*=.7). A total of 122 patients (54%) in the post-intervention period and 56 (53%) in the pre-intervention had door-to-CT <30 minutes (*P*=.8), while 37 patients (80%)in the pre-intervention and 17 (77%) in the post-intervention period had door-to-needle times <60 minutes (*P*=.8). Median door-to-groin puncture times were 94 minutes (IQR 80-114) and 110 minutes (IQR 99-138) pre- and post-intervention, respectively (*P*=.1). There was no statistically significant difference in acute stroke metrics between the pre- and post-intervention. Figures 1-5 provide a comparison of door-to-CT, door-to-needle, and door-to-groin puncture times pre- and post-intervention.

## DISCUSSION

Efficient and timely evaluation and management of acute ischemic strokes are imperative in improving morbidity after stroke. The NIHSS is one part of stroke management that can impact key stroke metrics, such as door-to-CT, door-to-needle, and door-to-groin puncture times. As the NIHSS is at the crux of management of acute stroke, particularly in community EDs, our goal was to assess whether emergency physicians trained in using the NIHSS and performing the NIHSS alongside neurology residents at an academic institution would affect key stroke metrics. We found that EM resident-led NIHSS assessment had no impact on door-to-CT, door-to-needle, and door-to-groin puncture times. During both the pre-intervention and post-intervention periods, most door-to-needle times were <60 minutes, meeting the national goal of the AHA Stroke Phase III guidelines. Most of the median door-to-groin puncture times, however, were >90 minutes for both the pre- and post-intervention periods, which exceeded the door-to-device goal set by the AHA.[9] We did not investigate the reasons for longer door-to-groin puncture

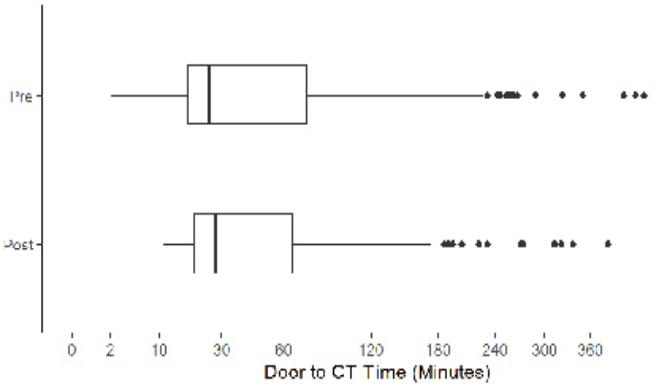


**Figure 1.** Door-to-computed tomography times in minutes in a study of National Institutes of Health Stroke Scale performance by emergency medicine residents compared with neurology residents.

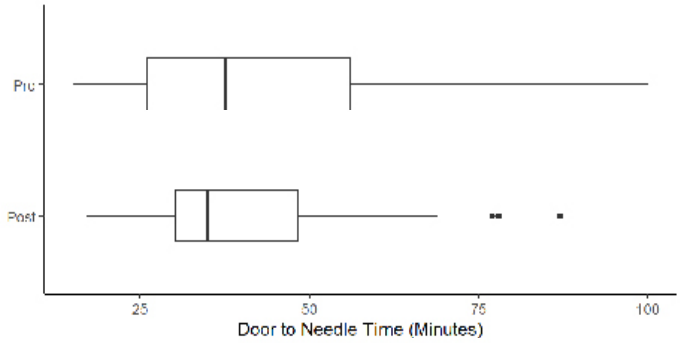


**Figure 2.** Door-to-needle time in minutes in a study of National Institutes of Health Stroke Scale performance by emergency medicine residents compared with neurology residents.

| Ischemic Strokes (n=369) | Estimated Mean Difference (95% CI), in Minutes* |
|---|---|
| Door-To-CT (Minutes), Median(IQR) | 1.01 (0.97 - 1.08) |
| Door-To-Needle (Mins), Median(IQR) | 0.96 (0.75 - 1.23) |
| Door-To-GP (Mins), Median(IQR) | 1.72 (1.01 - 2.94) |

**Figure 4.** Estimated mean difference in minutes in a study of National Institutes of Health Stroke Scale performance by emergency medicine residents compared with neurology residents.
*CI,* confidence interval; *CT,* computed tomography; *IQR*, interquartile range.

| Ischemic Strokes (n=369) | Mean Difference in Proportions (95% CI) |
|---|---|
| Door-To-CT < 30 minutes, n(%) | -0.02 (-0.12 to 0.09) |
| Door-To-Needle < 45 minutes, n(%) | 0.09 (-0.16 to 0.35) |
| Door-To-GP < 60 minutes, n(%) | -0.04 (-0.36 to 0.28) |

**Figure 5.** Estimated mean difference in proportions (95% CI) in a study of National Institutes of Health Stroke Scale performance by emergency medicine residents compared with neurology residents.
*CI,* confidence interval; *CT,* computerized tomography.

times; the impact of the NIHSS on these times specifically remains unknown.

Our QI initiative demonstrated that it is possible to incorporate NIHSS training within EM residency training without having the detrimental effect of prolonging stroke metrics. While there is limited literature on NIHSS training among EM residency programs, one study did survey neurology residents' comfort with assessing and managing acute ischemic strokes with components including NIHSS evaluation and tPA. This 10-year survey showed significantly increased reported proficiency and comfort levels.[12] However, more studies are needed to further investigate this relationship.

## LIMITATIONS

There were several limitations to our study. While the NIHSS scores were blinded, the exam itself was done in tandem. While residents were instructed not to disclose scoring during the examination, the exam itself was not completely blinded. The NIHSS surveys were voluntarily submitted by EM and neurology residents. Thus, not every stroke-activated patient had documented surveys. Of 122 post-intervention strokes there were 29 surveys completed by both EM and neurology residents. Additionally, surveys were anonymized, and the level of training for each resident was not recorded. This could have had some unmeasured effect on door-to-CT, door-to-needle, and door-to-groin puncture times, wherein more senior residents could have made their assessments and management decisions faster than junior residents.

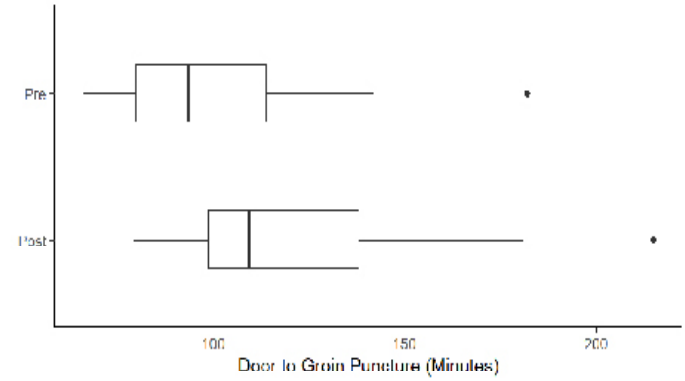


**Figure 3.** Door-to-groin puncture time in minutes in a study of National Institutes of Health Stroke Scale performance by emergency medicine residents compared with neurology residents.

Further, because the dates of the surveys collected were not recorded, we did not perform a time series analysis, which could have helped determine whether other factors led to effects on stroke metrics. A final limitation to our study was our designation of neurology residents as the gold standard for acute ischemic stroke care. Our pre-intervention metrics were all based on neurology-led NIHSS assessments; however, the variability in training and accuracy may have had an unmeasured effect. Our study was also conducted at an urban, Level I trauma center and public, safety-net hospital with 24-hour neurology consultation, which may limit generalizability. However, our study population did include a diversity of socioeconomic statuses and primary languages spoken, which could be generalized to other study populations.

## CONCLUSION

The National Institutes of Health Stroke Scale is a vital part of acute ischemic stroke assessment and can be

incorporated into EM resident training without delaying critical imaging or treatment metrics. Future studies that address the limitations are necessary to further characterize EM resident impact on key stroke metrics in a variety of settings including demographics, time frame, geography, and in-house resources.

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# Prevalence and Impact of Violence Against Healthcare Workers in Brazilian Emergency Departments: A National Survey

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**Introduction:** Workplace violence (WPV) is a significant occupational hazard in healthcare, with emergency departments (EDs) recognized as high-risk environments. Although globally significant, data from Latin America remain scarce. In this study we aimed to evaluate the prevalence and effects of WPV on healthcare workers in Brazilian EDs.

**Methods:** We conducted a cross-sectional survey of healthcare workers in Brazilian EDs. Respondents indicated verbal and physical violence experienced within the preceding six months, along with associated psychological and occupational impacts. Univariable models identified significant associated factors, followed by multivariable models to determine independent associated factors of WPV. We reported results as adjusted odds ratios (aOR) with 95% confidence intervals. Statistical analyses were performed in R v4.4.1, and significance was defined as $P < .05$.

**Results:** The response rate was 19.1% (1,255/6,570), Of those responses, 61.3% (769/1,255) met the inclusion criteria and were included in the analysis. Of all respondents, 84.0% were physicians. Respondents indicated 79.6% (612/769) occurrence of WPV, including verbal abuse (79.5%) and physical assault (12.1%). Physical assaults against co-workers were witnessed by 40.3% of respondents. Perpetrators included visitors (85.3%), patients (80.7%), and co-workers (35.8%). The absence of institutional preventive measures was associated with increased WPV (aOR, 2.47; 95% CI, 1.71-3.57; $P < .001$), while the presence of security staff reduced WPV (aOR, 0.61; 95% CI, 0.42–0.89; $P = .01$). Indicated impact included post-traumatic stress symptoms (88.4%), considering leaving their job (49.5%), impaired workplace performance (75.2%), and time off work (10%), including 11.5% permanently leaving.

**Conclusion:** Workplace violence is highly prevalent in Brazilian EDs, with substantial psychological and occupational consequences. The absence of protocols or preventive measures may increase WPV risk, emphasizing the urgent need for public policies to protect healthcare workers in emergency settings. [West J Emerg Med. 2025;26(6)1769–1780.]

## INTRODUCTION

Workplace violence (WPV) has emerged as a critical occupational hazard in healthcare since its initial recognition in the 1990s.[1-3] The Joint Commission report defines WPV as "any act or threat that occurs in the workplace, including verbal, nonverbal, written, or physical assaults, as well as threats, intimidation, harassment, or humiliating words or actions".[4] A systematic review including studies from Asia, Europe, and North America reported that 61.9% of healthcare workers experience WPV, with 42.5% indicating verbal abuse and 24.4% encountering physical assault.[5]

The emergency department (ED) is a high-risk environment for violence, driven by factors such as crowding, staff shortages, off-hours work, and the presence of patients with substance use disorder, acute intoxication, behavioral health conditions, delirium, or altered mental status.[6-8] Recent surveys conducted in ED of the United States and a systematic review found that 71.5% to 75.0% of healthcare workers indicated being victims of verbal abuse, while physical assault was reported by 18-30.8%.[7,9-11] Workplace violence significantly impacts staff, increasing the risk of burnout and post-traumatic stress disorder (PTSD) and decreasing job satisfaction, all of which threaten staff retention and lead to high staff turnover.[12]

Furthermore, WPV impacts patient care and has significant effects on the healthcare system, with increased financial costs due to healthcare needs for staff injuries and absenteeism following a violent event.[6] These findings have led national healthcare organizations to implement preventive measures, including legislative reforms, institutional protocols, and increased criminal penalties for WPV.[13] Although single-center studies in Brazil show WPV rates similar to those reported in other countries, a national assessment is lacking, limiting awareness and establishment. of effective interventions.[14,15]

Therefore, we conducted a national cross-sectional survey to determine the prevalence of WPV in EDs across Brazil and to assess how WPV affects healthcare workers.

*Population Health Research Capsule*

What do we already know about this issue?
*Workplace violence is a major occupational hazard in emergency departments worldwide, associated with negative psychological impacts.*

What was the research question?
*What is the prevalence and impact of workplace violence on ED healthcare workers across Brazil?*

What was the major finding of the study?
*Workplace violence affected 79.6% of respondents, and the absence of prevention measures was associated with higher odds of exposure (adjusted OR, 1.88; 95% CI, 1.10-3.21; P = .02).*

How does this improve population health?
*This study highlights the need of policies to protect ED staff and ensure care quality under high-risk conditions.*

## METHODS

### Study Design and Setting

We conducted a cross-sectional survey of healthcare workers in EDs across Brazil. The survey was administered using the Research Electronic Data Capture (REDCap) platform, hosted at Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo.[16] Informed consent was obtained at the beginning of the survey, with respondents indicating their agreement by responding affirmatively to the initial consent question. Responses were collected anonymously. The study protocol was approved by the institutional review board. This study is reported in accordance with the Checklist for Reporting Results of Internet E-Surveys (CHERRIES) guidelines.[17]

The setting was Brazilian EDs, which is divided into three sectors: the public sector (Unified Health System, SUS); the private sector; and the private health insurance sector.[18] Public emergency care encompasses prehospital services, community EDs, and hospital facilities. Community EDs, which provide services of intermediate complexity, along with some hospitals, serve as primary access points to emergency care. Meanwhile, other EDs are referral-only centers that primarily treat patients referred from lower complexity healthcare services, along with a smaller proportion of individuals from prehospital care and those seeking care independently. The public sector serves the majority of the population, with 74% of individuals relying on public hospitals for care.[19] However, EDs in the public sector face significant challenges, including crowding, elevated mortality rates, and staffing shortages.[18,20] Furthermore, emergency medicine (EM). is a relatively new specialty in Brazil, officially recognized only in 2015[21] and represented just 0.2% of all medical specialties in 2022.[22]

### Selection of Participants

The target population was Brazilian healthcare staff who had worked in the ED for at least 12 hours a week in the prior six months (March/April to September/October 2024). These healthcare workers included physicians, nurses, nursing technicians, and respiratory therapists, including workers in training. The survey was distributed by email using the distribution list of the Brazilian Association of Emergency Medicine (ABRAMEDE), which includes 6,570 members,

primarily consisting of emergency physicians. Four reminders were sent during the collection period. We included in the study only the respondents who consented to the research, completed the survey, and had worked in the ED for at least 12 hours a week in the prior six months. To prevent multiple entries from the same individual, a log file analysis was carried out by the REDCap platform to ensure only one response by the individual link sent to each email.

**Survey Development and Measurements**

Survey participation was voluntary, with no incentives provided. Responses were collected via the REDCap platform from September 11–October 14, 2024. The survey (eTable 4, Appendix 1) was adapted from McGuire et al,[6,11] which examined WPV in Midwestern EDs in the United States. To ensure clarity and comprehension, we conducted a pilot study with 150 emergency physicians and EM residents. The Portuguese-language survey was comprised of 76 questions organized into five categories: demographic data, including self-reported sex and race; verbal abuse; physical assault; institutional characteristics; and the impact of violence on staff. Respondents were able to review and change their answers through a "back button," and all surveys were checked for completeness after submission.

Staff were asked whether they had experienced verbal abuse or physical assault, either personally or as a witness, over the prior six months. The definition of verbal abuse, as outlined by Farrell et al,[23] was "any form of mistreatment, whether explicit or implied, that causes feelings of devaluation or humiliation through derogatory language, threats, accusations, or disrespectful expressions.". The definition of physical assault was based on the World Health Organization's description as "the use of physical force that results in physical, sexual, or psychological harm."[24]

For those who indicated experiencing verbal abuse, further questions were asked to categorize the type of abuse, including: threatening tone, abusive language, verbal harassment (racial, sexual, gender-based, or other), or other forms of verbal abuse. Regarding physical assault, respondents were asked to specify the nature of the assault, including physical assault with objects, body fluids, physical harm with punching, biting, rough handling, scratching, kicking, shoving/pushing, or hitting, sexual assault, or other forms of physical assault.

For each type of verbal abuse and physical assault, respondents were asked to indicate the frequency of occurrence over the prior six months: none; once; 2-5 times; 5-10 times; or more than 10 times. They were also asked to identify the perpetrator—whether a patient, visitor, or coworker—and specify the frequency of such incidents for each type of perpetrator over the prior six months using the same frequency options. Additionally, staff were questioned about the impact of the violence, such as whether it necessitated taking time off work (days, weeks, or permanently), influenced their consideration of leaving their job, affected their interactions with patients, or led to symptoms of post-traumatic stress.

Respondents were also surveyed regarding their perception of safety in the ED, as well as the availability of institutional WPV preventive measures, such as protocols for managing severe agitation, staff training, security personnel in the ED, and the presence of metal detectors. They were further questioned about their preferred medication for managing severe agitation, with options including ketamine, haloperidol, a benzodiazepine, a combination of haloperidol and a benzodiazepine, a combination of haloperidol and promethazine, propofol, or other medications.

**Outcomes**

The primary outcome was the prevalence of WPV, defined as the presence of verbal or physical assault experienced by healthcare workers during their clinical shift. To minimize recall bias, the assessment period was restricted to incidents occurring within the six months prior to the survey. Secondary outcomes included the prevalence of witnessed physical assault, the prevalence of workers temporarily absent from work due to assault, the incidence of post-traumatic stress symptoms, and description of factors associated with verbal and physical assault.

**Analysis**

The response rate was defined as the number of people who responded to the survey divided by the number of total potential respondents. We summarized the survey responses using frequency counts and percentages. Demographic characteristics and ED practice features were compared between respondents who indicated experiencing WPV and those who did not, using two-sided chi-square tests or Fisher exact tests, as appropriate. We employed logistic regression to evaluate potential risk factors for WPV, including respondent demographics, ED practice characteristics, and institutional violence prevention measures. The primary outcome was self-reported verbal abuse or physical assault within the prior six months. Based on expert knowledge, we pre-selected variables hypothesised to be risk factors for WPV. These variables were initially assessed using univariable logistic regression.

To account for potential confounding by age and sex, we performed an additional logistic regression model adjusted for these two variables. Finally, variables with significant associations ($P < .05$) were included in a multivariable logistic regression model to identify independent associated factors of WPV. All statistical analyses were performed using R v4.4.1 (The R Foundation for Statistical Computing, Vienna, Austria). Statistical significance was defined as a two-sided *P*-value of < .05. We calculated nonresponse bias by wave analysis, using survey question 49 "How safe do you feel in the Emergency Department?" as a five-point Likert scale (1 - extremely safe and 5 - not at all safe).[25]

## RESULTS

Of the 6,570 emails sent, 1,255 surveys were returned, with a response rate of 19.1% (1,255/6,570). Of those, 769/6,570 (11.7%) were included in the analysis.[25] We excluded 391 surveys (31.1%) with incomplete responses, defined as those with at least two unanswered questions; 91 respondents (7.2%) with fewer than six months of ED experience; and four surveys that lacked consent (0.3%) (eFigure 1, Appendix 1). The survey completion rate, calculated as the percentage of respondents who fully completed the survey among those who initially agreed to respond, was 71.8%.[17] The nonresponse bias was 0.048, with a proportion of nonrespondents of 5,315/6,570, mean true respondents of 3.408 from 115 responses, and mean proxy nonrespondents of 3.467 from 75 responses.[25]

The majority of respondents were physicians (n = 646; 84.0%), of whom 80.5% were attending physicians and 19.5% were resident physicians, followed by 62 who were nurses (8.1%) and 28 nursing technicians (3.6%). Respondent demographic characteristics are summarized in Table 1. The median age of respondents was 32 years, (interquartile range 28-39 years), with most identifying as cisgender women (n = 437; 56.8%) followed by cisgender men (n = 318; 41.4%). The majority identified as heterosexual (n = 642; 83.5%) and White (n = 590; 76.7%). The primary region of practice was the Southeast (n = 371; 48.2%), followed by the South (n = 205; 26.7%), with a minority from the Northeast (n = 120; 15.6%), West (n = 51; 6.6%) and North (n = 22; 2.9%) region.

Most respondents were employed in public hospitals (n = 654; 85.1%), with the majority working in facilities located in capital cities (n = 369; 48.0%) or community EDs (n = 234; 30.4%). Work experience was predominantly more than five years (n = 353; 45.9%) or between 1-5 years (n = 329; 42.8%).

### Prevalence of Workplace Violence

A total of 612 respondents (79.6%) indicated experiencing some form of violence in the preceding six months, including, 611 (79.5%) who had experienced verbal abuse and 93 (12.1%) who had experienced physical assault. Additionally, 310 (40.3%) respondents witnessed physical assault against

**Table 1.** Demographic and work environment characteristics of survey respondents regarding workplace violence in Brazilian emergency departments.

| Demographic | All respondents (N = 769) | No violence (N = 157) | Any volence (N = 612) | P-value |
|---|---|---|---|---|
| Age, years | 32 (28, 39) | 36 (29, 44) | 31 (28, 38) | < .001 |
| 21-25 | 55 (7.2%) | 15 (9.6%) | 40 (6.5%) | |
| 26-30 | 272 (35.4%) | 35 (22.3%) | 237 (38.7%) | |
| 31-35 | 160 (20.8%) | 27 (17.2%) | 133 (21.7%) | |
| 36-40 | 115 (15.0%) | 27 (17.2%) | 88 (14.4%) | |
| 41-45 | 79 (10.3%) | 19 (12.1%) | 60 (9.8%) | |
| 46 or older | 88 (11.4%) | 34 (21.7%) | 54 (8.8%) | |
| Sex and Gender, n (%) | | | | .01 |
| Cisgender female | 437 (56.8%) | 80 (51.0%) | 357 (58.3%) | |
| Cisgender male | 318 (41.4%) | 73 (46.5%) | 245 (40.0%) | |
| Transgender female | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | |
| Transgender male | 3 (0.4%) | 0 (0.0%) | 3 (0.5%) | |
| Other gender | 3 (0.4%) | 3 (1.9%) | 0 (0.0%) | |
| Did not disclose | 8 (1.0%) | 1 (0.6%) | 7 (1.1%) | |
| Sexual orientation, n (%) | | | | .77 |
| Heterosexual | 642 (83.5%) | 136 (86.6%) | 506 (82.7%) | |
| Homosexual | 63 (8.2%) | 11 (7.0%) | 52 (8.5%) | |
| Bisexual | 53 (6.9%) | 8 (5.1%) | 45 (7.4%) | |
| Pansexual | 1 (0.1%) | 0 (0.0%) | 1 (0.2%) | |
| Other orientation | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | |
| Did not disclose | 10 (1.3%) | 2 (1.3%) | 8 (1.3%) | |
| Self-reported Race/skin-color, n (%) | | | | .02 |
| White | 590 (76.7%) | 118 (75.2%) | 472 (77.1%) | |

**Table 1.** Continued.

| Demographic | All respondents (N = 769) | No violence (N = 157) | Any volence (N = 612) | P-value |
|---|---|---|---|---|
| Black | 24 (3.1%) | 12 (7.6%) | 12 (2.0%) | |
| Asian | 8 (1.0%) | 1 (0.6%) | 7 (1.1%) | |
| Pardo | 139 (18.1%) | 26 (16.6%) | 113 (18.5%) | |
| Other race | 2 (0.3%) | 0 (0%) | 2 (0.3%) | |
| Did not disclose | 6 (0.8%) | 0 (0%) | 6 (1.0%) | |
| Role, n (%) | | | | < .001 |
| Attending physician | 520 (67.6%) | 97 (61.8%) | 423 (69.1%) | |
| Resident physician | 126 (16.4%) | 24 (15.3%) | 102 (16.7%) | |
| Nurse | 65 (8.5%) | 11 (7.0%) | 54 (8.8%) | |
| Respiratory therapist | 16 (2.1%) | 10 (6.3%) | (1.0%) | |
| Nursing technician | 28 (3.6%) | 9 (5.7%) | 19 (3.1%) | |
| Other role | 14 (1.8%) | 6 (3.8%) | 8 (1.3%) | |
| Years of experience, n (%) | | | | < .001 |
| Under 1 year | 87 (11.3%) | 21 (13.4%) | 66 (10.8%) | |
| 1-5 years | 329 (42.8%) | 49 (31.2%) | 280 (45.8%) | |
| More than 5 years | 353 (45.9%) | 87 (55.4%) | 266 (43.5%) | |
| Hospital region, n (%) | | | | .02 |
| Southeast | 371 (48.2%) | 78 (49.7%) | 293 (47.9%) | |
| South | 205 (26.7%) | 35 (22.3%) | 170 (27.8%) | |
| Northeast | 120 (15.6%) | 36 (22.9%) | 84 (13.7%) | |
| West | 51 (6.6%) | 4 (2.5%) | 47 (7.7%) | |
| North | 22 (2.9%) | 4 (2.5%) | 18 (2.9%) | |
| Main place of work, n (%) | | | | .07 |
| Community ED | 234 (30.4%) | 33 (21.0%) | 201 (32.8%) | |
| Small hospital (5-50 beds) | 37 (4.8%) | 8 (5.1%) | 29 (4.7%) | |
| Medium hospital (51-150 beds) | 93 (12.1%) | 20 (12.7%) | 73 (11.9%) | |
| Large hospital (>150 beds) | 369 (48.0%) | 87 (55.4%) | 282 (46.1%) | |
| Other | 36 (4.7%) | 9 (5.7%) | 27 (4.4%) | |
| ED population | | | | .61 |
| All populations | 336 (43.7%) | 71 (45.2%) | 265 (43.3%) | |
| Adult - non trauma | 353 (45.9%) | 69 (43.9%) | 284 (46.4%) | |
| Trauma | 19 (2.5%) | 6 (3.8%) | 13 (2.1%) | |
| Pediatric | 38 (4.9%) | 7 (4.5%) | 31 (5.1%) | |
| Unknown/ not reported | 23 (3.0%) | 4 (2.5%) | 19 (3.1%) | |
| Type of ED, n (%) | | | | < .001 |
| Public ED | 525 (68.3%) | 92 (58.6%) | 433 (70.8%) | |
| Referral-only public ED | 129 (16.8%) | 37 (23.6%) | 92 (15.0%) | |
| Private ED | 92 (12.0%) | 24 (15.3%) | 68 (11.1%) | |
| Unknown/ not reported | 23 (3.0%) | 4 (2.5%) | 19 (3.1%) | |

*ED,* emergency department.

a co-worker. The frequency of each type of violence is summarized in Table 2. Among those indicating verbal abuse, 596 (97.5%) experienced threatening tone of voice, 575 (94.1%) abusive language, and 343 (56.1%) verbal harassment. Furthermore, among those indicating physical assault, 83 (89.2%) experienced physical harm, 39 (41.9%)

**Table 2.** Prevalence of self-reported verbal or physical assault in the past six months, report of violence, and its impact on staff in Brazilian emergency departments.

| Prevalence of workplace violence | N (%) |
|---|---|
| Any form of workplace violence | 612 (79.6%) |
| Verbal abuse | 611 (79.5%) |
| Threatening tone | 596 (77.5%) |
| Abusive tone | 575 (74.8%) |
| Verbal harrassment | 343 (44.6%) |
| Other physical assault | 211 (27.4%) |
| Physical assault | 93 (12.1%) |
| With an object | 24 (3.1%) |
| With body fluids | 39 (5.1%) |
| Physical harm | 83 (10.8%) |
| Sexual assult | 11 (1.4%) |
| Other physical assault | 11 (1.4%) |
| Who was the perpetrator of the violence | |
| Patient | 494 (64.2%) |
| Family member | 522 (67.9%) |
| Coworker | 275 (35.8%) |
| Other perpetrator | 32 (4.2%) |
| Was the attacker intoxicated by a substance? [N=612] | |
| Yes | 118 (19.3%) |
| Did the attacker have an acute change in mental status? [N=612] | |
| Yes | 127 (20.8%) |
| Reporting Workplace Violence | |
| Did you report the incident to your supervisor? [N=612] | |
| Yes | 299 (48.9%) |
| No | 313 (51.1%) |
| If you didn't report the incident, why not? [N = 313] | |
| It wasn't important | 46 (14.7%) |
| Feeling of guilt or shame | 22 (7.0%) |
| Fear of negative consequences | 67 (21.4%) |
| Didn't have time to report violence | 94 (30.0%) |
| Reporting violence is useless | 159 (50.8%) |
| It's part of the job | 46 (14.7%) |
| Didn't know how to report violence | 63 (20.1%) |
| Other reason | 14 (4.5%) |
| Impact of Workplace Violence | |
| Do you believe being a victim of violence impacted your performance at work? [N = 612] | |
| No | 152 (24.8%) |
| Yes- for the remainder of the shift | 133 (21.7%) |
| Yes- for 1 day | 18 (2.9%) |
| Yes-for 2-7 days | 95 (15.5%) |
| Yes- for 2-3 weeks | 61 (10.0%) |
| Yes- for 1-4 months | 49 (8.0%) |
| Yes- for 2-6 months | 104 (17.0%) |

**Table2.** Continued.

| Prevalence of workplace violence | N (%) |
|---|---|
| Do you believe being a victim of violence changed the way you interact with patients? [N = 612] | |
| Yes | 458 (74.8%) |
| After the attack, did you experience repetitive thoughts, significant anxiety, loss of interest in daily activities, distance yourself from others, or avoid thinking about the incident? [N = 612] | |
| Never | 71 (11.6%) |
| Rarely | 126 (20.6%) |
| Sometimes | 193 (31.5%) |
| Often | 134 (21.9%) |
| Very often | 88 (14.4%) |
| After the attack, did you take time off work? [N = 612] | |
| No | 551 (90.0%) |
| Yes- for 1 day | 7 (1.1%) |
| Yes- for 2-3 days | 8 (1.3%) |
| Yes- for 1 week | 13 (2.1%) |
| Yes- for 2-3 weeks | 5 (0.8%) |
| Yes- for 1 month | 6 (1.0%) |
| Yes-for 2-6 months | 10 (1.6%) |
| Yes- for >6 months | 5 (0.8%) |
| Yes- permanently | 7 (1.1%) |
| Workplace Violence Against Colleagues | |
| In the past six months, have you witnessed any physical assault against a colleague? [N = 769] | |
| Physical assault | 310 (40.3%) |
| With an object | 56 (7.3%) |
| With body fluids | 95 (12.4%) |
| Physical harm | 243 (31.6%) |
| Sexual assault | 9 (1.2%) |
| Other physical assault | 27 (3.5%) |

were assaulted with body fluids, 24 (25.8%) were assaulted with objects, and 11 (11.8%) indicated sexual assault (Figure 1). Perpetrators were reported as visitors (n = 522; 85.3%), followed by patients (n = 494; 80.7%) and co-workers (n = 275; 35.8%). In most cases, the perpetrator was not perceived to be intoxicated (n = 494; 80.7%) or experiencing altered mental status (n = 485; 79.2%) (Table 2).

**Factors Associated with Workplace Violence**

In the multivariable model, the absence of preventive measures (question 63, eTable 4, Appendix 1) in the workplace was associated with an increased risk of WPV (OR, 1.88; 95% CI 1.10-3.21; *P* = .02). In the univariable analysis, the presence of an institutional protocol for managing severe agitation was associated with a reduced risk of WPV (OR, 0.46; 95% CI 0.31-0.70; *P* <.001; Table 3). However, no significant difference was observed in the multivariable analysis (OR, 0.65; 95% CI .39-1.08; *P* = .09). Public EDs were associated with a higher risk of WPV compared to private and referral-only EDs (OR, 1.79; 95% CI 1.24-2.60; *P* = <.001). However, this difference was not significant in the multivariable analysis (OR, 1.41; 95% CI 0.83-2.40; *P* = .20).

Increasing staff age was associated with a reduced risk of WPV (OR, 0.72; 95% CI 0.61-0.84; *P* < .001). There was no significant difference in the multivariable analysis between more than five years of staff experience compared with less than one year (OR, 1.06; 95% CI 0.35-3.22; *P* = .91) and one to five years of experience (OR, 0.84; 95% CI 0.43-1.64; *P* = .61). No significant differences in risk of WPV were observed by staff sex or gender (OR, 1.32; 95% CI 0.92-1.88; *P* = .13), staff sexual orientation (OR, 1.39; 95% CI, 0.82-2.35; *P* = .22), or self-reported non-White skin color (OR, 0.86; 95% CI 0.57-1.29; *P* = .47). No significant differences were found when comparing attending physicians with nurses (OR, 1.25; 95% CI 0.55-2.86; *P* = .59) or residents (OR, 0.79; 95% CI 0.36-1.71; *P* = .54) (Table 3).

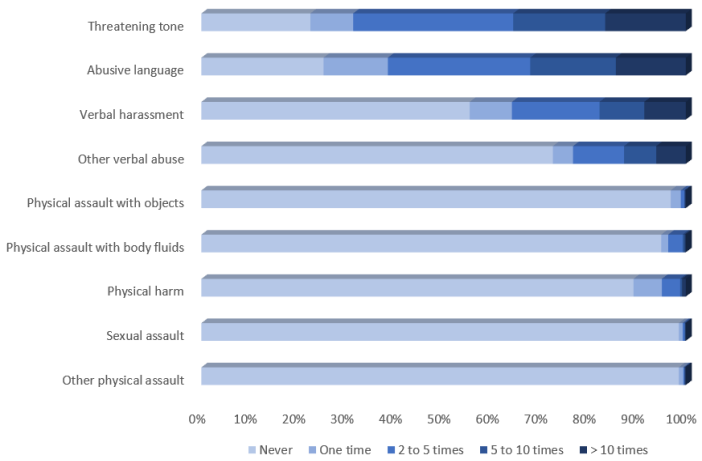


**Figure 1.** Frequency of each type of workplace violence experienced by Brazilian emergency department staff in the prior six months.

### Impact of Workplace Violence and Availability of Institutional Resources

The majority of staff respondents indicated feeling unsafe in the ED (n = 697; 90.6%; eTable 2, Appendix), with only 72 (9.4%) respondents feeling extremely or very safe in their workplace. Among all respondents, 496 (64.5%) indicated that their institution lacked preventive measures. Only 103 (13.4%) respondents reported having an institutional protocol for severe agitation, 195 (25.4%) referenced the presence of security staff, 57 (7.4%) reported available staff training, and none indicated the availability of metal detectors at their ED (eTable 3, Appendix).

Additionally, 469 (61.0%) respondents indicated security staff were unavailable to assist with physical restraint when needed (eTable 3, Appendix). Symptoms of post-traumatic stress after the incident, such as repetitive thoughts about the event or severe anxiety were reported to be present by 541 (88.4%) victims, and nearly half (n = 303; 49.5%) considered leaving their job following the assault. A total of 61 workers (10.0%) required time off work following a violent incident, whether for a temporary period or permanently. Of these, seven cases (11.5%) resulted in permanent leave. Workplace performance was reported as negatively impacted in 460 (75.2%) cases, and 458 (74.8%) respondents reported changes in their interactions with patients after the violence (Table 2).

More than half of staff victims (n = 313; 51.1%) did not report the incident to their supervisor. Reasons for not reporting included perceptions that doing so would be ineffective (n = 159, 50.8%), lack of time (n = 94, 30.0%), fear of negative consequences (n = 67, 21.4%), or uncertainty about the reporting process (n = 63, 20.1%; Table 2).

Less than one-third of respondents (n = 227, 29.5%) indicated having an established institutional protocol for managing agitation. The most commonly chosen treatment for severe agitation by clinicians was the combination of haloperidol and promethazine, accounting for 34.5% (n = 265) of responses. This was followed by the combination of haloperidol and a benzodiazepine at 26.5% (n = 204). A benzodiazepine used alone was reported by 107 respondents (13.9%), while haloperidol was used by 91 reapondents (11.8%), and ketamine by 80 (10.4%; eTable 3, Appendix 1).

**Table 3.** Respondents and institutional characteristics associated with workplace violence in Brazilian emergency departments.

| | Univariable | | Age and gender adjusted | | Multivariable | |
|---|---|---|---|---|---|---|
| Characteristic | Odds ratio (95%CI) | P-value | Odds ratio (95%CI) | P-value | Odds ratio (95%CI) | P-value |
| Age, per 5 years | 0.81 (0.74, 0.89) | < .001 | --- | --- | 0.72 (0.61, 0.84) | < .001 |
| Sex/gender | | | | | | |
| Male | Reference | --- | --- | --- | Not used | --- |
| Female | 1.32 (0.92, 1.88) | .13 | --- | --- | -- | |
| Race | | | | | | |
| White | Reference | --- | Reference | --- | Not used | --- |
| Non-White | 0.86 (0.57, 1.29) | .47 | 0.87 (0.57, 1.33) | .52 | -- | |
| Sexual orientation | | | | | | |
| Heterosexual | Reference | --- | Reference | --- | Not used | --- |
| Not heterosexual | 1.39 (0.82, 2.35) | .22 | 1.14 (0.66, 1.95) | .64 | -- | |
| Years of experience | | | | | | |
| >5 years | Reference | --- | Reference | --- | Reference | --- |
| 1-5 years | 1.87 (1.27, 2.76) | < .001 | 1.17 (0.71, 1.91) | .54 | 0.84 (0.43, 1.64) | .61 |
| <1 year | 1.03 (0.59, 1.78) | .92 | 0.60 (0.32, 1.13) | .11 | 1.06 (0.35, 3.22) | .91 |

**Table 3.** Continued.

| Characteristic | Univariable Odds ratio (95%CI) | Univariable P-value | Age and gender adjusted Odds ratio (95%CI) | Age and gender adjusted P-value | Multivariable Odds ratio (95%CI) | Multivariable P-value |
|---|---|---|---|---|---|---|
| Role | | | | | | |
| Attending physician | Reference | --- | Reference | --- | Reference | --- |
| Nurse | 1.19 (0.59, 2.43) | .63 | 1.55 (0.73, 3.31) | .25 | 1.25 (0.55, 2.86) | .59 |
| Resident | 0.92 (0.57, 1.49) | .73 | 0.64 (0.39, 1.07) | .09 | 0.79 (0.36, 1.71) | .54 |
| Emergency department (ED) region | | | | | | |
| Southeast | Reference | --- | Reference | --- | Reference | --- |
| South | 1.29 (0.83, 2.01) | .25 | 1.27 (0.81, 2.00) | .30 | 0.90 (0.49, 1.63) | .72 |
| Northeast | 0.62 (0.39, 0.99) | .04 | 0.53 (0.33, 0.85) | < .001 | 0.28 (0.15, 0.52) | < .001 |
| West | 3.13 (1.09, 8.95) | .03 | 3.03 (1.05, 8.76) | .04 | 1.84 (0.51, 6.66) | .35 |
| North | 1.20 (0.39, 3.64) | .75 | 1.38 (0.44, 4.33) | .58 | 1.03 (0.25, 4.27) | .96 |
| Place of work | | | | | | |
| Large hospital (>150 beds) | Reference | --- | Reference | --- | Reference | --- |
| Hospital (5-150 beds) | 1.12 (0.69, 1.82) | .64 | 1.04 (0.64, 1.71) | .86 | 1.60 (0.80, 3.20) | .18 |
| Community ED | 1.88 (1.21, 2.92) | < .001 | 1.73 (1.11, 2.71) | .01 | 1.49 (0.78, 2.87) | .23 |
| Other | 0.93 (0.42, 2.04) | .85 | 1.61 (0.66, 3.94) | .29 | 1.13 (0.41, 3.07) | .81 |
| ED population | | | | | | |
| All populations | Reference | --- | Reference | --- | Not used | --- |
| Adult medical | 1.10 (0.76, 1.60) | .61 | 1.05 (0.71, 1.53) | .82 | -- | |
| Pediatric or surgical clinic | 0.91 (0.46, 1.78) | .78 | 1.23 (0.60, 2.52) | .57 | -- | |
| Type of ED | | | | | | |
| Private or referral-only public ED | Reference | --- | Reference | --- | Reference | --- |
| Public ED | 1.79 (1.24, 2.60) | < .001 | 1.87 (1.28, 2.75) | < .001 | 1.41 (0.83, 2.40) | .20 |
| Institutional preventive measures | | | | | | |
| Severe agitation protocol | 0.46 (0.31, 0.70) | < .001 | 0.51 (0.33, 0.78) | < .001 | 0.65 (0.39, 1.08) | .09 |
| Availability of security personnel | 0.68 (0.47, 0.98) | .03 | 0.61 (0.42, 0.89) | .01 | 0.73 (0.44, 1.20) | .22 |
| Staff training on how to deal with potentially violent patients | 0.69 (0.28, 1.66) | .40 | 0.86 (0.35, 2.15) | .75 | Not used | |
| Staff training on difficult communications | 0.70 (0.38, 1.29) | .25 | 0.66 (0.35, 1.24) | .20 | Not used | |
| No preventative measures | 2.49 (1.74, 3.56) | < .001 | 2.47 (1.71, 3.57) | < .001 | 1.88 (1.10, 3.21) | .02 |

## DISCUSSION

Our study highlights the high prevalence and impact of WPV among ED staff in Brazil, with 79.6% indicating exposure to some form of violence, including 79.5% verbal abuse and 12.1% physical assault. Additionally, 40.3% witnessed physical assault against co-workers. Workplace violence had consequences, with most victims reporting post-traumatic stress symptoms, nearly half considering leaving their job, and over 75.0% experiencing a negative impact on workplace performance and patient interactions. Despite these effects, more than half of the incidents were not formally reported, often due to perceptions of futility, time constraints, or fear of negative repercussions.

Our findings on the prevalence of overall and verbal abuse closely align with data of ED surveys in the United States, which indicate that 71.5-86.0% of the workers indicated verbal abuse, while 21.0- 37.0% indicated being victims of physical assault.[6,9-11] A systematic review and meta-analysis reported that 77.0% of ED staff experienced verbal violence, and 18.0% experienced physical abuse, with family members of patients being the most common perpetrators.[7] In our study, although the prevalence of self-reported physical assault was low at 12.1%, a higher proportion of respondents, 40.3%, indicated witnessing physical assaults against coworkers. The lower incidence of self-reported physical assault compared to previous studies, along with the higher frequency of witnessed

violence, may reflect a reduced perception of violence and higher social tolerance.[26]

Similar to other studies, we found that the most likely perpetrators of violence were family members and patients; however, up to 35.8% of the perpetrators were coworkers, which could influence the belief that WPV is an inherent part of the job, leading to the naturalization of violence. Violence by coworkers in the healthcare setting has been previously reported in several studies, mostly in the form of bullying.[27,28] Differences in prevalence may be attributable to the time frame for assessing WPV, with most surveys evaluating a 12-month period [9,10], while our study examined the prior six months, similar to those conducted by McGuire et al.[6,11] In comparison to primary healthcare settings, a systematic review by Tian et al reported that 33.8% of respondents experienced verbal abuse, while 8.5% indicated physical assault.[29] The consistently higher rates of violence observed in EDs supports the hypothesis that these environments are at greater risk for WPV. This increased vulnerability may be attributed to factors such as the high volume of critically ill patients, crowding, and the emotionally charged interactions among patients, families, and healthcare workers during emergency care.

The prevalence of violence observed in our study may have been influenced by institutional factors, including the lack of protocols for managing severe agitation (reported by 70.5% of respondents), inadequate security staffing for managing physical restraint (74.6%), and insufficient staff training (96.6%). In the multivariable analysis, the absence of preventive measures established by the ED was associated with higher odds of violence. Additionally, the presence of an institutional protocol for managing severe agitation was identified as a protective factor in the univariable analysis but did not remain significant after multivariable analysis.

The absence of standardized institutional protocols likely contributes to suboptimal pharmacological management of severe agitation. This is evident in the reported treatment choices, with 34.5% of respondents favoring a combination of haloperidol and promethazine, 26.5% opting for haloperidol and benzodiazepines, and 10% using ketamine. Thus, a minority of staff select one of the last two medications as their first choice, which are level B and C recommendations by the American College of Emergency Physicians[30] in the management of severe agitation. Structured de-escalation training for ED staff has been shown to positively affect the reporting of WPV incidents and possibly reduce its impact.[11]

The impact of WPV is evident in several key outcomes: only 9.4% of respondents reported feeling extremely or very safe during clinical work in the ED, and 88.4% of victims experienced post-traumatic stress symptoms. Additionally, our findings suggest that older age may serve as a protective factor, although years of experience did not demonstrate a significant association, consistent with previous studies.[31,32] The age-related difference may be attributed to enhanced communication skills and behavioral strategies developed with age, as well as the increased vulnerability of less experienced young workers.[32] Our study population consisted of younger respondents, with a mean age of 32 years. Notably, only 45.9% of respondents reported having more than five years of work experience, a proportion substantially lower than prior studies, which reported 68.6% to 72.2% of staff with similar levels of experience.[6,11] This difference may be attributed to EM being a relatively recent specialty in Brazil and may reflect younger workers' interest in study participation.[21]

A cross-sectional study conducted in a large urban ED in 2023 found that healthcare workers experienced WPV once every 3.7 shifts, with nurses and younger staff being at higher risk.[27] Additionally, a descriptive study in an urban ED highlighted that WPV incidents occurred almost daily, with 20.0% involving physical violence and a significant portion involving racist, sexist, or homophobic bias.[33] Our study found no significant difference in the risk of WPV between cisgender women and cisgender men. These findings are consistent with some studies.[6,10] However, a study by Kowalenko et al[9] reported that female emergency physicians were at a higher risk of experiencing physical assault, or being bullied by coworkers.[34]

## LIMITATIONS

Limitations of our study include that the sample was majorly represented by physicians, probably due to the distribution by ABRAMEDE's mailing list, which is composed mainly of these healthcare workers. Therefore, our results may have limited generalizability; the sample of other workers such as nurses and nursing technicians who may be at higher risk of WPV was significantly smaller,.[27]

Furthermore, as it was a self-reported survey from the prior six months, there may have been recall bias and possibly those that had experienced violence were more likely to complete the questionnaire, which could lead to selection bias. Also, the length of the survey may have contributed to the high rate of incomplete responses.

Additionally, due to the subjective nature of the questions the survey was susceptible to different interpretations among the respondents even with the definitions provided in the instructions for each question. Finally, only 19.1% of the initial respondents screened answered the survey, which limits the generalizability of our study. We assessed the lower response rate by examining the characteristics of non-respondents, which closely resembled those of our sample. Additionally, we calculated the nonresponse bias, as recommended by the International Association for Health Professions Education guidelines. Despite the low response rate, the wave analysis revealed minimal differences between the responses.[25, 35].

## CONCLUSION

Our study identified a high self-reported prevalence of workplace violence among healthcare Workers in the

emergency department, emphasizing the importance of public and institutional awareness to create protocols aimed at the prevention, education and management of WPV. These findings suggest potential implications for healthcare workers' mental health, workplace well-being, workforce attrition, and patient care.

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# National Survey on Infection Prevention and Control in United States Emergency Departments

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**Introduction:** In the emergency care setting, implementation of infection prevention and control (IPC) practices can be challenging due to numerous factors including emergency department (ED) crowding and boarding of patients, high staff-turnover rates, and acuity of patient needs. Understanding how the unique nature of the ED environment impacts IPC implementation is essential to reducing healthcare-associated infections and to improving patient safety. In this study we aimed to assess ED leaders' perceptions of IPC practices to identify areas for potential intervention and inform targeted process improvement initiatives.

**Methods:** Between January–July 2023, ED leaders across the United States were queried about their IPC practices using the National Emergency Department Inventories (NEDI)-USA survey, which is administered annually to all EDs in the US. An expanded survey was administered in a subset of EDs to assess healthcare personnel training for IPC, reported adherence to recommended practices and policies related to disinfection of reusable medical equipment and environment, use of personal protective equipment, hand hygiene practices, patient care space cleaning and disinfection, use of transmission-based precautions signage, risk perceptions of how healthcare personnel practice contributes to healthcare-associated infections and barriers to appropriate room cleaning.

**Results:** Of the 289 facilities surveyed, 159 (55%) responded, and among responding EDs, 67 (42%) reported seeing ≥ 40,000 patients in the prior year. Regarding healthcare personnel training, 84% (131/156) of ED leaders reported that ≥80% of their ED healthcare personnel were correctly trained in IPC procedures according to their hospital's policies. Perception of healthcare personnel compliance with IPC practices, however, was lower. Although 75% (118/157) of EDs reported > 80% compliance with correct N95 respirator use, compliance with transmission-based precaution signage was identified as a significant gap, with 30% (47/159) of EDs reporting that they never, rarely, or only sometimes posted signs for patients who required them. Further, 69% (61/89) of EDs reported that they never, rarely, or only sometimes posted transmission-based precaution signs for patients in hallways or overflow treatment spaces.

**Conclusion:** This national survey found that ED leaders perceive that their healthcare personnel have a high level of knowledge of IPC policies and compliance with some, but not all, IPC policies in the ED. The overall high perceptions of compliance stand in contrast to prior published observations of poor IPC practice in ED settings, suggesting complex relationships between perception and practice that may impact patient safety outcomes. These findings can guide future targeted interventions to improve IPC compliance, reduce healthcare-associated infections, and improve patient safety in emergency settings. [West J Emerg Med. 2025;26(6)1781–1789.]

## INTRODUCTION

The emergency department (ED) is often seen as the frontline of healthcare delivery, characterized by an unpredictable and dynamic environment that can amplify challenges seen throughout the healthcare system.[1] While infection prevention and control (IPC) practices are critical for maintaining patient safety in all healthcare settings, successfully adhering to them in the ED environment presents unique challenges that stem from multiple factors including ED crowding, patients presenting with a diverse array of acute and often undifferentiated medical conditions, and comparatively high rates of staff turnover.[2-8] The urgent nature of providing clinical care in the ED can negatively affect healthcare personnel ability to implement essential IPC measures, such as proper hand hygiene, appropriate use of personal protective equipment, and thorough cleaning and disinfection of spaces and equipment between patient encounters.[9-11] These challenges in maintaining effective IPC practice increase the risk of healthcare-associated infections and the potential for iatrogenic morbidity and mortality.[12,13] Healthcare-associated infections are a major public health concern, causing an estimated 75,000 deaths annually in the United States. Advancing IPC efforts in emergency care is both timely and necessary.[12]

Although IPC is a critical component of safe care delivery, previous research has shown that compliance remains persistently low. Reported hand hygiene adherence rates range from 20-70%, frequently lower than in other hospital units such as intensive care units or inpatient wards.[15,16] Barriers commonly identified in those settings, such as time constraints, staffing limitations, and environmental challenges, are often even more pronounced in the ED.[17,18] Yet despite these barriers, few studies have specifically assessed IPC practices in emergency settings, highlighting a persistent gap in the literature. To address this gap, we sought to evaluate ED leaders' perceptions of the current state of IPC practices within US EDs, focusing on reported compliance, barriers, and perceptions of risk. Our study included select items from a 2011 IPC survey to facilitate longitudinal comparisons, and the survey was administered to the same cohort of responding hospitals.[19]

*Population Health Research Capsule*

What do we already know about this issue?
*Infection prevention and control (IPC) compliance in emergency departments is low, with adherence rates frequently below those in other hospital settings.*

What was the research question?
*How do US emergency department leaders perceive training, compliance, and barriers to IPC practices?*

What was the major finding of the study?
*Of 159 EDs, 84% reported high rates of IPC staff training, and 71% reported high rates of hand hygiene compliance.*

How does this improve population health?
*Gaps between perceptions and realities from the literature in ED IPC point to opportunities to improve IPC compliance and patient safety.*

## METHODS

### Study Design

This was a cross-sectional survey of US EDs. The Mass General Brigham Institutional Review Board reviewed this project and classified it as exempt (IRB Protocol: 2005P000015). This study was reported in accordance with the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines.[20]

### Sample

We selected EDs to receive the survey using the National ED Inventory (NEDI)-USA, a database of all non-federal, non-specialty EDs open 24 hours per day, seven days per week, and 365 days per year.[19] The NEDI-USA dataset also includes publicly available information about Urban Influence Codes developed by the the Department of Agriculture Economic Research Service (to classify EDs as urban, large rural, or small rural), academic ED and hospital status, Council of Teaching Hospital status, and Critical Access Hospital status.[21-24]

The selected EDs previously participated in a survey assessing IPC characteristics in 2011.[19] The original sample was selected using multistage stratification, including purposeful oversampling of high-volume EDs (those with > 50,000 annual visits) and teaching hospitals. These facilities tend to have a higher burden of healthcare-associated infections and exert greater influence on the practice of emergency medicine, making them particularly relevant for tracking changes in IPC implementation across the healthcare system.[25] Of the 301 EDs that responded to the earlier survey, 12 had closed by 2022 and thus were excluded. The remaining 289 eligible EDs were in each of the four US regions (Northeast, Midwest, South, and West) in 48 states plus the District of Columbia. All EDs were hospital-based; none were freestanding. Within each ED, key leadership personnel targeted for survey response included physician medical directors, nurse managers, infection control leaders, and department administrators. We selected these roles based on their decision-making roles in clinical operations and infection prevention.

**Survey and Administration**

The survey instrument was developed by the research team, including subject matter experts in IPC, ED operations, and research design and was built upon the previous 2011 survey.[19] The present study included select items from the 2011 study of the same ED cohort to enable longitudinal comparison, while expanding into new areas of inquiry. Between January–July 2023, a three-page survey (Supplement A) was administered to study participants to characterize emergency care and ED IPC policies and practices in 2022. The survey included questions about ED characteristics (eg, annual visit volume). The IPC policies and practices were assessed with questions related to healthcare personnel training, reported adherence to IPC policies related to disinfection of reusable medical equipment and environment, use of personal protective equipment, hand hygiene practice, care-space cleaning and disinfection, use of transmission-based precautions signage, risk perceptions of how ED practice contributes to healthcare-associated infections, and barriers to appropriate room cleaning. Except for hand hygiene compliance, for which respondents were asked to report based on available audit data, all survey responses reflected ED leadership's self-reported assessments rather than verified metrics. All questions about IPC asked the respondents to select from multiple options, with the exception of one ranking question. A note on a question modification is available (Supplement B).

We administered the survey using mixed modalities. It was sent by US mail to ED leaders up to three times between January–April 2023. A link to an online version of the survey was included in each mailing. Emergency department leaders who provided an email address in response to a previous NEDI-USA survey also received a copy of the survey by email. Those who returned an incomplete survey were contacted by phone or email to re-administer questions left blank. We contacted EDs that did not respond to mailed surveys by telephone for survey completion.

**Data Analysis**

We calculated response rate by using the number of EDs that responded divided by the total number of potential respondent EDs, all of which were confirmed eligible before being surveyed.[26,27] Data were summarized with descriptive statistics (eg, counts, proportions). For ease of interpretation, we grouped survey response options estimating ED compliance rates into two categories: low/medium (0-79%); and high (≥ 80%). This threshold (≥ 80%) was selected as it represented the highest response category for many survey items and is in alignment with previous research. It was then applied uniformly across all variables to facilitate consistent analysis. This cutoff is also consistent with thresholds used in prior IPC studies, where ≥ 80% has commonly been used to indicate high compliance.[28,29] For all survey items, we excluded EDs that did not provide a response (≤ 3% per item). Bivariate comparisons of categorical variables were made using $\chi 2$ tests. A two-tailed $P < .05$ was considered statistically significant. We completed analyses in Stata 18.0 (StataCorp, LLC, College Station, TX).[30]

**RESULTS**

Of the 289 EDs surveyed, 159 (55%) responded (Table 1). Comparing the characteristics of responding vs nonresponding EDs, there was no material difference by US region, academic ED status, and Council of Teaching Hospitals status. However, responding EDs more often had annual visit volumes of < 15,000 visits per year (31% vs 16%; $P = .01$), were in rural areas (31% vs 19%; $P = .05$), and designated as a Critical Access Hospital (24% vs 11%; $P < .01$). Among responding EDs, the 2022 ED visit volume remained at a comparable level, with about a third (46, 29%) of EDs having < 15,000 visits per year.

Regarding healthcare personnel training, 84% (131/156) of ED leaders reported that ≥ 80% of their ED staff are correctly trained in their hospital's IPC policies and procedures. In addition, compliance with IPC policies was reported as relatively high in some metrics, with 89% (140/157) of EDs reporting ≥ 80% compliance with appropriate room cleaning and disinfection after the patient leaves, and 82% (130/158) of EDs reporting ≥ 80% compliance with policies regarding cleaning reusable medical equipment (Figure 1). Hand hygiene compliance in EDs that reported conducting auditing was relatively low compared to the other domains, with only 71% (107/150) of respondents reporting ≥ 80% compliance with recommended hand hygiene protocols. Proper gown usage was among the lowest reported compliance with 64% (101/157) reporting ≥ 80% compliance.

Approximately 91% (145/159) of respondents reported that their healthcare personnel have a sufficient understanding of transmission-based precautions (Figure 2); however, 19% (31/159) indicated that transmission-based precaution policies are never, rarely, or sometimes followed. Compliance with signage was also identified as a significant gap, with 30% (47/159) of EDs reporting that they never, rarely, or only sometimes posted signs for patients who required them. This gap was more pronounced with patients placed in hallways or overflow treatment spaces. In hospitals that use hallway or overflow spaces, 42% (37/89) reported that transmission-based precautions were followed correctly never, rarely, or sometimes, and 69% (61/89) of EDs never, rarely, or only sometimes posted transmission-based precaution signs.

Leaders' perceptions of the overall importance of IPC policy and procedure adherence varied significantly (Figure 3). Most ED leaders (59%, 92/155) reported that they did not perceive healthcare-associated infections to pose a significant risk to patients relative to other patient safety issues in the ED

**Table.** Hospital emergency department (ED) characteristics by survey responders vs non-responders. Chi-square test was used to test the association between ED characteristics and response (responding vs non-responding) to a national survey of US ED infection prevention and control compliance.

| Characteristics | All US EDs (N = 5,580) n (%) | Responders (n = 159) n (%) | Non-responders (n = 130) n (%) | P-value |
|---|---|---|---|---|
| 2021 ED Visit Volume | | | | .01 |
| < 15,000 | 2,410 (43) | 49 (31) | 21 (16) | |
| 15,000-39,999 | 1,868 (33) | 40 (25) | 37 (28) | |
| ≥ 40,000 | 1,302 (23) | 70 (44) | 72 (55) | |
| Region | | | | .19 |
| Northeast | 628 (11) | 27 (17) | 35 (27) | |
| Midwest | 1,513 (27) | 43 (27) | 34 (26) | |
| South | 2,398 (43) | 59 (37) | 43 (33) | |
| West | 1,041 (19) | 30 (19) | 18 (14) | |
| Setting | | | | .05 |
| Urban | 3,705 (66) | 109 (69) | 105 (81) | |
| Large rural | 761 (14) | 23 (14) | 14 (11) | |
| Small rural | 1,114 (20) | 27 (17) | 11 (8) | |
| Academic ED | 235 (4) | 24 (15) | 31 (24) | .06 |
| Council of Teaching Hospital | 261 (5) | 36 (23) | 35 (27) | .40 |
| Critical Access Hospital | 1,351 (24) | 38 (24) | 14 (11) | < .01 |

*US,* United States.

or felt neutral about the issue. Only about one-third of respondents (34%, 53/155) felt that their ED did not have a significant impact on risk of healthcare-associated infections; however, approximately 77% of respondents (120/155) perceived a strong collaboration between IPC staff and the ED.

About half of EDs (49%, 77/157) reported that a room/care space is always cleaned to their hospital's standard after a patient leaves, and the 80 others were asked to rank factors that affect the ED's ability to appropriately clean rooms between patient care episodes (Figure 4). Respondents identified clinical urgency of room turnover as the main negative influence, with a mean rank of 1.71. Other important factors reported included having sufficient staffing dedicated to room cleaning and sufficient time available in staff workflows, with mean ranks of about 2.3 and 2.4, respectively. Considered less influential were factors such as staff knowledge and education about cleaning procedures, with an approximate mean rank of 4.1, and the immediate accessibility of cleaning supplies, with a mean rank of about 4.6.

### Comparison to 2011 Survey Results

Of the 412 EDs surveyed in 2011, 301 (73%) responded. Regarding questions that were consistent across both surveys, more EDs reported at least 80% correct hand hygiene upon audit in 2022 vs 2011 (71% vs 46%, respectively). Respondents were less likely to agree that healthcare-associated infections were a significant risk to patients compared with other safety concerns (41% vs 63%) and more likely to believe that patients discharged from the ED are at minimal risk of healthcare-associated infections (53% vs 31%) in 2022 vs 2011. Further, fewer ED leaders felt that the ED does not have a significant impact on risk of healthcare-associated infections (34% vs 23%) and more respondents perceived a strong collaboration between IPC staff and the ED in 2022 vs 2011 (77% vs 63%).

## DISCUSSION

In this national survey we aimed to evaluate the reported compliance with IPC policies in EDs across various US hospitals, identifying strengths and gaps in IPC adherence as perceived by ED leaders. In this study, ED leaders perceived their healthcare personnel to have a high level of knowledge about IPC policies, and leaders reported generally high compliance across most IPC domains including disinfection of reusable medical equipment, hand hygiene, and room/care space cleaning and disinfection. This is generally consistent with previous studies that have shown that healthcare personnel, including those in EDs, self-report high levels of knowledge of recommended IPC practices.[31,32] Additionally, a recent meta-analysis found that healthcare personnel generally demonstrate adequate to high levels of knowledge concerning standard precautions, hand hygiene, and care pertaining to specific diseases.[33]

However, the finding that ED leaders perceived a generally high level of compliance contrasts with the broader observational studies in the literature, which typically indicate

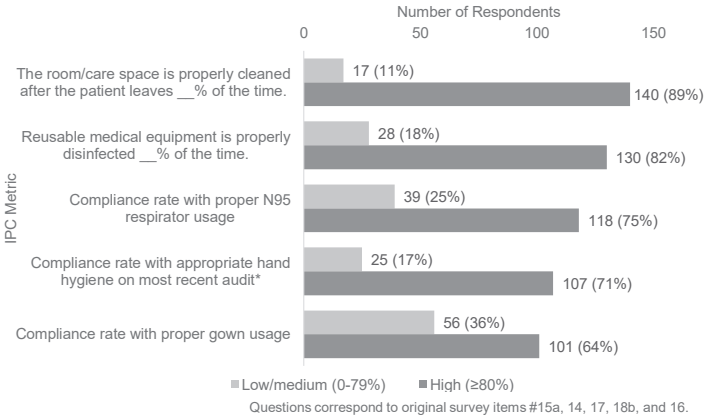


**Figure 1.** Reported compliance across infection prevention domains. Questions were edited for brevity, and clarifications were provided on the survey of US emergency department infection prevention and control compliance. The room/care space cleaning was specified to hospital's standard. Reusable medical equipment disinfection was specified according to hospital's policies. Compliance with N95 respirator usage specified proper donning and doffing, ensuring a clean-shaven face, and use when specified when indicated by hospital policy. Donning and doffing PPE was described in the proper gown usage question.
*18 emergency departments (ED) indicated "unsure" of hand hygiene audit compliance (not shown); 9 EDs did not audit hand hygiene compliance and were excluded.
*PPE*, personal protective equipment; *US,* United States.

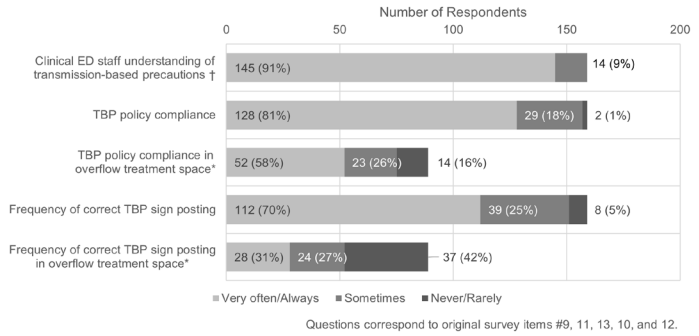


**Figure 2.** Transmission-based precaution understanding and adherence. In a study of US emergency department (ED) infection prevention and control compliance, ED leaders were asked, "How well do you believe your clinical ED staff understand the concept of transmission-based precautions?" with the examples of contact, droplet, and airborne provided. Overflow treatment spaces include hallway spaces. Questions and responses were edited for brevity.
† Clinical ED staff understanding was asked on a scale "Very well" to "Not at all." Answers are pooled "Very well/Well" and "Somewhat." No EDs answered "Not well/Not at all."
* 69 EDs indicated that use of overflow treatment space was not applicable and were excluded.
*TBP*, transmission-based precautions.

low compliance in ED settings.[34-36] For example, a study that examined the terminal cleaning thoroughness of 23 acute care hospitals found that only 49% of surfaces were sufficiently cleaned and disinfected, significantly lower than most EDs reported in this study.[37] Similarly, even after intervention, an observational study reported compliance with recommended hand hygiene policies to be 44.9%—again significantly lower than most respondents reported in this study.[38] This discrepancy suggests potential differences between leadership perceptions and the realities captured by direct observations.

This divergence in perceived vs observed IPC practice has meaningful clinical implications. Healthcare-associated infections are associated with considerable morbidity and mortality, contributing to an estimated 75,000 deaths annually in US hospitals.[14] While standard surveillance programs are designed to attribute healthcare-associated infections to inpatient settings, there is growing recognition that breakdowns in infection prevention practices in the ED do contribute.

Interestingly, we also found that most ED leaders do not perceive healthcare-associated infections as a significant risk relative to other patient safety issues, with only a third believing the ED significantly impacts hospital-associated infection rates. While previous research has shown that ED leadership recognizes the value of specific infection prevention guidelines, broader perceptions of the risk of healthcare-associated infections have not been well-studied.[39] Although direct attribution of healthcare-associated infections to ED care is challenging due to existing standardized surveillance definitions, evidence suggests that ED practices, such as unnecessary urinary catheter placement, contribute to catheter-associated urinary tract infections.[40] This potential impact, combined with the ED's role as a primary entry point for patients with diverse infectious conditions requiring specific precautions, suggests a possible disconnect between ED leaders' risk perception and the department's role in IPC, patient safety, and quality of care.

This study also documents IPC challenges that are specific to the ED environment, such as adherence to policy in non-traditional care spaces like hallways and overflow treatment spaces. In these areas, which have been increasingly used in EDs across the US, compliance with transmission-based precautions was reported to be significantly lower as compared to care delivered in typical care areas.[41] The most significant barriers to proper room cleaning and disinfection between patients identified in the survey—clinical urgency of room turnover, staffing constraints, and time limitations—also align with previous findings.[2,42,43] Studies have documented that time pressure for rapid room turnover contributes to incomplete surface disinfection, particularly of high-touch surfaces in ED treatment areas.[44] These reported challenges are consistent with previous studies that have noted how ED conditions, including urgency, crowding, and hallway care delivery, often compete with IPC protocols.[11,36,45]

Importantly, these strategies, including care in overflow

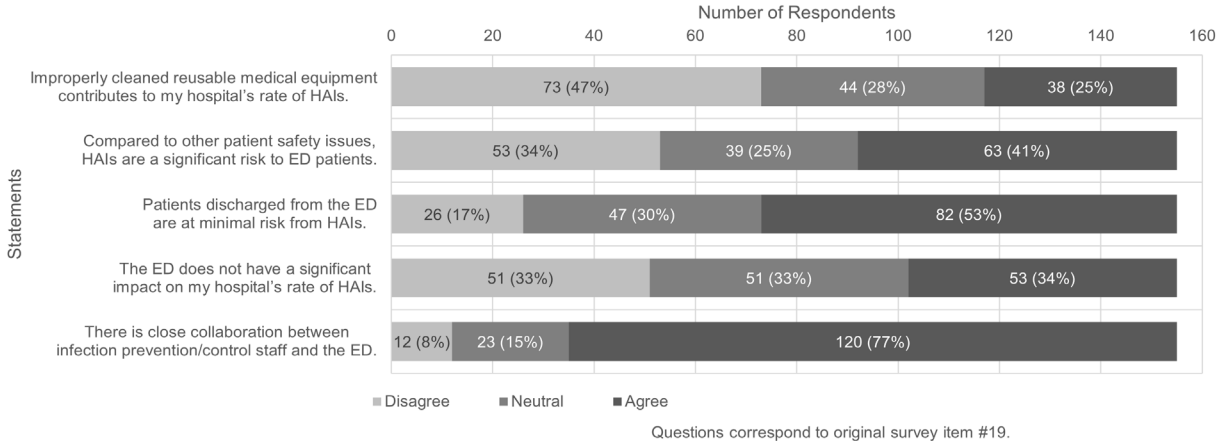


**Figure 3.** Perceptions of importance of infection prevention in the emergency department (ED). In a study on US ED infection prevention and control compliance, ED leaders were asked to indicate their level of agreement with each of the statements. *HAI,* healthcare-associated infection.

areas, while aimed at addressing crowding and throughput, may inadvertently compromise IPC adherence and increase patient risk.[46] These adaptations have become increasingly common, but their downstream consequences have been under-investigated and are not routinely reported; even local IPC lapses in the ED may contribute to infection risk across the broader continuum of care.

Comparison with the 2011 survey data reveals that ED leaders in 2022 reported higher levels of hand hygiene compliance and perceived stronger collaboration with IPC staff. Fewer leaders now view healthcare-associated infections as a significant patient safety risk or see the ED as a key contributor to those infections. While these shifts could reflect increased confidence in ED practices or the emergence of competing safety concerns, such as crowding or violence, they may also suggest a potential underestimation of the ED's role in infection risk.[47] This is particularly noteworthy given the ongoing discrepancy between reported and observed adherence. If perceived improvements outpace behavioral change, the ED's contribution to preventable healthcare-associated infections may remain underestimated and not addressed.

## LIMITATIONS

Several limitations must be acknowledged in interpreting the results of this study, particularly regarding the potential for misestimation of practice adherence. While hand hygiene compliance rates were requested in the survey to be reported from audits, all other data in this study reflect ED leaders' reported assessments of their department's practices rather than verified observations or formal audit data. The approach of querying leaders, while valuable in understanding their perspectives, may not fully capture the reality of day-to-day IPC practices.

The discrepancy between reported and observational compliance rates in IPC in the literature suggests these findings may overestimate actual practice adherence. While ED leaders reported that they believed their EDs had medium to high rates of compliance with IPC policies in several areas, at the same time, they also described significant practice challenges such as inadequate IPC signage and inconsistent use of transmission-based precautions, especially when care was delivered in hallways or other surge spaces. Given that prior observational studies have consistently documented significant lapses in even basic IPC protocols, these reported challenges likely represent minimum estimates of actual practice gaps.

Multiple factors may have influenced the accuracy of leadership assessments. Social desirability bias may have affected responses, as ED leaders may be reluctant to document compliance with recommended IPCs lower than required, given that this affects patient safety and is a regulatory requirement of agencies such as The Joint Commission and is monitored by the Centers for Medicare & Medicaid Services.[48,49] The proximity of the COVID-19 pandemic at the time of data collection may have further heightened this bias, as IPC practices had received increased attention and scrutiny across healthcare settings. Assessments by ED leaders may also be influenced by factors such as their specific role, level of involvement in daily operations, institutional reporting structures, and individual understanding of IPC best practices. While many ED leaders are involved in operations such as patient flow and clinical care, some IPC practices can often be the responsibility of personnel from separate departments, such as environmental services. This limitation is relevant for many metrics in this study, including data on environmental cleaning and transmission-based precautions, where compliance was assessed through leadership perception rather than audit data.

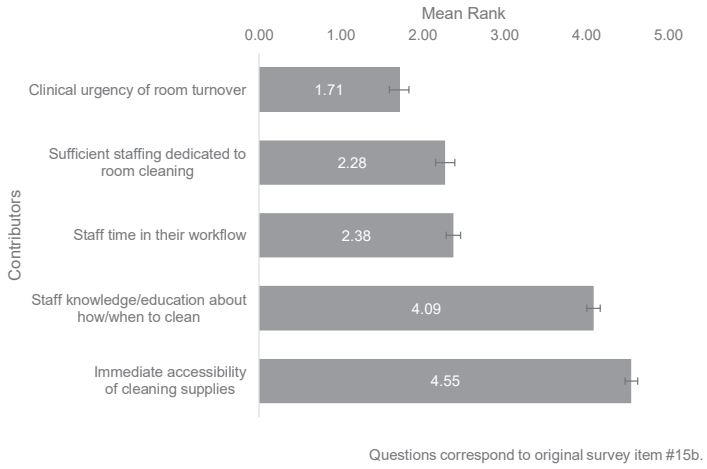


**Figure 4.** Rankings of perceived barriers to proper room cleaning. In a study of infection prevention and control compliance in US emergency departments, participants were asked to "rank from 1 to 6, with 1 being the biggest contributor and 6 being the smallest contributor, the reasons you believe the room/care space is not properly cleaned to your hospital's standard." Lower mean rank indicates barrier perceived as more significant contributor to inadequate room cleaning. Emergency department leaders were also able to write in "other" responses, which were not included in the mean rank calculation. Repeated numbers were not allowed, and the mean rank is reported. Standard error was used for error bars. "Other" responses not included in calculation: "accidental misses"; "didn't realize"; room/equipment out of service; language barrier with cleaning staff; and "lack of integrity."

Even hand hygiene compliance rates, while derived from audits, may be subject to the Hawthorne effect and other observational biases. Additionally, because the survey did not ask how institutions assess IPC compliance across all metrics, variation in measurement approaches (eg, direct observation, electronic monitoring, or internal reporting) may further affect the consistency and comparability of reported adherence rates. These limitations underscore the need for future research that combines leadership perspectives with direct observational studies and input from frontline healthcare personnel to provide a more comprehensive picture of IPC realities in the ED.

Additionally, institutions with lower annual visit volumes and located in rural settings were over-represented in our study. This non-response bias may affect the overall representativeness of the findings, potentially influencing the reported compliance rates, given the different operational challenges faced by high-volume EDs. The over-representation of lower volume, rural EDs may have resulted in high reported compliance rates. Future studies may benefit from using shorter surveys, wave analysis, or modest incentives to improve response rates from under-represented institutions.[26]

### Implications for Future Work

The discrepancy between perceived and documented compliance highlights the importance of objective measurement. Individual institutions could benefit from monitoring systems to understand their specific IPC adherence rates, thereby helping ED leaders align their perceptions with operational realities. Given observational studies in the literature documenting IPC compliance challenges in EDs, we encourage future research on developing interventions that address systemic factors identified in this study such as time constraints, staffing levels, and the use of non-traditional care spaces. Such research would provide ED leaders with evidence-based options for improving compliance while accounting for the unique pressures and constraints of emergency care, as well as adding further evidence regarding the harms of ED crowding and hallway care and providing further impetus to urgently address these issues.

## CONCLUSION

Although 84% of ED leaders reported that the vast majority of staff were trained in infection prevention and control procedures, self-reported compliance varied considerably. High compliance was noted for room cleaning (89%), N95 use (75%), and hand hygiene (71%), but lower for gown use (64%). Signage for transmission-based precautions was particularly limited, with only 31% of EDs consistently posting signs in hallway or overflow spaces. These findings reflect substantial gaps even in self-reported data and likely underestimate true noncompliance, given prior observational studies. Without standardized measurement and ED-specific interventions, especially in non-traditional care areas, these risks to patients and staff are likely to persist.

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# Limiting Albuterol Use by EMS at the Start of the COVID-19 Pandemic: A Retrospective Analysis of Rapid Deimplementation

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**Introduction:** Deimplementation is the process through which an existing practice, procedure, or protocol is discontinued. Past deimplementation efforts in emergency medical services (EMS), such as reduction of liberal oxygen administration, backboard use, and lights and sirens responses, have been slow in rates of change and had varying levels of adoption. Our objective in this study was to analyze the deimplementation of albuterol administration in the beginning of the 2019 novel coronavirus (COVID-19) pandemic for the adoption of deimplementation guidelines, rate of change, and factors leading to this change in EMS practice.

**Methods:** Using the 2020 National Emergency Medical Services Information System (NEMSIS) dataset, we analyzed the change in EMS calls with albuterol administration following the US Centers for Disease Control and Prevention (CDC) advisory recommending limiting aerosol-generating procedures in response to the COVID-19 pandemic.

**Results:** The 2020 NEMSIS dataset included 43,488,767 total records, and 449,290 (1.0%) records included at least one albuterol administration. Calls with albuterol administration dropped 61.7% in a near-linear fashion in the six weeks following the publication of the CDC's guidance (from March 8–April 18, 10,426 absolute reduction; from 16,891 to 6,465, in average calls per week with albuterol administration). In the period before the guidance, there were on average 16,891 calls with albuterol administration of 640,597 (2.6%) calls per week. In the period after the guidance, there were, on average, 6,465 calls with albuterol administration of 601,943 (1.1%) calls per week. Therefore, while total EMS calls declined by 6% during the transition period, the proportion of albuterol calls within this decline went down by 1.5% (2.6% to 1.1%), reflecting rapid deimplementation.

**Conclusion:** Deimplementation of albuterol administration in the beginning of the COVID-19 pandemic was significant in its rate and success in adherence to guidelines when compared to other changes in EMS policies, procedures, and protocols. A better understanding of deimplementation can guide future EMS efforts to phase out ineffective practices while minimizing disruption to care. [West J Emerg Med. 2025;26(6)1790–1794.]

## INTRODUCTION

Deimplementation is the process through which an existing practice, procedure, or protocol is discontinued, reduced, reversed, or replaced.[1] While some consider deimplementation to be the opposite of implementation, differences in the motivations, procedures, and outcomes make the process more nuanced than a simple mirroring might suggest.[1,2] Adjustments and improvements in emergency medical services (EMS) practices are common, but the rate of change for discontinuation of existing practices is often slow or gradual.[3,4] One of the most notable deimplemented EMS procedures in recent history was the transition from the long-standing spinal immobilization paradigm.[5] A key feature of this deimplementation was a major reduction in the use of the long spine board.[6,7] A database review of over 25,000 electronic patient care records over a 10-year period demonstrated a considerable decrease in immobilization practices after a spinal motion restriction protocol was implemented, but there was an eventual plateau in the rate of use, and application of the protocol was inconsistent.[8]

American Heart Association (AHA) guideline changes have also led to changes in established practices. In 2010, recommendations for liberal oxygen administration were changed to titration to blood oxygen saturation and symptoms in patients with acute coronary syndrome.[9] In an evaluation of paramedic student documentation in the two years following the protocol change, decrease in oxygen administration was significant, but half of the patients who received the treatment still did not meet AHA criteria for the intervention.[10] Furthermore, among the Resuscitation Outcomes Consortium sites, it took on average over 13 months to implement the 2005 AHA Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiac Care.[4]

Finally, data over the past several decades indicate clear correlations between use of lights and sirens (L&S) in EMS and injuries or death of EMS professionals, their patients, and members of the public.[11,12] Revelations about the lack of time saved or improved patient outcomes in most cases have not reduced L&S use in a majority of EMS responses and transports.[11,13] Emergency medical services professionals understand the reasons for deimplementation of L&S, yet they continue to use them.[14] Public expectations of EMS responses and the need for EMS professionals to manage them may be associated with the slow decrease in L&S use.[13]

On January 20, 2020, the US Centers for Disease Control and Prevention (CDC) confirmed the first case of 2019 novel coronavirus (COVID-19) in the United States.[15] The unknown nature of the disease presented unique challenges for EMS clinicians. There was concern that being in enclosed spaces with patients suspected of having COVID-19 for an extended period could increase the risk of EMS clinicians contracting the virus. On March 10, 2020, the CDC published guidance and recommendations for EMS clinicians and organizations, which included a cautionary advisory regarding aerosol-generating procedures (AGP), such as nebulizing medications.[16] Nebulized albuterol has been a standard treatment for EMS clinicians treating patients with acute bronchospasm for decades. Our goal in this study was to describe the rapid deimplementation of prehospital albuterol administration at the start of the COVID-19 pandemic.

*Population Health Research Capsule*

What do we already know about this issue?
*Adjustments and improvements in EMS practices are common, but the rate of change for discontinuation of existing practices is often slow.*

What was the research question?
*How did EMS albuterol use change after the US Centers for Disease Control and Prevention (CDC) recommended limiting aerosol-generating procedures?*

What was the major finding of the study?
*The proportion of albuterol calls went down from 2.6% to 1.1% (P < .001) after the CDC recommendations.*

How does this improve population health?
*A better understanding of deimplementation can guide future EMS efforts to phase out ineffective practices while minimizing disruption to care.*

## METHODS

We performed a retrospective review of data from the 2020 National Emergency Medical Services Information System (NEMSIS) public-release dataset, which was released in May 2021. We used the NEMSIS data dictionary v3.5.0, which was released in 2019 and was the available data dictionary for 2020. This dataset has been previously described and used for COVID 19-related research.[17-20] This study was designated not human subjects research by the University at Buffalo Institutional Review Board (00005516). The abstractors were not blinded to the study hypothesis.

We identified EMS encounters that occurred in 2020, with at least one albuterol administration. Specifically, the data field, *eMedications.03*, was searched for albuterol and/or albuterol with ipratropium. Next, we identified the date of the call using a two-step process. First, the dispatch date and time were identified using the *eTimes.01* field. If the dispatch date and time were not recorded, then the date and time of the medication administration were identified using the

*eMedications.01* field. If there was no accompanying date or time in either field, we excluded the record. Dates were sorted by the week in which they occurred. We used weekly intervals, in place of daily or monthly intervals, to reduce the impact of outliers while allowing for timelier identification of change. Encounters that occurred during partial weeks at the start and end of the year were excluded. We calculated the proportions as number of calls per week with albuterol administration divided by number of calls dispatched in a given week.

The weeks prior to the publication of the March CDC guidance document were designated as the before period. The weeks between the CDC document's publication date and the nadir of albuterol administration were designated as the transition period. The nadir was defined as the week with the lowest number of calls with albuterol administrations. The weeks following the nadir were designated as the after period. We performed the descriptive statistic calculations using SAS 9.4 (SAS Institute Inc, Cary, NC).

## RESULTS

The complete 2020 NEMSIS dataset included 43,488,767 total records; of those records, 449,290 (1%) reported at least one albuterol administration. We excluded 12,001,540 cases because of the lack of a valid date in the record. We also excluded encounters from the incomplete weeks at the beginning and the end of the study period. The study time frame was January 5–December 26, 2020. Our analysis included a total of 30,726,473 records, 431,939 of which included documentation of at least one albuterol administration.

The CDC guidance was released on March 10, 2020 (week 11), and stayed in effect through the remainder of the study period. The before period was January 5, 2020 (week 2) to March 7, 2020 (week 10), during which there was an average of 16,891 calls (2.6% of all calls) with albuterol administration per week. The transition period was March 8, 2020 (week 11) to April 18, 2020 (week 16). Calls with albuterol administration fell in a near-linear fashion during this period. The after period was from April 19, 2020 (week 17) to December 26, 2020 (week 52), during which there was an average of 6,465 calls (1.1% of all calls) with albuterol administrations per week (Table 1).

This represents a 6% reduction in overall call volume between the before and after periods. The number of EMS calls with albuterol administrations in the after period compared to the before period was statistically significant ($P < .001$). There was a 61.7% reduction in the average albuterol administration between the before and after periods. All calls with albuterol administrations were grouped by week and graphed over the year (Figure 1). The proportion of all calls with albuterol administrations to the total number of calls were grouped by week and graphed over the year (Figure 2).

## DISCUSSION

The deimplementation of albuterol administration shortly after the release of the CDC's guidance is unlike prior EMS deimplementation efforts because of its speed and widespread adherence. Deimplementation of AGP use was unique since it was not a reversal or replacement of a defunct or disproven practice, nor was the recommendation based on a preponderance of evidence of the practice's danger or obsolescence.[1,2]

This precipitous and successful deimplementation of nebulized medications may have been driven by the prescribed action of ceasing AGPs, the larger sociocultural context of the pandemic, the healthcare system context, or the responsibility placed on EMS clinicians to change their patient care practices. Factors associated with deimplementation delays or efficacy may be related to systemic or logistic issues, such as lack of resources to conduct education or difficulty in coordinating with healthcare partners.[4,21,23]

**Table 1.** Number of emergency medical services (EMS) calls and EMS calls with albuterol administration throughout 2020 in a study of deimplementation of prehospital administration of nebulized albuterol at the beginning of the COVID-19 pandemic.

| | Before Transition | Transition | After Transition |
|---|---|---|---|
| Time period | Weeks 2-10 (January 5 – March 7) | Weeks 11-16 (March 8 – April 18) | Weeks 17-52 (April 19 – December 26) |
| Total calls in the time period | 5,765,374 | 3,291,118 | 21,669,981 |
| Total calls with albuterol administration in the time period | 152,018 | 47,177 | 232,744 |
| Average total calls per week (Minimum - Maximum) | 640,597 (626,675 - 656,833) | 548,520 (499,148 – 631,619) | 601,943 (514,914 - 662,756) |
| Average calls per week with albuterol administration (Minimum - Maximum) | 16,891 (16,320 to 17,332) | 7,863 (4,190 – 15,428) | 6,465 (4,186 to 7,766) |
| Percentage of total calls with albuterol administration | 2.6% | 1.4% | 1.1% |

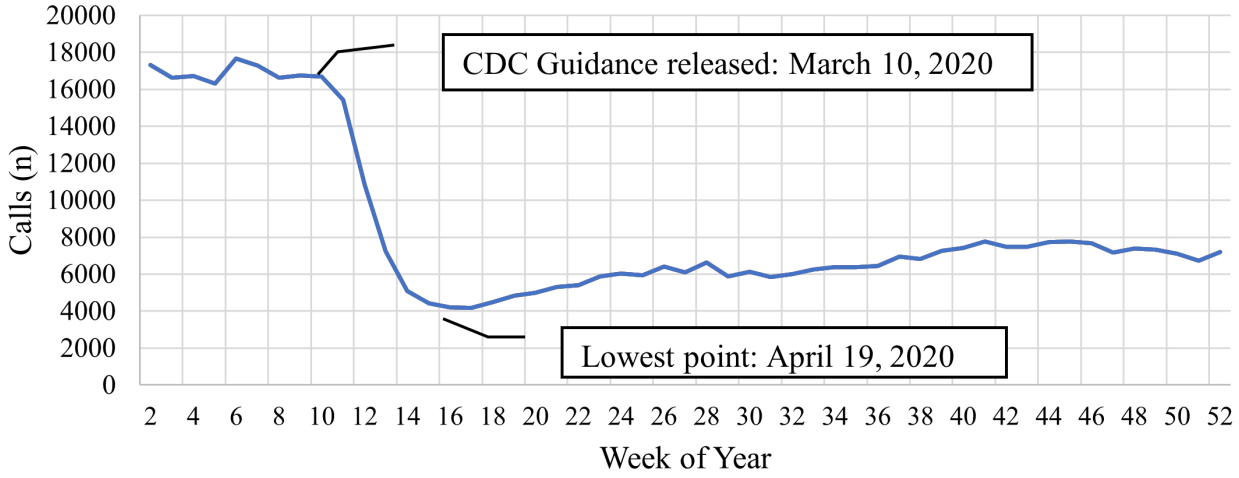


**Figure 1.** Number of emergency medical services calls with albuterol administration throughout 2020 in a study of deimplementation of prehospital administration of nebulized albuterol at the beginning of the COVID-19 pandemic (by week).
*CDC*, Centers for Disease Control and Prevention.

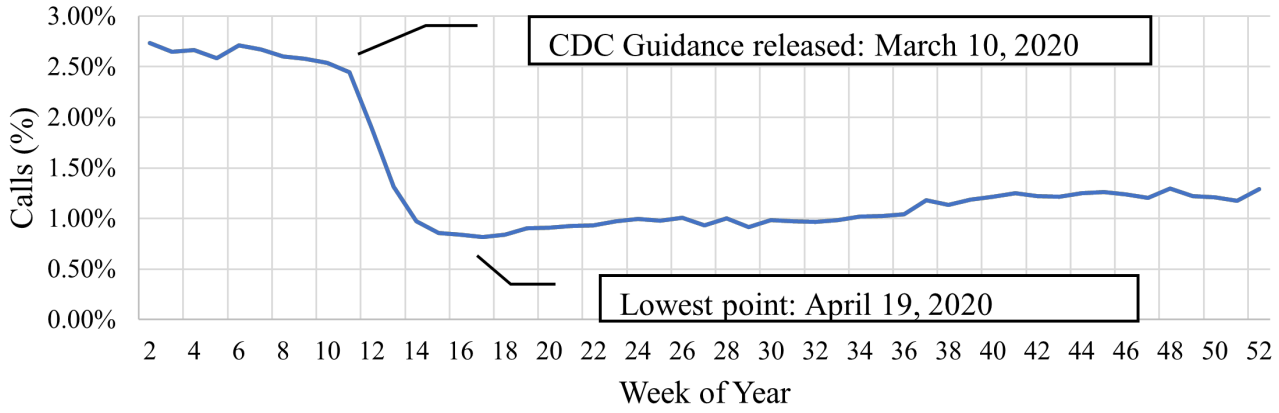


**Figure 2.** Proportion of the EMS* calls that had prehospital albuterol administration over all calls through 2020 in a study of deimplementation of prehospital administration of nebulized albuterol at the beginning of the COVID-19 pandemic (by week). This included a total of 30,726,473 records, 431,939 of which included documentation of at least one albuterol administration.
*CDC,* Centers for Disease Control and Prevention; *EMS,* emergency medical services.

## LIMITATIONS

This study examined the fixed elements in the NEMSIS dataset. A date/time in e.Times01 is not mandatory, and the date/time field in *e.Medications.01* is nillable, which contributed to the exclusion of 27% of the records from the study. It did not include patient factors and information available in the narrative section of EMS records, nor did this study review patient outcomes. The overall drop in total patient call volume may have contributed to a decrease in patients for whom AGPs would be typically indicated. This study did not analyze the routes of albuterol administration, recorded in the NEMSIS field *eMedications.04*, as the variability in medication route-labeling practice patterns would have added another confounding factor. Future research could study the EMS clinicians' perspectives on the deimplementation of AGP use. Finally, this methodology did not account for potential seasonal variations in respiratory illnesses.

## CONCLUSION

Deimplementation efforts in EMS are traditionally slow or gradual over time. In the case of the use of aerosol-generating procedures in the beginning of the COVID-19 pandemic, deimplementation occurred in the six weeks after CDC guidelines were published.

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# Optimizing Fluid Resuscitation Strategies: A Network Meta-analysis of Effectiveness and Safety for Hemorrhagic Shock Patients in Emergency Settings

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**Introduction:** Hemorrhagic shock is a life-threatening condition and remains a leading cause of death worldwide. Current European guidelines lack recommendations for one fluid type over another in the management of hemorrhagic shock. This study explores the effectiveness and safety of colloids and crystalloids in resuscitation of hemorrhagic shock patients.

**Methods:** We conducted a systematic search in PubMed, Cochrane Cenral Register of Controlled Trials (CENTRAL), Scopus, Web of Science, ProQuest, and Cumulative Index to Nursing and Allied Health Literature (CINAHL) up to January 3, 2024. We performed data analyses using Rstudio v.4.4.1 in Frequentist network meta-analysis with DerSimonian-Laird random-effects model. Subgroup and network meta-regression analyses was also performed in Bayesian methods. We analyzed safety aspects using meta-proportions with generalized linear mixed models models.

**Results:** A total of 3,693 patients from 23 randomized controlled trials were included in this study. Synthetic colloid demonstrated the lowest mortality rate (odds ratio 0.37, 95% CI, 0.15-0.93; *P-score* = .94) with the lowest fluid input requirement (mean difference -1.02; 95% CI, -1.62 to -0.41; *P-score* = .75). Subgroup and network meta-regression analysis revealed none of the covariates significantly influenced these two outcomes. Regarding safety aspects, isotonic crystalloid caused the most diverse adverse events, with acute respiratory distress syndrome (prop = 0.067) and overload syndrome (prop = 0.063) being the most common adverse events.

**Conclusion:** This study provides robust evidence favoring the initial use of synthetic colloid in the management of patients with hemorrhagic shock. [West J Emerg Med. 2025;26(6)1795–1803.]

## INTRODUCTION

Hemorrhagic shock is a life-threatening, medical emergency condition of intravascular volume depletion through blood loss, leading to inadequate perfusion of tissues and organs to oxygen.[1] If left uncorrected, acidosis with persistent hypoxemia will eventually cause the loss of peripheral vasoconstriction, worsening hemodynamic compromise, and death. Hemorrhagic shock remains a leading

cause of death worldwide, which is responsible for over 80% of deaths in the operating room and nearly 50% of deaths within 24 hours after injury.[2]

The current suggestion for hemorrhagic shock management is based on a timely, rapid, definitive source control of bleeding and blood loss replacement.[3] Therefore, fluid resuscitation emerges as a cornerstone of effective medical management, highlighting its vital role in restoring intravascular volume, maintaining tissue perfusion, and preventing the onset of shock and organ failure, particularly in situations where blood is not available.[4] The most frequently used types of fluid for resuscitation are crystalloid and colloid solutions.[5] Crystalloid solutions that mimic the electrolyte composition of plasma, such as normal saline, Ringer lactate, bicarbonated Ringer solution, hypertonic saline, Ringer acetate, and Plasma-Lyte A, are associated with lower incidence of acute kidney injury, decreased need for renal-replacement therapy, and reduction in mortality.[6]

In comparison to colloids, however, resuscitation using crystalloids requires two to four times more fluid to replenish and sustain intravascular fluid volume, which dilutes plasma proteins, lowering colloid osmotic pressure, and quickly leaks into the interstitial space.[7,8] On the other hand, colloids are solutions containing high molecular weight substances, which do not easily cross capillary membranes. Colloids, including dextran, mannitol 15%, hydroxyethyl starch, plasma, albumin, gelatin, and hypertonic colloid, increase survival rates in several studies.[5,9] Colloid osmotic pressure in the plasma helps keep fluids inside the blood vessels, resulting in quicker and more effective resuscitation.[5,9]

Nevertheless, current European guideline for traumatic hemorrhagic shock noted that there is no accepted intervention regarding the superiority of one among the others.[10] Although many studies have been conducted to compare types of fluid interventions, a quantitative analysis comparing all available interventions has never been conducted. Our goal in this study was to provide evidence and fill the knowledge gaps regarding the effectiveness and safety of each fluid resuscitation strategy in improving hemorrhagic shock-related patient outcomes.

*Population Health Research Capsule*

What do we already know about this issue?
*Current fluid selection for hemorrhagic shock largely depends on availability, and existing guidelines lack firm recommendations.*

What was the research question?
*Which fluid type is most effective in reducing mortality and ensuring safety in hemorrhagic shock resuscitation?*

What was the major finding of the study?
*Synthetic colloids showed the lowest mortality (OR 0.37, 95% CI 0.15–0.93; P-score = .94) and reduced fluid input (MD −1.02; 95% CI −1.62 to −0.41).*

How does this improve population health?
*Provides evidence-based guidance for optimal fluid selection in hemorrhagic shock, improving survival and emergency care outcomes.*

## METHODS

We conducted this systematic review and network meta-analysis (NMA) in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) NMA Checklist of Items (**Table S1**).[11] The study protocol has been registered on PROSPERO (Record No. CRD42024516480).[12]

### Search Strategies

We conducted a computerized systematic literature data search in PubMed, Scopus, CENTRAL, CINAHL, ProQuest, and Web of Science up to January 3, 2024. To ensure comprehensive coverage, we established a list of primary keywords that included "hemorrhagic shock," "crystalloid," "colloid," and "resuscitation." We then added several Medical Subject Headings and other accessible text terms to construct the database-specific search terms. The entire search terms for each database are provided in Table S2.

### Study Selection, Eligibility Criteria, and Data Extraction

We used the Population, Intervention, Comparison, Outcome (PICO) framework[13] (Table 1), which is specifically designed for systematic reviews to establish the eligibility criteria. The full inclusion and exclusion criteria of the studies are depicted in Table 2. A full explanation of study selection and data extraction can be accessed in Supplementary Material.

### Quality Assessment of Individual Studies

Risk of bias of each eligible study is evaluated by the Cochrane risk of bias 2 (RoB-2) tool.[14] The RoB-2 plots were generated using the "robvis" software.[15]

### Statistical Analysis

We performed NMA using Frequentist[16] methods with netmeta[17] packages in Rstudio v4.4.1 (Posit, Boston, MA,).[18] We conducted NMA using pooled mean difference (MD) and odds ratio (OR) based on the reported type. The DerSimonian-Laird random-effects model was used to accommodate unavoidable heterogeneity.[19] A higher *P*-score indicates a

**Table 1.** Characteristics of studies, using the PICO* framework to explore the effectiveness and safety of colloids and crystalloids in resuscitation of hemorrhagic shock patients.

| Components of PICO | Definition |
|---|---|
| **P**opulation | Adult patients with hemorrhagic shock |
| **I**ntervention | Isotonic Crystalloid (RL, Plasma-Lyte A, BRS)<br>Hypertonic Crystalloid (HS)<br>Natural Colloid (plasma, albumin)<br>Synthetic Colloid (HES, gelatin)<br>Combination (HH, HSD) |
| **C**omparison | Isotonic crystalloid: Normal saline |
| **O**utcome | Primary outcomes<br>Mortality rate and total fluid input<br>Secondary outcomes<br>Any adverse effects due to fluid resuscitation |

**PICO*, Population, Intervention, Comparison, and Outcome. *RL*, Ringer lactate; *BRS*, bicarbonated Ringer solution; *HS*, hypertonic saline; *HES*, hydroxyethyl starch; *HH*, hypertonic saline + hydroxyethyl starch; *HSD*, hypertonic saline dextran.

**Table 2.** Summary of *P*-values for mortality rate and total fluid input network meta-analysis.

| A. Mortality rate | |
|---|---|
| Treatment | *P*-score |
| Synthetic colloid | **.94** |
| Natural colloid | .63 |
| Hypertonic crystalloid | .52 |
| Combination | .34 |
| Isotonic Crystalloid | .07 |
| B. Total fluid input | |
| Treatment | *P*-score |
| Synthetic colloid | **.75** |
| Hypertonic crystalloid | .73 |
| Combination | .71 |
| Natural colloid | .17 |
| Isotonic cystalloid | .14 |

Higher *P*-value indicates a better treatment for that outcome.

better treatment for that outcome. Publication bias was assessed both qualitatively using an inverted funnel plot and quantitatively using the Egger regression test.[20] Heterogeneity was examined with Cochran's *Q* statistics.[21] The inconsistency assessment was conducted using global and local approaches.[19] The local inconsistency assessment is carried out using the Separating Indirect from Direct Evidence (SIDE) method.[22] Global inconsistency was assessed using between designs *Q* statistics value.[23] The Grading of Recommendations, Assessment, Development and Evaluation) to rate the quality of evidence (GRADE) methodology evaluates findings based on six domains: within-study bias based on the RoB-2 tool assessment; reporting bias; indirectness; imprecision; heterogeneity; and incoherence.[24] Frequentist framework is preferred for the primary NMA to ensure accessibility and interpretability for a broad readership, as it provides confidence intervals and *P*-values that are widely recognized in clinical research. We applied Bayesian models for subgroup and meta-regression analyses because of their greater flexibility in exploring effect modification and complex relationships. Both approaches yielded consistent conclusions, supporting the robustness of our findings.

### Meta-proportions for Analyzing Safety Outcomes

We performed meta-proportion analysis using generalized linear mixed models (GLMM) methods.[25] Meta-analyses of proportions focuses on estimating the overall (median or population-averaged) proportion, regardless of the transformation used. In this sense, they differ from meta-analyses of treatment comparisons, which may aim at estimating different relative effects (eg, OR, risk ratio or risk difference), depending on how event rates are transformed.[26,27]

In a network meta-analysis, the P-score indicates the relative ranking of each treatment, ranging from 0 to 1, with higher scores reflecting more favorable treatments.

## RESULTS

### Overview of Study Selection Process

A PRISMA flowchart of the entire study selection process is depicted in Figure 1. The initial search of the six databases yielded 44,191 hits. Among these, we removed 3,474 duplicates; and 36,045 records were found to be ineligible by the automated tool. Of the remaining 4,672 studies, 4,046 and 233, respectively, were excluded based on their title and abstracts. Neither did we retrieve 11 trial registers, four conference abstracts, and 80 articles with no available full-text. We conducted a detailed examination of the full text of the remaining 298 studies, which resulted in the exclusion of 236 studies due to the following: inappropriate population with animals as study subjects (n = 63) and not assessing hemorrhagic shock-related patients (n = 50); not intervening with fluid resuscitation (n = 64); not reporting the outcome of interest (n = 23); inappropriate study design (n = 7); and non-randomized studies (n = 88). In addition to database searching, we identified 55 additional records from websites and reference lists searches, of which 20 reports were not retrieved. After assessing the eligibility of the remaining reports, we excluded 15. Finally, a total of 23 randomized controlled trials (RCT)[28-50] were included in this systematic review and NMA.

### Characteristics and Baseline Outcomes of Included Studies

The characteristics of the included studies are presented in Table 3. A total of 3,693 patients were included across 23 RCTs,

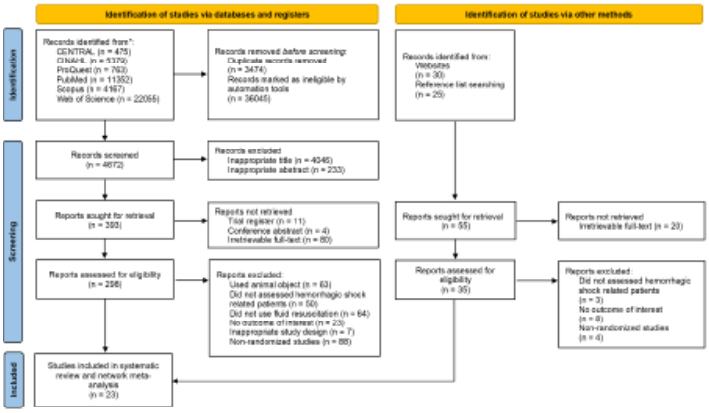


**Figure 1.** PRISMA* flow diagram of the study selection process. *PRISMA, **Preferred Reporting Items for Systematic Reviews and Meta-Analyses.**
*CENTRAL,* Cochrane Central Register of Controlled Trials; *CINAHL,* Cumulative Index to Nursing and Allied Health Literature.

with participants ranging from 31.3-48.25 years of age. Of these patients, 1,048 were female, representing 28.37% of the study population. Study sample sizes varied from 23 to 626 patients. The included studies were geographically diverse, spanning four continents, with two studies from Africa, 14 from America, five from Asia, and two from Europe. The included studies assessed two types of patient characteristics, including hemorrhagic shock patients (n = 12) and trauma hemorrhagic shock patients (n = 11). The average adherence rate of the included studies was 89.69%. Most of the studies performed intention-to-treat analysis (n = 21), while the remaining used per-protocol analysis (n = 2). Patient baseline data from each study can be seen in Table 4. The data include information related to the shock hemorrhagic condition: Injury Severity Score (ISS); revised trauma score; Glasgow Coma Scale (GCS), time to point of injury to arrival on scene; time from point of injury to the emergency department; patient's hemodynamics (pH, hemoglobin levels, lactate levels, heart rate, systolic blood pressure, mean arterial pressure, central venous pressure, osmolarity, and hematocrit); and electrolyte balance (sodium, potassium, chloride, and bicarbonate levels).

**Quality Assessment of Included Studies**

The results of the domain-specific quality assessment are presented in Figure S1, while the ROB evaluation for each study is summarized in Figure S2. Based on Cochrane's ROB-2 tool, six and 17 studies demonstrated low and moderate risk of bias in all domains, respectively.

**Network Meta-Analysis and Rank Probability**

The established network plots for fluid resuscitation are displayed in Figure S3. The detailed results of each fluid resuscitation are displayed in the form of pairwise meta-analysis, which can be seen in Figure S4-S5. Figure 2.1A shows the results of frequentist NMA for mortality rate outcome. The forest plot revealed that patients with synthetic colloid resuscitation (OR 0.37, 95% CI, 0.15-0.93, P = .94 had the lowest mortality rate and also required the least resuscitation volume (MD -1.02, 95% CI, -1.62 to -0.41; P = .75) compared to the others. Meanwhile, use of natural colloid also proved to result in significantly lower mortality rates (OR 0.70; 95% CI, 0.55-0.88, P = .63). However, Figure 2.1B, shows that those who received natural colloid (OR 0.04, 95% CI, -1.06 to 1.13, P = .17) needed more volume of fluid resuscitation compared to those receiving combination (OR -0.96, 95% CI, -1.67 to -0.24, P = .71) or hypertonic crystalloid resuscitation (OR -1.00; 95% CI, -2.03 to 0.03, P = .73).

Funnel plots results show no publication bias in all outcomes, including mortality rate and total fluid input (refer to Figure 2.2AB). The results of the frequentist NMA are also presented in the form of a league table in Table S3, while summary of the P-values, which display the probabilities for each treatment to the outcomes, are depicted in Table 5. The results of the funnel plots agreed with the results of the Egger

**Table 3.** Summary of meta-proportions on adverse effects from fluid resuscitation.

| | Isotonic crystalloid | | | Natural colloid | | | Synthetic colloid | | | Combination | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Adverse effect | k | Proportion | 95% CI | k | Proportion | 95% CI | k | Proportion | 95% CI | k | Proportion | 95% CI |
| Acute kidney injury | 2 | 0.012 | 0.000; 0.966 | - | - | - | - | - | - | 1 | 0.009 | 0.000; 0.054 |
| Acute respiratory distress syndrome | 6 | 0.067 | 0.015; 0.260 | 1 | 0.043 | 0.023; 0.081 | 2 | 0.103 | 0.002; 0.867 | - | - | - |
| Bloodstream infection | 2 | 0.017 | 0.000; 0.913 | 1 | 0.014 | 0.003; 0.053 | - | - | - | - | - | - |
| Coagulopathy | 3 | 0.046 | 0.013; 0.147 | - | - | - | - | - | - | 1 | 0.009 | 0.001; 0.034 |
| Overload syndrome | 1 | 0.063 | 0.026; 0.126 | - | - | - | - | - | - | 1 | 0.059 | 0.022; 0.125 |
| Pneumonia | 3 | 0.015 | 0.002; 0.112 | 1 | 0.431 | 0.317; 0.553 | - | - | - | 2 | 0.018 | 0.000; 0.918 |

test, boh indicating no publication bias within the mortality rate (P = .99) and total fluid input (P = .99) outcomes.

Negligible heterogeneity level was found in mortality rate NMA (refer to Table S4). However, moderate to high heterogeneity was discovered between combination and isotonic crystalloid ($I^2$ = 86.4%), between synthetic colloid and isotonic crystalloid ($I^2$ = 53.3%). The SIDE methods revealed inconsistency was not present in all comparisons (Table S4). This result agrees with the global inconsistency result, which also found no significant inconsistency within mortality rate (Q = 5.83, P = .05) and total fluid input (Q = 1.12, P = .57) (Figure S3-S4). The direct and indirect evidence plot of each network meta-analysis also presented in Figure S8 and Figure 9, demonstrate that the evidence of some comparisons are limited, whether it was obtained by either direct or indirect, while others are evidenced by both direct and indirect.

### Adverse Effects

The results of meta-proportions on adverse effects from every fluid resuscitation group are summarized in Table 6. Among all the fluid groups, isotonic crystalloid was associated with the most diverse adverse events, with acute respiratory distress syndrome (proportion = 0.067) and overload syndrome (proportion = 0.063) being the most common adverse events. Both natural and synthetic colloids also led to various side effects, with pneumonia (prop = 0.431) and acute respiratory distress syndrome (proportion = 0.103) being the most prevalent side effects, respectively. Lastly, combination therapy showed overload syndrome (proportion = 0.059) as the most prevalent adverse effect.

### Subgroup and Network Meta-Regression Analysis

**Table S8** contains the results of the subgroup and network meta-regression analysis for mortality rate and total fluid input outcomes. The subgroup analysis revealed that no statistical difference was found in 1) continent, 2) patient characteristics, 3) type of analysis, and 4) risk of bias results between two outcomes. Subsequently, network meta-regression analysis also found that none of the covariates significantly influenced these two outcomes.

### Quality of Evidence

The within-study bias assessment revealed several concerns (Figure S10, S11). The indirectness in the network assessment is depicted in Figure S12, S13. Furthermore, the full GRADE report assessment identified significant issues related to imprecision, within-study bias, and heterogeneity, which can lead to a decrease in the confidence rating level (Table 7).

## DISCUSSION

Hemorrhagic shock is a critical condition in trauma and emergency settings, while crystalloids playing a significant role in volume resuscitation.[1] In this study we compared the effectiveness of various resuscitation fluids, finding that synthetic colloids led to greater mortality reduction than isotonic crystalloids. Furthermore, synthetic colloids, hypertonic crystalloids, and colloid-crystalloid combinations significantly reduced overall fluid input compared to isotonic crystalloids. These results are consistent with the pathophysiology of hemorrhagic shock, supporting the use of appropriate fluids in clinical settings.

During hemorrhagic shock, the loss of circulating blood volume reduces oxygen supply to tissues, triggering compensatory mechanisms such as vasoconstriction, increased heart rate, and activation of the renin-angiotensin-aldosterone system.[51] While these responses help maintain perfusion to vital organs, tissue hypoxia eventually leads to anaerobic metabolism, lactic acidosis, and organ failure. Prompt volume restoration is essential to reverse these processes.[52]

### Mortality

Our study found that synthetic colloids significantly reduced mortality compared to isotonic crystalloids (Figure 2A). Colloids are known for their superior volume-expansion properties, requiring smaller volumes to achieve the same hemodynamic effect as crystalloids.[9] However, while they are effective in trauma settings by maintaining adequate intravascular volume and tissue perfusion, colloids can increase the risk of renal complications.[53] Nevertheless, newer generation starch-based synthetic colloids can stabilize hemodynamics with fewer complications in trauma-induced hemorrhagic shock.

Synthetic colloids have been shown to stabilize key hemodynamic parameters, such as mean arterial pressure (MAP) and central venous pressure (CVP), more effectively than crystalloids.[54] Early stabilization of MAP and CVP correlates with improved survival and a lower incidence of multiorgan failure. By reducing the volume needed to restore circulation, synthetic colloids also minimize tissue edema and prevent dilutional coagulopathy.[55,56] Additionally, the reduced fluid input helps maintain serum bicarbonate levels, stabilizing pH and reducing lactate accumulation, which is a key indicator of anaerobic metabolism.[57] Studies suggest that rapid restoration of hemodynamics with these fluids limits the extent of metabolic acidosis.[58]

### Fluid Input

Our analysis also revealed that synthetic colloids, hypertonic crystalloids, and colloid-crystalloid combinations have more reduction on total fluid input compared to isotonic crystalloids (Figure 2B). The colloid-crystalloid combinations demonstrate the synergism between colloids, which have a longer lasting volume-expanding effect and crystalloids, which rapidly distribute into both the intravascular and interstitial spaces.[59] Hypertonic crystalloids, such as 3% sodium chloride, require smaller volumes due to their osmotic effect, which pulls fluid into the intravascular space from the

interstitial and intracellular compartments. The use of hypertonic crystalloids reduce edema formation, which is beneficial in the resuscitation,[60] as opposed to the isotonic crystalloid administration, which results in approximately 75% of the fluid being distributed in the interstitial space.[61]

Another reason that fluids like synthetic colloids, hypertonic crystalloids, and colloid-crystalloid combinations reduce fluid input may be a result of their positive impact on sodium and potassium balance. The effectiveness in electrolyte control reduces the need for excess fluid.[10] Their role in maintaining a stable electrolyte profile prevents the dilutional hyponatremia and hyperkalemia, which increase the need of fluid input that occurs with isotonic solutions.[58] Studies showed a correlation between elevated serum potassium levels and early mortality, as well as its association with prolonged resuscitation efforts.[62]

### Meta-Regression

Meta-regression analysis indicates that the use of these fluid resuscitation is both applicable and safe for patients of all genders and ages who suffer from hemorrhagic shock. These results align with previous studies, which found that despite differences in the fluid composition, there was no significant difference in resuscitation outcomes.[63] Further analysis of any others shock-related outcomes, such as ISS, GCS, prehospital time, blood pressure, pH, hemoglobin levels, and lactate levels also revealed that the effectiveness of fluid resuscitation applied to hemorrhagic shock patients with a variety of diverse characteristics.

### Adverse Effect

As the significant portion of isotonic crystalloid fluids distribute into the interstitial space, large volumes are often required to achieve adequate resuscitation.[64] The need to administer large volumes of isotonoic crystalloid fluids in hemorrhagic shock can lead to hemodilution. Hemodilution of blood components impairs hemostasis due to coagulation factor depletion.[65] Hemodilution is associated with low oxygen-carrying capacity of blood, increasing the risk of acute kidney injury.[66] The hemodiluted patients were more susceptible to bloodstream infection due to impairment of immune response, although this is still more related to the cause of hemorrhagic shock and aseptic technique.[67] This aligns with European Society of Intensive Care Medicine guidelines, which conditionally recommend using balanced crystalloids instead of isotonic saline for patients with sepsis or kidney injury.[68] Our findings demonstrated that natural colloids increase blood viscosity, which can elevate the risk of thrombosis. However, the effects of colloids on blood coagulation vary depending on the type of colloid used. The synthetic colloid hydroxyethyl starch has been linked to increased pulmonary capillary permeability and greater pulmonary leak index. This explains the high risk of acute respiratory distress syndrome in the synthethic colloid groups.[69]

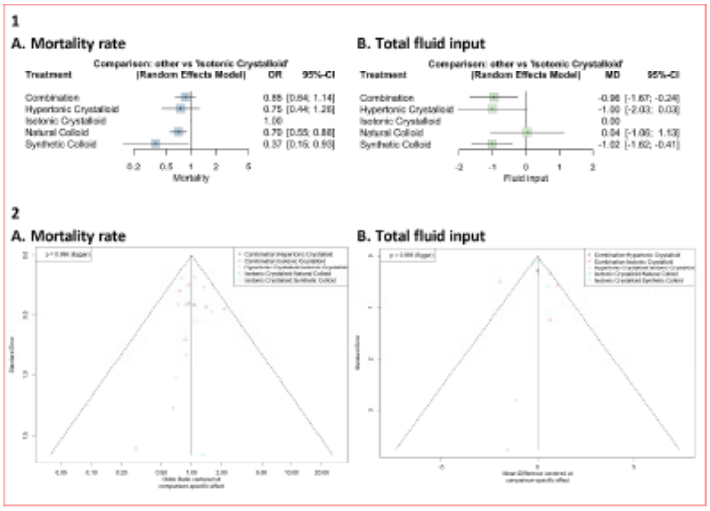


**Figure 2.** Forest plot of relative effect (1A and 1B) and funnel plot (2A and 2B) from network meta-analysis using a frequentist random-effects model for mortality rate (A) and total fluid input (B). The vertical line indicates the line of no effect. Values to the left of the line favor the compared interventions, while values to the right favor the reference interventions.
*MD,* mean difference; *OR,* odds ratio.

## LIMITATIONS

To the best of our knowledge, this study is the first systematic review and network meta-analysis to analyze both the effectiveness and safety of any fluid resuscitation in hemorrhagic shock-related patients. Previously, the National Association of Emergency Medical Services Physicians published a statement paper that provides recommendations and position statements based on a broad synthesis of the available literature.[70] In contrast, our study employed a rigorous network meta-analysis that included only randomized controlled trials, enabling both direct and indirect comparisons across all major fluid types. This approach addresses a specific evidence gap by offering a comprehensive, head-to-head evaluation of fluid resuscitation strategies. We believe that our findings not only complement existing position statements but also contribute novel, quantitative comparative evidence that may inform future clinical guideline development in trauma resuscitation. Furthermore, the study also covered a wide range of areas and included a sufficient number of samples for all analyses, which will enhance the study's findings.

Despite our attempts to deliver the best possible quality of study, we acknowledge areas for improvement, including some concerns that we found in imprecision, within-study bias, and heterogeneity evaluation, which resulted in a downgrade in the confidence rating. We also included seven studies that are over 20 years old; we conducted a network meta-regression analysis to assess whether the year of publication had a significant influence on the study outcomes. The results of this analysis indicated no significant effect of publication year on the

network estimates, thus mitigating concerns about the potential impact of older studies on our overall findings.

We also acknowledge the study by Andrews et al, which demonstrated that aggressive fluid resuscitation in adults with sepsis and hypotension in low-resource settings was associated with increased harm. However, this population differs substantially from patients with hemorrhagic shock, where the underlying pathophysiology, resuscitation goals, and standard of care are distinct. While the findings raise important considerations about fluid overuse in resource-limited environments, their applicability to hemorrhagic shock remains limited.[71] Furthermore, Andrews' study primarily focused on crystalloid-based strategies, whereas blood products remain the cornerstone of resuscitation in hemorrhagic shock. The precise role of crystalloids when used in conjunction with blood products is not fully established, and addressing this question was beyond the scope of the present analysis.

## CONCLUSION

Our study supports the use of synthetic colloids, including hydroxyethyl starch and gelatin, as the first choice in treating patients with hemorrhagic shock-related disease due to associated decreases in mortality and adverse events. Considering the accessibility of colloids, the use of a combination of colloids and crystalloids may be an option. It would be beneficial for future studies to analyze the long-term outcomes of fluid resuscitation, such as the need for renal replacement therapy, as well as evaluate the efficacy of whole blood in hemorrhagic shock resuscitation. It is imperative to consider the cost implications, accessibility, and clinical suitability inherent to each fluid type.

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# "Predictive Factors and Nomogram for 30-Day Mortality in Heatstroke Patients: A Retrospective Cohort Study"

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**Dear Editor:**

With the continued rise in global environmental temperatures, and the resultant increase in heatstroke deaths,[1] we would like to recognize and highlight the importance of the article "Predictive Factors and Nomogram for 30-Day Mortality in Heatstroke Patients: A Retrospective Cohort Study," from Li et al published in May 2025.[2] We agree that the management of heatstroke continues to be of increasing importance, which the study authors further support with their findings. However, after reviewing their methods, we believe further study participant detail could enhance readers' understanding and applicability of their findings.

The study authors cite the Chinese Expert Consensus on the Diagnosis and Treatment of Heatstroke to support their study inclusion criteria, which defines heatstroke as "a core temperature of > 40 °C AND abnormalities of the central nervous system, including changes in mental status, convulsions or coma AND accompanied by life threatening multiple organ damage."[3] However, the reported study inclusion criteria require only one of the following heatstroke-associated features: central nervous system dysfunction; core body temperature exceeding 40 °C; or functional impairment of multiple organs. According to the study results, the mean core temperature at admission was 39.09 °C. We feel this necessitates further detail of how many of the patients included in the study met the entirety of the heatstroke diagnostic criteria set forth by Liu et al, and specifically how many were noted to be hyperthermic, > 40 °C, at any point during their illness. A further description of the study population, clarifying the number of patients who were hyperthermic at any point, including prehospital temperatures, would help readers better interpret the study cohort.

We would also ask for a further description of the cooling therapy used in this study. The study authors note that "the average cooling time was 3.13 hours." Given that the average core temperature at admission in the study was 39.09 °C and the stated goal temperature for cooling cessation was 38.5 °C, or approximately a 0.59 °C reduction, this results in an approximate average rate of cooling of 0.003 °C per minute. Comp et al noted that cooling rates can be as fast as 0.13 °C per minute with cold water immersion.[4] Further, the study authors note that "the average time from onset to initiation of treatment was 8.29 hours." We concur with their assessment of the importance of initiating heatstroke care within the "golden window" of the first 30 minutes post heat exposure.[5] The study authors report "a lower risk of death when the core temperature at 30 minutes after admission was below 39.5 °C," yet it is unclear how often this occurred in this study as the care was, on average, initiated many hours after exposure, and most often lasted over three hours once initiated. How do the study authors believe the delay in the initiation of treatment and the prolonged cooling duration may have impacted their findings? Was this considered when developing the risk predictions? Further clarification of the cooling treatment, including how many patients were treated within the "golden window," and the outcomes among this group, we believe, would be helpful to better understand the study findings.

Overall, we applaud the study authors for their work and agree that this contributes to our current understanding of heatstroke management, continuing to emphasize the importance of timely cooling therapy. We are optimistic that additional descriptions of the study participants and the therapeutic interventions will further strengthen this work.

We appreciate your consideration of these questions and welcome any feedback. Thank you.

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