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Impact of Post-Intubation Interventions on Mortality in Patients Boarding in the Emergency Department

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Introduction: Emergency physicians frequently perform endotracheal intubation and mechanical ventilation. The impact of instituting early post-intubation interventions on patients boarding in the emergency department (ED) is not well studied. We sought to determine the impact of post-intubation interventions (arterial blood gas sampling, obtaining a chest x-ray (CXR), gastric decompression, early sedation, appropriate initial tidal volume, and quantitative capnography) on outcomes of mortality, ventilator-associated pneumonia (VAP), ventilator days, and intensive care unit (ICU) length-of-stay (LOS).

Methods: This was an observational, retrospective study of patients intubated in the ED at a large tertiary-care teaching hospital and included patients in the ED for greater than two hours post-intubation. We excluded them if they had incomplete data, were designated “do not resuscitate,” were managed primarily by the trauma team, or had surgery within six hours after intubation.

Results: Of 169 patients meeting criteria, 15 died and 10 developed VAP. The mortality odds ratio (OR) in patients receiving CXR was 0.10 (95% CI 0.01 to 0.98), and 0.11 (95% CI 0.03 to 0.46) in patients receiving early sedation. The mortality OR for patients with 3 or fewer interventions was 4.25 (95% CI 1.15 to 15.75) when compared to patients with 5 or more interventions. There was no significant relationship between VAP rate, ventilator days, or ICU LOS and any of the intervention groups.

Conclusion: The performance of a CXR and early sedation as well as performing five or more vs. three or fewer post-intubation interventions in boarding adult ED patients was associated with decreased mortality. [West J Emerg Med. 2014;15(6):708-711]

INTRODUCTION

Emergency physicians (EP) frequently care for intubated and mechanically ventilated patients while these patients board in the emergency department (ED) waiting for an intensive care unit (ICU) bed.^{1,2} As the volume of critically ill patients in the ED continues to rise,^{1,3} defining optimal ED

care is becoming increasingly important. There are several post-intubation interventions commonly performed in the ED, which include ventilator management, initiation of sedation, gastric decompression via orogastric tube (OGT) placement, arterial blood gas (ABG) analysis, performance of chest X-ray (CXR), quantitative capnography, and

elevation of the head of the bed to greater than 30 degrees. Head elevation was found to significantly reduce the rate of ventilator-associated pneumonia (VAP).⁴ The effects of the other six interventions individually and as a group on patient outcomes have not been well studied. McGillicuddy et al examined the utility of CXR in identifying malpositioned endotracheal tubes; however, they did not investigate the impact that CXR performance had on patient outcome.⁵ Lung protective strategies (LPS) have a clear role in patients with acute respiratory distress syndrome (ARDS) when initiated in the ICU.^{6,7} Despite data that suggest a high prevalence of acute lung injury (ALI) in mechanically ventilated patients in the ED, initiating LPS early after intubation in the ED has not been studied.⁸ Several studies suggest that using LPS in patients without ALI may decrease lung injury, although this hasn't been studied in a heterogeneous ED population.⁹⁻¹¹ Similarly, the use of quantitative capnography now has a level 1A recommendation for mechanically ventilated patients in the 2010 American Heart Association guidelines,¹² as well as a 1A recommendation in guidelines published in *Respiratory Care*.¹³ However, no study to date has shown a clear outcome benefit of quantitative capnography. Studies examining the utility of ABG analysis, gastric decompression, and initiation of sedation with regard to patient outcomes are similarly lacking.

The purpose of our current study was to better delineate the association between performance of post-intubation interventions in the ED and patient outcomes to guide optimal care of these patients in the ED. We hypothesized that performance of each of the six interventions, as well as an increasing numbers of interventions, would be associated with improved outcomes including decreased mortality, VAP rate, ventilator days, and ICU length-of-stay (LOS).

METHODS

This retrospective study used an existing database, collected by trained research assistants using standardized forms and blinded to the hypotheses, of all patients intubated in the ED of a large, urban, tertiary-care, teaching hospital from November 14, 2009, to June 1, 2011, and was approved by the institutional review board. The study site ED, with an annual census during the study period of approximately 84,000 patients, had a dedicated respiratory therapist, an emergency medicine residency program, a 26% admission rate, and accounted for over 50% of all hospital admissions. Of the admitted patients, 65.5% were classified as boarding (no bed assignment two hours after admission orders), with an average boarding time of 2.9 hours. Trauma patients were cared for in a unit separate from the ED. Post-intubation care during the study period was at the discretion of the treating emergency physician without a standardized bundle of care. Patients were included in the study if they were in the ED for greater than or equal to two hours post-intubation (boarding) and were

managed primarily by the ED team. They were excluded if they had incomplete data, were made "do not resuscitate" (DNR), or were primarily managed by the trauma service. Additionally, we excluded patients who underwent a major surgical procedure within six hours of intubation so that we would not confound medically managed ICU patients with surgical patients.

Statistical Analysis

Patients were evaluated for each individual type of ED intervention performed and categorized into two groups (performance of intervention and non-performance of intervention). For the individual continuous variables of ICU LOS and ventilator days, we tested the differences in mean duration between the two groups using the non-parametric Wilcoxon rank sum test since the normality assumption was not satisfied. We used chi-squared and Fisher's exact tests to investigate the difference between the two groups for categorical outcome variables of mortality and VAP rate. A p-value of <0.05 was considered a significant difference between the two groups.

We used multivariate logistic regression analysis, adjusted for illness severity using sequential organ failure assessment (SOFA) and acute physiology and chronic health evaluation II (APACHE II) scores, to examine the relationship between the six interventions and the categorical outcomes (mortality and VAP rate), and to determine if an increasing number of interventions (1-3 vs. 4 vs. 5-6) was associated with improved outcomes. This grouping was based on a relatively small number of patients receiving one, two, or six interventions, leaving too few patients for meaningful comparison (Table 1). A multivariate linear regression model was used for the continuous outcomes (ventilator days and ICU LOS), and was similarly adjusted to control for illness severity using SOFA and APACHE II scores.

RESULTS

We reviewed a total of 317 charts; of these, 148 were excluded (112 DNR, 16 incomplete data, 20 surgery within 6 hours of intubation), leaving 169 patients in our cohort. Of

Table 1. Number and percentage of patients receiving interventions.

Number of interventions	Number of patients receiving interventions	Percentage of patients receiving interventions
1	1	0.6%
2	8	4.7%
3	30	17.8%
4	51	30.2%
5	75	44.4%
6	4	2.4%

Table 2. Multivariate logistic regression of interventions with mortality and VAP adjusted for SOFA and APACHE II score.

Intervention	% Receiving intervention	Mortality odds ratio (95% CI)	VAP odds ratio (95% CI)
CXR (in the ED)	96.4%	0.10 (0.01, 0.98)	0.29 (0.02, 4.33)
OGT (in the ED)	84%	1.59 (0.26, 9.73)	0.70 (0.12, 4.18)
Early sedation (within 30 min.)	83.4%	0.11 (0.03, 0.46)	0.82 (0.14, 4.95)
ABG (in the ED)	76.9%	0.62 (0.14, 2.69)	1.25 (0.19, 4.33)
Appropriate tidal volume (6-10 cc/kg)	71%	1.54 (0.37, 6.45)	1.70 (0.32, 9.15)
EtCO ₂ (in the ED)	5.9%	<0.001 (<0.001, >100)	1.09 (0.12, 10.11)

VAP, ventilator-associated pneumonia; SOFA, sequential organ failure assessment; APACHE II, acute physiology and chronic health evaluation II; CXR, chest x-ray; OGT, orogastric tube; ABG, arterial blood gas; ED, emergency department

these, 154 patients survived; 15 died and 10 developed VAP, resulting in a mortality rate of 8.8% and VAP rate of 5.9%. Mean duration on the ventilator was 3.4 days and mean ICU LOS was 5.4 days.

In the group receiving a CXR, mortality was significantly lower than in the group not receiving a CXR, OR 0.10 (95% CI 0.01 to 0.98). Similarly in the group given sedation within 30 minutes, mortality was significantly lower than in the group not receiving sedation within 30 minutes, OR 0.11 (95% CI 0.03 to 0.46). There was no significant difference in mortality for the other 4 interventions (Table 2). There was no significant relationship between VAP rate, ventilator days, or ICU LOS and any of the intervention groups individually.

Patients who received fewer interventions (3 or fewer) had a significantly higher mortality rate when compared to the group with 5 or more interventions OR 4.25 (95% CI 1.15 to 15.75) (Table 3). There was no significant difference in VAP rate, ventilator days, or ICU LOS between the two groups.

DISCUSSION

To our knowledge, this is the first study to examine the outcome impact of post-intubation care in the ED setting. We chose to study boarding patients as opposed to all intubated patients to allow sufficient time for all six interventions to be performed. Prior studies have examined the effect of boarding on ICU outcomes such as mortality, VAP, as well as ICU LOS, and have found an association between increased ED LOS with poor outcome.^{14,15} These results have also been replicated in studies evaluating boarding and mortality for all admissions to the hospital.¹⁶ Additionally, two studies evaluating individual outcomes such as medication errors

Table 3. Mortality odds ratio by number of interventions adjusted for SOFA and APACHE II score.

Number of interventions	Mortality odds ratio (95% CI)
1-3 vs 4	4.10 (0.94, 17.92)
4 vs 5-6	0.98 (0.20, 4.68)
1-3 vs 5-6	4.25 (1.15, 15.75)

SOFA, sequential organ failure assessment; APACHE II, acute physiology and chronic health evaluation II

and delay in treatment times both showed an increase in adverse outcomes.^{17,18} In our study, the increased mortality rate in patients with fewer interventions may similarly be due to crowding leading to less vigilant monitoring and care of intubated patients. Our finding of decreased mortality with performance of an increasing number of post-intubation interventions is an important step in better elucidating optimal post-intubation ED care. It is unclear whether this association of increased interventions with improved mortality is due to the actual interventions performed or instead serves as a surrogate marker for attention paid toward these patients. Future study to determine if an ED intervention, such as a bundle of care or checklist to improve performance of post-intubation interventions and the impact of this intervention on outcomes, may be warranted.

LIMITATIONS

Notable limitations of this study include its retrospective, single-center study design. The total sample size available for analysis was also small (169 patients), and there was a low overall mortality in our study compared with prior studies evaluating mortality amongst patients intubated in the ED.¹⁹ Additionally, as patients who were made DNR were specifically excluded from our study, it is possible that we underestimated the impact ED interventions had on mortality. Our goal in excluding patients who were DNR was to eliminate the possibility that their outcome was based on withdrawal of care rather than ED management. Finally, although we attempted to control for illness severity in the groups receiving or not receiving specific interventions by adjusting for SOFA and APACHE II scores, it may be that other undetermined variables contributed to the change in mortality.

CONCLUSION

Initiating sedation within 30 minutes and obtaining chest radiograph post-intubation in adults intubated and boarding in the ED were associated with lower mortality. Performing five or six post-intubation interventions in adults intubated and boarding in the ED was associated with lower mortality compared to performing three or less interventions. Post-intubation

interventions in adults intubated and boarding in the ED were not associated with VAP rate, ventilator days, or ICU LOS.

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