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Optimizing Neurologically Intact Survival from Sudden Cardiac Arrest: A Call to Action

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The U.S. national out-of-hospital and in-hospital cardiac arrest survival rates, although improving recently, have remained suboptimal despite the collective efforts of individuals, communities, and professional societies. Only until very recently, and still with inconsistency, has focus been placed specifically on survival with pre-arrest neurologic function. The reality of current approaches to sudden cardiac arrest is that they are often lacking an integrative, multi-disciplinary approach, and without deserved funding and outcome analysis. In this manuscript, a multidisciplinary group of authors propose practice, process, technology, and policy initiatives to improve cardiac arrest survival with a focus on neurologic function. [West J Emerg Med. 2014;15(7):803-807.]

INTRODUCTION

For many years it has been documented that sudden cardiac arrest is among the leading causes of death, with victims numbering in the hundreds of thousands annually.¹ While the main focus of this manuscript is on out-of-hospital cardiac arrest, despite an upward trend in survival,² we believe the outcomes of these patients - as well as those treated for in-hospital arrests - could further improve.

A new paradigm in the management of sudden cardiac arrest is urgently needed. Why? In North America, the survival statistics remain markedly unfavorable in the vast majority of locales. The average reported survival-to-discharge-from-hospital rate is approximately 8%.³ This rate has remained static for more than thirty years, even given detailed and frequently updated practice guidelines issued by prestigious international organizations, such as the American Heart Association and the International Liaison Committee on Resuscitation (ILCOR). Although there is evidence that individual communities and hospitals are reporting increased survival rates, the national picture is still one that begs for substantial improvement.

As a consequence of these persistent statistics, many healthcare professionals harbor expectation that patients will not survive their arrest, let alone be discharged from the hospital with their pre-arrest neurological function intact. This combination of negative expectations and the comparative difficulty of assessing the likelihood of intact neurological status without expert on-site neurologist consultation too often results in the premature cessation of post-arrest resuscitation efforts. The expectation of bad outcomes only reinforces their repeated occurrence.

Encouragingly, reports from some geographical areas do show dramatic improvements in survival, particularly over the past decade. Patients who experience sudden cardiac arrest in these regions most typically receive high-quality cardiopulmonary resuscitation (CPR) within a systems-based, community-wide approach that includes a combination of bystander CPR, improved and coordinated clinical procedures, and appropriately aggressive use of resuscitative technology, and thus have outcomes far exceeding the national average.^{4,5} Amazingly, there can be as much as a 500% difference

in measured outcomes depending upon location; this is a staggering and unacceptable difference. What other medical condition would be allowed such disparate geographical outcomes? Cancer? If such highly varying statistics were reported for patients with neoplasms, it is likely that every institution involved in the treatment of these patients would be mobilized for change.

We believe that such mobilization by resuscitation scientists should be accelerated so that neurologically intact survival from cardiac arrest - whether out-of-hospital or in-hospital - will be a norm rather than an unexpected outcome. To this end, we offer the following, which constitutes a call to action.

Sudden cardiac arrest should be a reportable event. A national database of cardiac arrest events and outcomes should be established.

First, we can't improve what we don't consistently and reliably measure. Because sudden cardiac arrest is a leading cause of death in the U.S., classifying it as a reportable public health event holds the promise of improving both processes and outcomes across emergency medical services (EMS) and hospital organizations nationally. It would advance recognition of its impact on society and enhance accountability of communities, regions, and states that occurs only when outcomes data are shared across systems.

Mandated national reporting has been the norm in the field of communicable infectious diseases for many years, and while recognizing that some of the diseases included on the public health risk list have the potential to spread rapidly through populations if not urgently recognized and tracked, their modern day incidence and death rates are significantly lower than those for cardiac arrest. While mainstream media help to inform the public of the sporadic appearance of dangerous communicable diseases, the ongoing crisis of sudden cardiac arrest and its preventable lethality goes relatively unnoticed. The American Heart Association and other international organizations have frequently called for sudden cardiac arrests to be reported as public health events.⁶ In 2006, the Institute of Medicine noted that the majority of EMS organizations cannot document the impact of cardiac arrest on the communities they serve.¹ As a result, there has been a longstanding call - remaining largely unanswered - for integrated methods of data collection from EMS agencies, hospitals, and communities.

The Cardiac Arrest Registry to Enhance Survival, or CARES system, initiated in 2004, uses a standardized data collection system, and where it is implemented, it has provided EMS leaders with better understanding of the efficacy of resuscitation efforts in their communities.¹ The usefulness of this system, even in a limited way, is a good indicator of how valuable a national reporting base would be. Recently, the National Institutes of Health and the Center for Communicable Diseases announced their collaboration in the creation of the Sudden Death in the Young Registry for arrest

victims up to the age of 24. Data from as many as 15 states or major metropolitan areas will be entered into a centralized database from participating state public health agencies.⁷ Expansion of this concept to include all sudden cardiac arrests would increase the value of this registry.

For advancing and implementing a national reporting system, the Centers for Medicare and Medicaid Services (CMS) could be helpful in requiring outcomes reporting as a quality measure linked to reimbursement. CMS has the technical capability of comparing survival rates in different regions of the country in much the same way that it compares costs of treatment of medical conditions in different regions of the country. The data could be used to improve critical interventions, minimize future risk, and document strategies that prove most useful when deployed as a standardized, coordinated bundle of care. The analysis of the whole could provide targeted education and training for both layperson rescuers and resuscitation providers and increase general understanding of the overall problem across the country.

To complement the role of CMS, the Joint Commission and equivalent agencies could do the same for in-hospital arrests. Reporting in-hospital cardiac arrests is now voluntary. Mandating the reporting of in-hospital cardiac arrest incidence and outcomes would offer a key advantage as an out-of-hospital arrest reporting system: encouraging the adoption of protocols validated as associated with better neurological outcomes. Post-arrest outcomes of patients should also be a quality metric of hospital performance linked to reimbursement, an exact complement to what CMS could accomplish for out-of-hospital cardiac arrest.

High-Quality CPR, practiced in a system-wide, community-supported setting, should be a national norm.

The 2013 consensus paper from the American Heart Association addresses the key areas of high-quality CPR: providing compressions of adequate rate and depth, not leaning on the chest between compressions so that the chest can fully recoil, minimizing interruptions in chest compressions, and avoiding excessive ventilation. It emphasizes team logistics, monitoring, feedback, and continuous quality improvement on all levels.⁸

The guidance provided in the paper is an important step towards achieving the goal of high-quality CPR as a national norm. It is especially relevant in light of several publications from 2005, that described inconsistent and substandard CPR quality among those who resuscitate patients in sudden cardiac arrest in the field as well as those who treat in-hospital cardiac arrest.^{9,10} Those publications were intended as a wake-up call to resuscitation providers that the principles of high-quality CPR were not being widely practiced.¹¹ For example, the authors showed that when rescuers compressed at a suboptimal rate, survival-to-discharge rates after out-of-hospital arrests were reduced by as much as 30%.¹² When rescuers compressed too slowly, return of spontaneous

circulation for in-hospital cardiac arrests declined from 72% to 42%.¹¹

In addition to the basics in CPR,⁸ there are management steps that were described, including the rigorous and ongoing training of resuscitation team members, the choreography of their interrelationship during resuscitation, the appropriate use of technologies that enhance good neurological outcomes, rotation of members to decrease fatigue, good communication within the team so that each member clearly knows his/her role, and continual monitoring and feedback both in real time and post event. All of these are features of high-quality CPR.

Technologies and procedures that support the administration of high-quality CPR should be included in treatment protocols when there is substantial laboratory evidence and clinical experiential observation to support their use.

Randomized clinical studies are the gold standard of evidence-based care, but these are often difficult to design and execute meaningfully, particularly given the dynamics of the resuscitation environment in the out-of-hospital setting. Many accepted medical procedures and treatments have not been put to the test of randomized clinical trials, such as closed-chest massage, pre-hospital defibrillation, and artificial rescue breathing.¹³ The multidimensional aspects of cardiac arrest interventions, applied in situations that are sometimes chaotic, often lead to problems with adherence to intended protocols which in turn affect both the accuracy and applicability of results. This dynamic has been described as “fundamental tensions between the principles of randomized trial design and the practice of resuscitation that make the conduct of any clinical trial of out-of-hospital cardiac arrest challenging.”¹³ This is not to say that high-quality research attempts should not continue but rather that treatments that appear beneficial to a consensus of resuscitation leaders should not be withheld until benefit is fully demonstrated in primary and confirmatory randomized controlled trials.

Increasingly, the treatment of cardiac arrest is leaning towards a bundled approach, where studying each intervention in isolation is not simple, and may not be necessary when it is clear that the whole leads to a positive treatment effect. A “bundle” is a group of interventions applied from the outset of a 911 call through post-arrest care in hospital, in a standardized, coordinated way, inclusive of resuscitation technology. As examples of technology, automated external defibrillators (AED) have for some time been used for early defibrillation when a shockable rhythm is present. Methods employed to increase circulation and lower intracranial pressure improve mean arterial pressure and cerebral perfusion.^{14,15} While presently published studies do not confirm statistically significant benefit to outcomes using at least one commercially available device, many emergency clinicians still utilize an impedance threshold device for its touted physiological effects on coronary and cerebral perfusion. Mechanical

chest compression devices are also being usefully deployed, particularly in settings with limited numbers of available professional rescuers on scene, so that compressions can be continued uninterrupted at optimal rate and depth. The combination of these and other technologies should be considered important tools in the hands of well-trained rescue teams implementing bundled, high-quality CPR.

Regional resuscitation centers of excellence should be established that optimize both out-of-hospital and in-hospital treatment.

As already noted, survival rates from out-of-hospital cardiac arrest vary widely not only in the pre-hospital setting but also after patients are transported to the hospital for post-arrest treatment. Most regions do not have a well-coordinated approach to post-arrest care¹⁸ despite the many efforts of professional organizations to develop and disseminate treatment guidelines.

There are long-standing precedents for implementation of regional centers of care. Trauma, stroke, burn, and acute myocardial infarction treated in regional centers have experienced significant improvement in outcomes.¹⁹ Emerging interventions for cardiac arrest including early goal-directed therapy, glucose control, seizure control, hemodynamic support, therapeutic hypothermia, cardiac catheterization, and automatic implantable cardioverter defibrillator screening, can be carried out best in a regional specialty center. If high-quality CPR becomes a national standard, hospitals can expect to receive more patients who require treatments that can lead to improved neurological outcomes. There are issues to be resolved that include the need for a strong research infrastructure to validate new therapies, and the commitment of financial resources required to care for critically ill patients.²⁰ A thorough discussion of the concept and implementation of regional systems for cardiac arrest resuscitation has been published by the American Heart Association.¹⁸ We recommend that community stakeholders convene to discuss their pros and cons in light of the recognized benefits in other serious medical conditions that have taken this approach.

“Neurologically intact survival” should be the criterion by which treatment success is ultimately judged. Post-arrest psychological distress should be regarded as an element of neurological status.

Research into the neurological status of patients after cardiac arrest has been lacking. There is a general perception among neurologists called to assess patients that those who are unresponsive following return of spontaneous circulation have poor prognoses, although they have tools to mitigate poor prognoses. Neurologists can give guidance on whether continuous electroencephalographic monitoring in the intensive care unit should be the standard of care, whether an escalation of anti-seizure medications for refractory seizures should be given, on the duration of induced hypothermia and

other neuro-protective techniques, and on how to prevent reperfusion injury. Detailed neurological investigation of patients is needed before a decision is made to end post-arrest, intensive care treatment. Without such specialty consultation, termination of treatment may well occur prematurely.

EMS personnel are very aware that perfusing the brain is as important as perfusing the heart and is an essential part of high-quality CPR. It has been well accepted that achieving return of spontaneous circulation counts as a successful outcome, and now there is a rapidly emerging consensus that returning the patient to pre-arrest neurological functional status is far more important than simple return of circulation to define treatment success. Studies have verified that this is an achievable goal. Early defibrillation, active compression and decompression and the use of an impedance threshold device have been shown to be important to neurological outcome. Therapeutic hypothermia has been much discussed as another advance favoring neurological outcome, but recent studies have concluded that pre-hospital initiation may not impact survival or neurologic status.²¹ Cooling in the hospital setting does make a difference, although the exact depth of targeted temperature is still a matter of debate.²²

Another aspect of neurological injury includes post-arrest psychological distress in the form of anxiety, depression, and post-traumatic stress syndrome. Incidence rates of depression have ranged from 14% to 45%; anxiety rates have ranged from 13% to 61%; posttraumatic stress disorder rates reportedly range from 19% to 27%.²³ These high percentages call for better psychological screening, earlier intervention, and more frequent post-arrest evaluation for much longer periods, from six months to perhaps two years.

Public policy changes that would increase bystander CPR - a well-recognized factor in patient survival - should be addressed.

Successful CPR depends upon citizens and rescuers working together in a web of community-based strategies designed to smooth out the vast differences in survival rates now seen from region to region. It is well known that bystander CPR is a major factor in survival from out-of-hospital cardiac arrest, and yet fewer than half of sufferers receive it. Public education is a major factor. One of the ways this could be remedied is to institute a national training program in schools. As of this date, 36 states require CPR training for high school graduation, but training could begin earlier. There is evidence that students as early as the eighth grade can become and remain proficient at CPR and the use of an AED.²⁴ We recommend that all states require CPR training in schools beginning at the middle school level and continuing through high school. Most people are aware that giving blood is a lifesaving gift. The public is not as aware that bystander CPR is also a lifesaving gift. Community outreach programs and public

service announcements could make learning CPR as valued as giving blood.

Establishing a tradition of multi-specialty communication and care co-ordination throughout the treatment pathway is a vital initiative for improved outcomes.

Sudden cardiac arrest is a complex disease process requiring co-ordination of care among many specialties - emergency care, neurology, respiratory therapy, cardiology, critical care, psychiatry, anesthesiology, rehabilitation medicine, among others - and many disciplines - EMS providers, medicine, nursing, respiratory care, etc. Routine collaboration across the continuum of care is not customary. A model can be taken from Tumor Boards consisting of the many specialties that guide the therapeutic pathway of patients with cancer. Committed leaders in resuscitation science could help organize such teams and publicize successful models.

Some specialties have developed sub-branches that have accomplished these goals, for example, stroke neurologists, medical and interventional cardiologists, and medical and radiation oncologists. We recommend that corresponding subspecialties of resuscitation be developed, such as resuscitation cardiology and neuro-resuscitation, a concept that would likely fit best in regional resuscitation centers of excellence. Barring the ability to implement these centers in the near term, we recommend that the disciplines named above participate in each other's meetings and publish papers in each other's journals. Such steady collaboration could transform the field of resuscitation, leading to formal interdisciplinary scientific investigations, clinical protocol development, outcomes analysis, and clinical education.

Collaboration would also highlight the fact that patients should be the focus of clinical care, whether they are located in the pre-hospital setting, the emergency department, the critical care unit, inpatient unit, the rehabilitation unit, or back in their homes and communities after discharge. A coordinated approach to the care of the patient will ultimately result in an improved rate of neurologically intact survival, the goal of resuscitation.

SUMMARY

We are well aware that, on average, survival statistics from cardiac arrest have been less than optimal despite many years of the efforts of individuals, communities, and professional societies focused on improving them. Reasons are partly the lack of financial resources and infrastructure available to local, state, and national entities, and partly due to the lack of effective and persistent commitment and leadership within communities.

We believe that measures can and should be taken on a local, regional, and national scale that can make a difference in outcomes. The lack of financial resources cannot be underestimated, but even in their absence, there are helpful decisions that can be made within the respective specialties

that treat sudden cardiac arrest.

The unwillingness to adopt new ideas and therapies until they are proven beyond any doubt via randomized clinical trials also holds back progress. Overwhelming evidence is often years in coming, and while we wait, patients die. The context in which we work as resuscitation scientists is dynamic, complex, and even sometimes chaotic, yet we have made great strides in discovering new processes and technologies that have resulted in better outcomes. We are learning that a bundled, system-wide approach to resuscitation in the field, and multi-specialty and multi-disciplinary collaboration for post-arrest treatment in the hospital and beyond, can lead to better results. We are beginning to understand that systematic continuous quality improvement may be more useful as a treatment model, with less dependence on specific study results and more on strategies that make a verifiable difference in positive neurological outcome. We urge action on the ideas we have offered, and invite all who review them to join us in our pledge to move neurologically intact survival from sudden cardiac arrest forward.

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