Life After Death: Improving Outcomes Following In-Hospital Cardiac Arrest

Paul S. Chan, MD, MSc.[†] and **Brahmajee K. Nallamothu, MD, MPH**[@]
[†]Saint Luke's Mid America Heart Institute, Kansas City, MO

[@]The VA Ann Arbor Health Services Research & Development Center of Excellence and the University of Michigan Division of Cardiovascular Medicine, Ann Arbor, MI

Approximately 160,000 U.S. patients die annually from an in-hospital cardiac arrest, yet we continue to have a poor understanding of how to improve patient survival after these events. In part, this is because cardiac arrest is an unexpected event that is difficult to predict with great certainty. Moreover, it involves heterogeneous groups of patients necessitating the engagement of numerous physician specialties, hospital floors, and allied health care personnel to improve resuscitation outcomes.

Fortunately, several important epidemiological studies have provided us with new insights and opportunities for improving patient survival after cardiac arrest. Risk-adjusted survival after in-hospital cardiac arrest has significantly improved over the past decade, from 13.7% in 2000 to 22.4% in 2009.[1] Yet reasons for the improvement remain fairly opaque, although factors such as delays in defibrillation,[2] off-hours or unwitnessed arrests,[3] and black race[4] have been associated with lower survival. Furthermore, substantial variation in survival outcomes exists across hospitals,[5] which suggests that some facilities may be instituting better strategies for resuscitation care. These strategies are likely to be driven by better implementation of processes of care rather than by enhanced technologies (e.g., remote intensive care unit monitoring, automated external defibrillators, controlled hypothermia), which have shown inconsistent improvements in survival.[6–7]

While the potential exists for great advancements in resuscitation over the next decade, the field will need to directly address 3 important knowledge gaps over the coming years that all relate to measurement of outcomes.

Gap 1: Is Cardiac Arrest Survival the Best Outcome Measurement?

Discharge survival ("case-survival") rates have been the focus of most studies of in-hospital cardiac arrest. Such rates are easy to measure, meaningful, and more important than intermediate outcomes such as return of spontaneous circulation or 24-hour survival. But, 2 fundamental questions regarding the outcome of survival to discharge remain.

First, is it possible that hospitals with high case-survival rates are being mislabeled as 'high performers' because they do a poor job of preventing cardiac arrests from occurring in the first place? If these hospitals, for example, allow cardiac arrest to occur even in low-risk patients, who are more likely to survive a cardiac arrest, their *appearance* as high-performers

Send correspondence and reprint requests to: Paul Chan, MD, MSc, Mid America Heart Institute, 5th Floor, 4401 Wornall Road, Kansas City, MO 64111, Phone: (816) 699-3409, Fax: (816) 932-5613, Attn: Paul Chan, pchan@saint-lukes.org.

for resuscitation care would be misleading. Given that efforts to reduce cardiac arrest incidence with rapid response teams and remote intensive care unit monitoring have failed to demonstrate consistent reductions in hospital mortality,[6, 8] this concern becomes even more critical to address.

Second, are differences in case-survival rates affected by hospital variations in use of advanced directives, which are known to exist across different geographic regions? If so, this might suggest that hospitals with high rates of cardiac arrest survival are doing a better job of involving patients and families in shared decision making which, although laudable, does not necessarily mean that these hospitals are providing better resuscitation care. We believe that it would be important to clarify these 2 issues before expending significant resources to identify which hospital practices are associated with high case-survival rates.

Gap 2: Measuring Care During the Arrest: What is Good Care?

Perhaps the most obvious gap in knowledge involves an improved understanding of processes driving hospital variation in survival rates after cardiac arrest. There is currently no prescription of best practices or interventions to achieve optimal outcomes for patients with an in-hospital cardiac arrest. Contemporary registries are limited in their ability to collect information on key factors which are likely to distinguish high-performing hospitals from other hospitals (e.g., timeliness and quality of cardiopulmonary resuscitation [CPR], real-time audio feedback, quality of teamwork, frequency and intensity of resuscitation training, conduct of mock codes, debriefing after clinical resuscitations, administrative leadership, and care coordination). Not surprisingly, 'structural' hospital characteristics (size, teaching and academic status, and geographical location of hospitals) do not necessarily identify hospitals that have exceptional cardiac arrest survival outcomes.[5]

Consequently, to identify best practices, we will need different approaches and novel methodologies. Similar to the efforts for identifying physician and hospital factors associated with reduced door-to-balloon times for ST-elevation myocardial infarction more than a decade ago, a combination of rigorous qualitative and quantitative (i.e., 'mixed') methods may identify practices and interventions at high-performer hospitals that could be widely disseminated. Disagreement exists as to whether identification of high-performing hospitals should be based on raw or risk-adjusted rates, yet the use of qualitative study techniques using intensive site visits and detailed interviews could be useful in either case. From detailed interviews, characteristics distinguishing high-performer hospitals could be readily understood, classified and categorized.

It is likely that these characteristics will be multifaceted and multi-dimensional, and include quality improvement initiatives that require administrative support, clinical leadership, organizational goals, and effective use of clinical data for feedback. Once identified, these practices and interventions should be consolidated and disseminated to other hospitals for further study. Additionally, we could distinguish whether hospitals with high cardiac arrest survival rates are high-performers because they are providing uniquely better resuscitation care or simply because they excel in care for multiple medical conditions (i.e., high case-survival rates for cardiac arrest are markers of overall hospital quality).

Gap 3: Measuring Care After the Arrest: What is 'Success'?

Finally, to understand whether we have truly achieved success in hospital resuscitation, we need to look beyond survival to discharge – the primary outcome in most studies of in hospital cardiac arrest. There is currently a paucity of data on long-term outcomes of patients who survive a cardiac arrest and are discharged home. As a result, a number of critical questions remain unanswered among survivors and deserve attention. These include

the long-term survival of patients with an in-hospital cardiac arrest who are discharged alive from the hospital, their patterns of readmission, their long-term costs of care, their trajectory of health status and neurological disability over time, and whether important differences in survival and readmission rates exist across patients. These are high priority areas for the field, in order to place in proper context the significance of an outcome such as survival to discharge and to facilitate the identification of effective strategies which improve rates of both in-hospital and post-discharge survival.

Lastly, a key component of optimizing long-term outcomes is to develop validated bedside tools to assist physicians in the counseling of patients and their families about neurological and survival prognosis to ensure that decisions about subsequent therapy are aligned with patients' preferences. Ultimately, success in hospital resuscitation will be measured not only by improvements in short-term survival metrics, but also by gains in long-term survival and increased participation of patients in shared decision making.

Conclusion

Significant gains in overall survival after an in-hospital cardiac arrest have been achieved over the past decade. Yet, 3 important gaps in knowledge require attention to move the field forward. We need to examine whether case-survival rate is the best outcome for measurement. If so, we need to identify best practices which distinguish hospitals with exceptional survival rates so that these can be consolidated and disseminated to all hospitals. Finally, we need to look beyond in-hospital survival and further our understanding about the long-term outcomes after an in-hospital cardiac arrest. In successfully accomplishing these objectives, we will indeed have a better understanding of what 'life' is after a cardiac arrest death.

Acknowledgments

References

1. Girotra S, Nallamothu BK, Spertus JA, Li Y, Krumholz HM, Chan PS. Trends in survival after in-hospital cardiac arrest. N Engl J Med. 2012 (Revised manuscript submitted and decision pending).

2. Chan PS, Krumholz HM, Nichol G, Nallamothu BK. Delayed time to defibrillation after in-hospital cardiac arrest. N Engl J Med. 2008; 358(1):9–17. [PubMed: 18172170]

3. Peberdy MA, Ornato JP, Larkin GL, et al. Survival from in-hospital cardiac arrest during nights and weekends. JAMA. 2008; 299(7):785–792. [PubMed: 18285590]

4. Chan PS, Nichol G, Krumholz HM, et al. Racial differences in survival after in-hospital cardiac arrest. JAMA. 2009; 302(11):1195–1201. [PubMed: 19755698]

5. Chan PS, Nichol G, Krumholz H, Spertus J, Nallamothu BK. Hospital Variation in Time to Defibrillation After In-Hospital Cardiac Arrest. Archives of Internal Medicine. 2009; 169(14): 1265–1273. [PubMed: 19636027]

6. Young LB, Chan PS, Lu X, Nallamothu BK, Sasson C, Cram PM. Impact of telemedicine intensive care unit coverage on patient outcomes: a systematic review and meta-analysis. Arch Intern Med. 2011; 171(6):498–506. [PubMed: 21444842]

7. Chan PS, Krumholz HM, Spertus JA, et al. Automated external defibrillators and survival after in-hospital cardiac arrest. JAMA. 2010; 304(19):2129–2136. [PubMed: 21078809]

8. Chan PS, Jain R, Nallamothu BK, Berg RA, Sasson C. Rapid Response Teams: A Systematic Review and Meta-Analysis. Archives of Internal Medicine. 2010; 170(1):18–26. [PubMed: 20065195]