

## Survival From Out-of-Hospital Cardiac Arrest: Are We Beginning to See Progress?

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In its June 2015 publication, *Strategies to Improve Cardiac Arrest Survival: A Time to Act*, The Institute of Medicine (IOM) delineated the public health impact and scope of the problem of cardiac arrest in the United States. The IOM emphasized that although the survival rate varies widely across the country, it is generally low.<sup>1</sup> The IOM noted survival of <6% when cardiac arrest occurs outside the hospital and only 24% when cardiac arrest occurs inside the hospital. The IOM made specific recommendations to improve cardiac arrest survival, especially in the areas of data collection, education, and engagement of the public. The report emphasized the need to centralize the collection and distribution of data, monitor and improve the delivery of care, increase the impact of research and therapies, and strengthen stakeholder communication. The article by Van Diepen et al in this issue of *JAHA—Journal of the American Heart Association* reports on the first steps needed to fulfill many of the recommendations of the IOM report.<sup>2</sup>

Van Diepen and colleagues<sup>2</sup> report data from the initial 5 years of the HeartRescue Project, a multistate public health initiative focused on establishing state-wide out-of-hospital cardiac arrest (OHCA) systems of care to improve case capture rate and ultimately use the derived data to improve OHCA care at the community, the emergency medical services (EMS), and hospital levels. The initial data from the HeartRescue Project, reported by the authors, represent the first step in achieving the IOM recommendations. The HeartRescue Project has created a large US population-based registry that now captures almost 90% of all-rhythm OHCA in the participating states. The authors documented a modest temporal increase in prehospital bystander cardiopulmonary

resuscitation (CPR) and bystander automated external defibrillator (AED) application, with survival that has exceeded that reported in the IOM article.<sup>1</sup> Specifically, this public health initiative increased the capture rate of OHCA over a 5-year period from 39% to 89.2%. Bystander CPR was provided for 42.8% of people with OHCA, bystander AED application occurred in 4.6% of arrests, and AED application by bystanders, police, or first responders before EMS arrival occurred in 21.9% of OHCA.

Survival differences across the 5 states were observed in all-rhythm patients, ranging from 8.0% to 16.1%; in the Utstein subgroup (defined as bystander-witnessed OHCA with an initial shockable rhythm), survival differences ranged from 26.4% to 44.3%. Survival did increase across EMS agencies that treated >20 OHCA per year. In this latter group, survival among all-rhythm patients increased from 2.7% to 26.5%; in the Utstein group, survival increased from 10.0% to 57.0%.<sup>1</sup> Interestingly, survival did not increase over time in the entire cohort. These disparities across states and agencies indicate the need to examine the processes of care among the EMS agencies with both high and low OHCA survival to understand the heterogeneity and identify the characteristics that account for these differences. Targeting the disparities to enact the processes used by high-performing systems should enable improvement in OHCA survival.

Several important take-away messages can come out of this report of Van Diepen and colleagues.<sup>2</sup> First, the HeartRescue Project demonstrated successful creation of a true population-based registry with multiple diverse stakeholders. These essential data can be collected by most communities as an important first step recommended by the IOM report, to allow benchmarking and improvement of care and survival of those with OHCA.

As noted, the authors reported bystander CPR in excess of 40% among all-rhythm cardiac arrests and approaching 60% in the Utstein subgroup, results that surpass other North American and Asian reports. There are ample data in the literature to suggest that bystander CPR and public AED application can increase survival. Nakahara et al reviewed the OHCA data in Japan from 2005 to 2007, analyzing data from >167 000 bystander-witnessed OHCA of cardiac origin.<sup>3</sup>

The opinions expressed in this article are not necessarily those of the editors or of the American Heart Association.

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*J Am Heart Assoc.* 2017;6:e007469. DOI: 10.1161/JAHA.117.007469.

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They evaluated the incidence of bystander prehospital intervention and specifically reviewed neurologically intact survival at 1 month and at discharge. They found that neurologically intact survival at 1 month and discharge increased from 3.3% to 8.2% and attributed this to an increase in bystander CPR from 38.6% to 50.9% during the years of data collection. Using data from the voluntary Cardiac Arrest Registry to Enhance Survival, Hansen et al examined the temporal changes in bystander and first responder CPR and AED use and OHCA survival after state-wide initiatives to improve resuscitation efforts in North Carolina between 2010 and 2013.<sup>4</sup> Specific initiatives included the training of members of the general population in CPR and in the use of AEDs; training first responders in team-based CPR, including AED use and high-quality CPR; and training dispatch centers to rapidly recognize cardiac arrest and guide bystanders to perform CPR. This study specifically examined the association between bystander and first responder CPR efforts and survival and neurologic outcome in >4900 patients. Bystander CPR and first responder defibrillation in combination increased from 14.1% to 23.1%. Survival with favorable neurologic outcome increased from 7.1% to 9.7% and was favorably associated with bystander-initiated CPR. The odds ratio of survival with favorable neurologic outcome also increased in association with shortened time to defibrillation, confirming the importance of prompt AED use. When compared with survival associated with defibrillation >10 minutes after OHCA, survival was increased >7-fold if defibrillation occurred in <2 minutes, and more than tripled if defibrillation occurred within 5 to 10 minutes of OHCA. In 2015, Hasselqvist-Ax et al reported an analysis of the Swedish lay-public CPR training strategy.<sup>5</sup> Three million people in Sweden were trained to provide CPR. In an analysis of >30 000 episodes of OHCA between 1990 and 2011, CPR was performed before EMS arrival in 51.1% of the cases (and not performed before arrival in 48.9% of people experiencing OHCA). The 30-day survival was only 4.0% when CPR was not performed before EMS arrival, but was 10.5% (more than double the survival) when CPR was performed before EMS arrival. In 2013, Drezner et al reviewed the survival to hospital discharge from sudden cardiac arrest from 2009 to 2011 from a national registry of AED use in sports, involving >2000 high schools with CPR-AED programs.<sup>6</sup> The overall survival was 71%; survival in student athletes and in adults who were exercising at the time of arrest was 89%. This exceptional survival was associated with a 96% incidence of lay rescuer CPR. These studies demonstrate the improvements in OHCA survival that are possible in association with bystander recognition of cardiac arrest and bystander performance of CPR and use of an AED.

How can we increase bystander/community recognition of OHCA and bystander CPR and AED use? One important approach is the implementation of strategies to increase

public awareness about the issues associated with sudden cardiac arrest. It is not clear that the public understands the scope of this problem, with >347 322 adults experiencing EMS-treated OHCA each year.<sup>7</sup> Data regarding the incidence of OHCA in children and adolescents are more limited, but the incidence is estimated to be several thousand per year.<sup>7</sup> Information gleaned from EMS dispatchers indicate that the public does not understand the difference between a “heart attack” and sudden cardiac arrest. In addition, the public does not expect that sudden cardiac arrest can occur in a child or adolescent. Public service announcements could provide one mechanism to increase public awareness. Public service announcements developed and aired in cooperation with the National Football League, National Basketball Association, and/or National Hockey League specific sporting events could reach millions. There are many potential uses of public service announcements, such as airing in movie theaters and at the beginning of streaming videos or even video games.

In addition to public awareness, avenues to increase CPR-AED education of the public are critical to increase bystander CPR and AED use and improve survival. Partnership with the American Heart Association, the American Red Cross, and other professional and advocacy organizations can increase training. Mass CPR training endeavors are important, and innovative strategies, such as the American Heart Association CPR training kiosks placed in airports, can increase the reach of CPR training efforts.

An additional critically important endeavor is CPR-AED education for students before high school graduation. This concept makes sense. If students learn CPR-AED use before graduation, they will increase the number of bystanders that can recognize a cardiac arrest and have the skills, the ability, and the willingness to intervene.

In 2014, the American Heart Association reported that 27 states had passed laws or adopted curriculum changes to require hands-on CPR training before high school graduation.<sup>8</sup> This endeavor resulted in >1.6 million students being trained in CPR in the 2013 to 2014 academic year. Currently, 37 states mandate teaching CPR and AED use to students, further increasing the potential number of students who learn CPR-AED each year. We must continue to advocate until all 50 states have mandates for CPR-AED education for all high school students, and create the resources that teachers need. This is just a start. Advocacy for mass CPR education will further increase the pool of bystanders able to provide CPR and use AEDs.

Drezner et al<sup>6</sup> demonstrated that, in the specific and specialized location of the schools, we can create environments where the incidence of bystander CPR and AED use is high and OHCA survival is also high. Project ADAM, a project directed at students and schools, was created in 1999 after the sudden cardiac deaths of several students in southeastern

Wisconsin. The goals of Project ADAM are the promotion of awareness of sudden cardiac arrest and sudden cardiac death, the advocacy for CPR-AED education for students, and the implementation of CPR-AED programs in all schools. Project ADAM affiliates now exist in 11 states, typically coordinated by hospitals and in pediatric heart centers. Project ADAM programs across the United States have documented >100 lives saved in schools with Project ADAM-related CPR-AED programs.<sup>9</sup> Interestingly, 60% of the successful resuscitations have occurred in adults, and 40% have occurred in children and adolescents. This is certainly another example of how education, preparedness, and advocacy can save lives.

Our task is relatively simple, although its implementation is challenging. We must try to reproduce the successes documented in the school environment in every community in the United States. That includes the goal of targeting CPR-AED education for every high school student by the time of graduation and providing this education for as many members of the community as possible. Education and training must include recognition of cardiac arrest, and the skills needed to provide high-quality CPR and use an AED, with focus on factors to overcome hesitation to act.

The article by Van Diepen and colleagues<sup>2</sup> documents a successful first step in documenting OHCA case-capture rate. The HeartRescue Project is now challenged to identify the characteristics of the high-performing states and EMS systems that should be universally adopted to improve survival from OHCA. It is in this way that programs such as the HeartRescue Project can and will improve survival. The time is now, and the resources are potentially available. It is exciting to know that the data suggest that we truly can have a positive impact. We must not lose this opportunity.

## Disclosures

None.

## References

1. Institute of Medicine. *Strategies to Improve Cardiac Arrest Survival: A Time to Act*. Washington, DC: The National Academies Press; 2015.
2. Van Diepen S, Girotra S, Abella B, Becker LB, Bobrow BJ, Chan PS, Fahrenbruch C, Granger CB, Jollis JG, McNally B, White L, Yannopoulos D, Rea TD. Multi-statewide 5-year initiative to improve care for out-of-hospital cardiac arrest: primary results from the HeartRescue Project. *J Am Heart Assoc*. 2017;6:e005716. DOI: 10.1161/JAHA.117.005716.
3. Nakahara S, Tomio J, Ichikawa M, Nakamura S, Nishida M, Takahashi H, Morimura N, Sakamoto T. Association of bystander interventions with neurologically intact survival among patients with bystander-witnessed out-of-hospital cardiac arrest in Japan. *JAMA*. 2015;314:247–254.
4. Hansen CM, Kragholm K, Granger CB, Pearson DA, Tyson C, Monk L, Corbett C, Nelson RD, Dupre ME, Fosbøl EL, Strauss B, Fordyce CB, McNally B, Jollis JG. The role of bystanders, first responders, and emergency medical service providers in timely defibrillation and related outcomes after out-of-hospital cardiac arrest: results from a statewide registry. *Resuscitation*. 2015;96:303–309.
5. Hasselqvist-Ax I, Herlitz J, Svensson L. Early CPR in out-of-hospital cardiac arrest. *N Engl J Med*. 2015;373:1573–1574.
6. Drezner JA, Toresdahl BG, Rao AL, Huszti E, Harmon KG. Outcomes from sudden cardiac arrest in US high schools: a 2-year prospective study from the National Registry for AED Use in Sports. *Br J Sports Med*. 2013;47:1179–1183.
7. Benjamin EJ, Blaha MJ, Chiuve SE, Cushman M, Das SR, Deo R, de Ferranti SD, Floyd J, Fornage M, Gillespie C, Isasi CR, Jimenez MC, Jordan LC, Judd SE, Lackland D, Lichtman JH, Lisabeth L, Liu S, Longenecker CT, Mackey RH, Matsushita K, Mozaffarian D, Mussolino ME, Nasir K, Neumar RW, Palaniappan L, Pandey DK, Thiagarajan RR, Reeves MJ, Ritchey M, Rodriguez CJ, Roth GA, Rosamond WD, Sasson C, Towfighi A, Tsao CW, Turner MB, Virani SS, Voeks JH, Willey JZ, Wilkins JT, Wu JH, Alger HM, Wong SS, Muntner P; American Heart Association Statistics Committee and Stroke Statistics Subcommittee. Heart Disease and Stroke Statistics—2017 update: a report from the American Heart Association. *Circulation*. 2017;135:e146–e603.
8. American Heart Association News. CPR in school laws take effect in eight new states this year. <https://news.heart.org/cpr-school-laws-take-effect-eight-new-states-year>. Accessed September 8, 2017.
9. <http://www.projectadam.com/SuccessStories>. Accessed September 8, 2017.

**Key Words:** Editorials • arrhythmia • resuscitation • sudden cardiac arrest • sudden cardiac death • sudden death



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*J Am Heart Assoc.* 2017;6:e007469; originally published September 22, 2017;

doi: 10.1161/JAHA.117.007469

The *Journal of the American Heart Association* is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231  
Online ISSN: 2047-9980

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<http://jaha.ahajournals.org/content/6/9/e007469>