Treatment for Out-of-Hospital Cardiac Arrest
Is the Glass Half Empty or Half Full?

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During the past 40 years, knowledge has accumulated that survival increases significantly if the OHCA is quickly recognized and responded to with prompt activation of 911, bystander-initiated cardiopulmonary resuscitation (CPR), lay application of an automated external defibrillator (AED) before arrival of emergency medical services (EMS) providers on scene, advanced life support, and postresuscitation care. Recent analyses of a multicenter observational study have demonstrated that multiple components of CPR process are associated with survival in patients with OHCA. However, there are significant and important variations in the process and outcome for care for patients with OHCA. These differences appear to be much larger than variations associated with care of other acute cardiovascular conditions such as ST-elevation myocardial infarction. Despite advances in resuscitation knowledge, many communities have not achieved significant improvements in outcomes after OHCA over time. This lack of improvement in survival has led some skeptics to conclude that the glass is half empty and that patients with OHCA have a dismal prognosis.

Recent, tantalizing suggestions that outcomes after OHCA can improve over time have emerged from multicenter observational studies, including Arizona and Denmark. The relative contribution of interventions to increased survival in these communities is difficult to tease out because multiple changes in resuscitation care were implemented contemporaneously. Three important papers published in this issue of Circulation provide compelling evidence that the nation and the world is improving outcomes after OHCA over time. Each of these large cohort studies demonstrates that OHCA is indeed a treatable condition and that a community can improve outcomes after OHCA.

The first analysis described temporal changes in risk-adjusted survival after OHCA. Included were patients with OHCA of noncardiac cause who were enrolled in the Cardiac Arrest Registry to Enhance Survival (CARES) quality improvement registry from 2005 to 2012. After adjustment for age, sex, race/ethnicity, first recorded rhythm, location of arrest, and whether the arrest was witnessed, survival improved among EMS agencies that voluntarily participated throughout the study period (rate ratio, 1.70 [1.38–2.10]; P for trend < 0.001). Smaller improvements over time were seen in neurological disability after resuscitation from OHCA. Greater improvements in survival were seen in the Northeast, and little or no improvement was seen in the Midwest. During the observation period, use of lay provision of CPR or use of an AED increased, but adjustment for these factors did not account for improved survival.

The improvement in survival and neurological disability after OHCA among communities participating in CARES is laudable. But should we really conclude that bystander CPR and AED use did not appear to be the principal contributors to improved survival, as the authors did? The analysis did not adjust for other important factors associated with survival, such as EMS response time interval or CPR process, because such data have a high rate of missingness or are not available to characterize the effect of other treatments for OHCA in this registry. Importantly, greater changes in survival were observed when all EMS agencies were considered, as opposed to only those agencies that have participated in CARES since its inception. One potential interpretation of these differences in the magnitude of change is that EMS agencies that joined or dropped out of CARES at different timepoints had differential survival. This impacts on the generalizability of the results of the study to other communities.

In Ontario, Canada, multiple sources of administrative data were linked to describe secular changes in the incidence and outcome of resuscitation care. Included were patients transported to hospital alive, after out-of-hospital cardiac arrest. Throughout the study period from 2002 to 2011, short (ie, 30-day) and long (ie, 1-year) survival increased. The robustness of these findings was confirmed by validating them with data collated by EMS agencies participating in the Toronto site of the Resuscitation Outcomes Consortium from 2006 to 2010.

The inclusion criterion of transported alive was not defined in the Ontario report, but it presumably refers to patients who had spontaneous circulation on emergency department arrival. Importantly, several EMS agencies that contributed patients to this study of outcomes from hospital arrival to discharge were simultaneously participating in study of a strategy to promote termination of resuscitation in the field. Could increased cessation of efforts in the field during the study period have introduced some selection bias into assessment of the prognosis of patients transported to hospital over time? The incidence rate and survival to discharge for patients with cardiac arrest are somewhat different from those previously reported by the region. If the study population had more closely resembled patients treated by EMS for cardiac arrest, as recommended by guidelines for standardized reporting, the incidence rate would have been much higher and the survival rate significantly lower. As well, inclusion of

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all patients rather than just those transported to hospital would have allowed the reader to assess the impact efforts to terminate resuscitation in the field in patients with a poor prognosis.

The Amsterdam Resuscitation Study (ARREST) is an ongoing registry of all patients with OHCA in the North Holland province of Netherlands. Throughout the study period from 2006 to 2012, the proportion of patients who received bystander CPR, early defibrillation by laypersons (onsite) or firefighters or police (dispatched to scene), and application of therapeutic hypothermia on hospital arrival increased. This was associated with a significant and important improvement in the proportion of patients who had neurologically favorable status at discharge (defined a priori as Cerebral Performance Category ≤2) among all patients as well as those who had a first recorded rhythm. When the analysis adjusted for increased use of AEDs, secular changes in survival were no longer significant, which the authors interpret as suggesting that increased AED use contributed to increased survival.

The Dutch study included patients with cardiac arrest of cardiac cause rather than all patients treated by EMS. As a consequence, the reported proportion of arrests in public locations that received bystander CPR or that had a first recorded rhythm that was shockable is higher than usually observed in population-based studies of OHCA. Each of these factors has a favorable prognosis. As well, the study grouped AED use by laypersons and safety personnel dispatched to the scene together, whereas contemporary American data suggest that <5% of individuals with OHCA have an AED applied by a layperson. Nonetheless, the same definitions were used throughout the Dutch study period, so the reported improvement in survival is credible.

Comparing the process and outcome of care for OHCA between centers is challenging despite efforts to standardize reporting. Common methods of enhancing data quality and completeness are necessary in addition to use of a common population and data definitions. Assessment of the relative contribution of changes in the process of care to improvements in outcome would require assessment of how much the overall variability in outcome is explained by each factor. Importantly, it appears that variation in outcome from one community to another is explained incompletely by those factors traditionally regarded as important.

Recognition and successful treatment of ventricular fibrillation is highly time dependent. As a consequence of this time-dependent treatment, multiple manufacturers have developed and marketed AEDs that are intended to simplify rhythm analysis and subsequent defibrillation. These enable minimally trained laypersons to recognize and treat cardiac arrest before the arrival of EMS providers. In recognition of the demonstrated beneficial impact of AEDs on public health, many have been installed in public locations anticipated to be close to the scene of cardiac arrest to decrease the time to recognition and treatment of OHCA. Collation of cumulative data from medical device manufacturers in the United States shows dissemination of more than 2400000 AEDs intended for use by laypersons in public locations (Figure; unpublished data, AED Industry Working Group, September 25, 2014). AEDs are still the only intervention shown to be an effective and cost-effective intervention to improve survival after OHCA in a large randomized trial. The remarkable growth in placement of AEDs in public locations so that minimally trained laypersons can recognize and treat cardiac arrest before the arrival of EMS providers has undoubtedly contributed to improved survival after OHCA. It is premature to abandon efforts to improve bystander CPR and AED use. The glass is half full.

Importantly, we need additional information to be able to fill the glass to its rim. How can we improve the ability to monitor the process and outcome of care for patients with OHCA in the United States and the rest of the world? Although Japan has established an ongoing national registry of patients with OHCA to attempt such, multiple analyses of observational data from Japan have yielded conflicting information about the effectiveness of interventions for OHCA. This suggests that a national registry alone may be insufficient to inform understanding of resuscitation care.

We urgently need a simple, sustainable, and comparable approach to collecting key factors associated with risk after the onset of arrest or effective treatment of it so that we can understand and reduce variation in care and improve outcomes associated with OHCA throughout the world. The large variation in resuscitation care would be considered unacceptable for infection rates associated with handwashing or other patient safety measures. It is time for the cardiovascular community to embrace the spirit of the patient safety movement and apply it to the treatment of OHCA. This should take priority over other patient safety initiatives because OHCA remains a leading cause of death. Measurement of common data, along with common measures of ensuring data quality, would promulgate adoption of the American Heart Association systems of care approach to improving acute cardiovascular care. (http://www.heart.org/HEARTORG/HealthcareResearch/MissionLifelineHomePage/Mission-Lifeline-Home-Page_UCM_305495_SubHomePage.jsp accessed on September 25, 2014).

National public reporting and pay-for-performance efforts, such as those implemented by the Centers for Medicare & Medicaid Services (CMS), have contributed to improvements in care for patients with myocardial infarction or heart failure. Differences in outcome after hospital-based care for ST-elevation myocardial infarction were incompletely explained by differences in processes of care but were explained by differences in institutional culture.
Notwithstanding the contributions of increased AED use to survival, it seems plausible that some of the increase in survival reported in these communities is attributable to improvements in resuscitation culture. As Rosie the Riveter said in a slightly different context, “Yes, We Can!”

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