Toward Efficient Improvements in Resuscitation for Cardiac Arrest

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Cardiac arrest is the “cessation of cardiac mechanical activity, as confirmed by the absence of signs of circulation.”1 If deaths due to out-of-hospital cardiac arrest (OOHCA) are separated from deaths due to other cardiovascular causes, OOHCA is the third-leading cause of death in the United States.2 Moreover, there are considerable opportunities to improve outcomes after OOHCA, because there is a more than 5-fold regional variation in survival after OOHCA. Approximately 25% of cardiac arrest patients treated by emergency medical services providers have a first recorded rhythm of ventricular fibrillation, which is usually responsive to defibrillation. Moreover, early provision of cardiopulmonary resuscitation to maintain blood flow or defibrillation to restore mechanical activity is a critical component of effective treatment of OOHCA.3

The American Heart Association has promulgated the concept of training and equipping targeted groups to perform timely rhythm analysis and defibrillation in the event that a person has cardiac arrest at a location in which large numbers of people congregate, a concept known as public access defibrillation.4 The rationale for doing so includes the fact that approximately one fourth of OOHCA occur in public locations; OOHCA is often witnessed by laypeople; laypeople available on the scene can perform defibrillation while awaiting the arrival of emergency medical services providers; and improvements in technology have increased the portability, ease of use, and safety of automated external defibrillators (AEDs). A large randomized trial demonstrated that training and equipping lay volunteers to recognize OOHCA and then perform cardiopulmonary resuscitation (CPR) and use an AED within 3 minutes of event identification was medically effective5 and cost-effective.6

Although there is great potential for reducing death and disability associated with OOHCA by dissemination and implementation of public access defibrillation programs, healthcare resources are limited. In this issue of Circulation, Folke and colleagues7 have evaluated whether targeted deployment of AEDs in locations with a high incidence of cardiac arrest could improve resuscitation outcomes at comparatively little cost. In this retrospective observational study, the incidence and characteristics of OOHCA in central Copenhagen, Denmark, were examined by use of small-area variation techniques. Individuals who experienced OOHCA in residential locations were older, more likely to arrest at night, and less likely to have ventricular fibrillation and had longer ambulance response times and lower survival to discharge than individuals who experienced OOHCA in public locations. The incidence of OOHCA was significantly correlated with population density and neighborhood educational level. The incremental costs of selective deployment of AEDs in residential areas were estimated. The placement of AEDs in areas with more than 300 people per 100 m² (ie, more than 30 000 people per km²) in combination with the lowest income quartile was associated with an incremental cost of $55 000 to $96 000 per quality-adjusted life year. If the assumptions incorporated into the analysis are correct, it is rational to implement this type of program, because this incremental cost is similar to that of other commonly used health interventions (eg, dialysis).8

For more than a decade, the clinical community has been aware that patients who experience OOHCA in racially integrated neighborhoods were most likely to be provided with CPR, followed by those in predominantly white neighborhoods, with the lowest rates of CPR provision in predominantly black neighborhoods.9 At the individual level, middle-aged black residents (relative to older black and all white residents) were less likely to receive CPR. We are troubled by the recognition that the process and outcome of care for an acute cardiovascular event depends on the sociodemographic characteristics of the community. Others previously demonstrated that the incidence and outcome of OOHCA are correlated with socioeconomic status of the community,10 which in the United States is regrettably correlated with its ethnic and racial composition. But even in a country with universal health insurance, processes of care for patients with acute cardiovascular events differ according to the socioeconomic status of the community.11 The concept of targeted deployment of primary or secondary prevention toward high-risk (and disadvantaged) individuals is well accepted, but to date, few interventions to improve care for acute cardiovascular events such as OOHCA have been targeted toward high-risk individuals. Although efforts to improve prehospital emergency care in the United States have been rec-
ommended by experts, particular attention needs to be given to the enhancement of emergency care for the disadvantaged.

The analysis by Folke et al has some limitations. First, they assumed that 4 individuals would be in the proximity of the AED location and would have been trained in CPR and AED use. But the true relationship between the number of individuals trained in CPR and the likelihood that a bystander available on the scene will provide CPR is unknown. If a larger number of individuals must be trained, then the costs of the intervention would be increased.

Second, the analysis underestimates the overall effectiveness of resuscitation by considering only patients with ventricular fibrillation. Others have proposed concentrating efforts to improve resuscitation on patients with a favorable prognosis. Although patients with a nonshockable rhythm have a poorer prognosis than patients with a shockable rhythm, outcomes after pulseless electric activity appear to be improving over time. Ignoring the effect of CPR on such patients with a nonshockable rhythm biases the analysis in favor of placement of AEDs.

Conversely, the analysis extrapolates the effectiveness of lay use of AEDs in public locations to their effectiveness in residential locations. Two randomized trials failed to demonstrate whether lay use of AEDs in residences of patients with established cardiovascular disease improved their survival, but both of these trials lacked sufficient power to detect a clinically important difference. It remains unclear whether the effect of placement of AEDs in residential settings more closely resembles the experience in public locations or in patients with cardiovascular disease.

The economic analysis combines data from multiple sources and assumptions. The economic results are presented as a point estimate rather than an estimate of the joint density of cost and effect differences or to quantify the uncertainty about the incremental cost-effectiveness ratio for the intervention. The large number of input data incorporated into the analysis are likely to be associated with large confidence intervals such that the incremental cost-effectiveness of selective placement of AEDs overlaps the decision criterion for what is (or is not) cost-effective.

Finally, the generalizability of the relationship between the sociodemographic characteristics of a single European city and the incidence and outcome of cardiac arrest to such relationships in other settings remains unclear. Therefore, the results of this analysis require validation.

Nonetheless, Folke and colleagues have described a preliminary approach to efficient placement of AEDs in residential areas based on simple demographic characteristics of the community. These and other efforts are necessary so that we can reduce a major cause of death, disability, and disparity in our communities.

Disclosures
Dr. Nichol reports the receipt of research grants as Principal Investigator, Resuscitation Outcomes Consortium Coordinating Center (National Institutes of Health U01 HL077863-05) 2004–2015; Principal Investigator, Evaluation of Video Self-Instruction in Compressions-Only CPR (Asmund S. Laerdal Foundation for Acute Medicine) 2007–2010; Principal Investigator, Randomized Trial of Hemofiltration After Resuscitation From Cardiac Arrest (National Heart, Lung, and Blood Institute R21 HL093641-01A1) 2009–2011; Co-Investigator, Randomized Field Trial of Cold Saline IV After Resuscitation From Cardiac Arrest (National Heart, Lung, and Blood Institute R01 HL089554-03) 2007–2012; Co-Investigator, Novel Methods of Measuring Health Disparities (1RC2HL101759-01) 2009–2011; and Principal Investigator, Cascade Cardiac Resuscitation System (Medtronic Foundation) 2010–2015. Dr Nichol also served as a consultant or research collaborator for Gambro Renal Inc, Lakewood, Colo; Sotera Wireless, San Diego, Calif; and Lifebridge Medizintechnik AG, Ampfing, Germany. Dr. Nichol has served as the Chair of the American Heart Association’s (AHA’s) Executive Database Steering Committee; Chair, Mission: Lifeline EMS Task Force; Cochair, AHA Resuscitation Science Symposium Planning Committee; Member, AHA Advanced Cardiac Life Support Subcommittee; Member, AHA Epidemiology and Statistics Committee; Member, Pacific Mountain Affiliate Board of Directors, AHA; and has received travel reimbursement from the AHA. Dr McClure reports no conflicts.

References


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