Evolving Strategies in Cardiac Arrest Management

Bram J. Geller, MD[a,*], Benjamin S. Abella, MD, MPhil[b]

KEYWORDS

• Cardiac arrest • Cardiopulmonary resuscitation • CPR • Sudden death • ECMO

KEY POINTS

- Strong data for the use of mechanical chest compression devices over manual chest compressions is lacking; however, in certain situations, such as during prehospital transport or in the cardiac catheterization laboratory, these devices may offer a unique advantage.
- Although antiarrhythmic medications have a well-established role in cardiac arrest from ventricular arrhythmias, corticosteroids and thrombolytics may only have a role in select patients.
- End-tidal carbon dioxide monitoring may have clinical utility in assessing the quality of chest compressions during cardiopulmonary resuscitation (CPR) and help guide decisions to continue CPR.
- Extracorporeal membrane oxygenation during CPR is a promising advancement in cardiac arrest management with significant potential to redefine how resuscitation is performed in select patients.

INTRODUCTION

Cardiac arrest, defined as the abrupt and often unanticipated cessation of cardiac output, represents an enormous burden of disease with more than 400,000 cardiac arrests occurring annually in the United States. The national survival to hospital discharge for out-of-hospital cardiac arrest (OHCA) treated by emergency medical services is approximately 10%.[1] Owing to the challenges inherent in studying cardiac arrest, large randomized trials in the field are sparse. The management of cardiac arrest is based largely on consensus guidelines, which give treatment recommendations for the lay public, prehospital providers, and hospital-based providers. The guidelines most commonly referenced in the United States are developed under the auspices of the American Heart Association, drawing from scientific summaries prepared by the International Liaison Committee on Resuscitation. The American Heart Association advanced cardiovascular life support guidelines are meant to be straightforward and readily implemented across the country in a uniform fashion. However, beyond the guidelines are a variety of promising innovations in the management of cardiac arrest. In this article, evolving strategies for the management of cardiac arrest are reviewed. In addition, a large body of clinical science has focused on care for patients after resuscitation from cardiac arrest, including the use of targeted temperature management (TTM); these topics will be covered in a separate review manuscript within this issue.

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[a] Department of Cardiovascular Medicine, University of Pennsylvania, Perelman Center for Advanced Medicine, South Pavilion 11th Floor, 3400 Civic Center Boulevard, Philadelphia, PA 19104, USA; [b] Department of Emergency Medicine, University of Pennsylvania, 3400 Spruce Street Ground Ravdin, Philadelphia, PA 19104, USA

* Corresponding author.

E-mail address: bram.geller@uphs.upenn.edu

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CHEST COMPRESSIONS

The prompt delivery of cardiopulmonary resuscitation (CPR), and in particular chest compressions, has been shown in numerous studies to have a significant impact on survival from cardiac arrest. CPR, introduced in modern form by clinical investigators in 1960,[2] continues to evolve as new evidence suggests the relative importance of chest compressions compared with ventilation.

Compression-Only Cardiopulmonary Resuscitation

Although an early study of layperson compression-only CPR (COCPR) was inconclusive,[3] a subsequent observational study of COCPR showed an association with increased rates of survival to hospital discharge when compared with conventional CPR and no bystander CPR.[4] This was the rationale behind 2 large randomized trials.

In one study, 1276 patients with witnessed OHCA were randomly assigned to either bystander education for COCPR or conventional CPR. There was no difference with respect to 30-day survival between the 2 groups.[5] In the other study, 1941 patients with witnessed OHCA were randomly assigned to layperson education on COCPR or conventional CPR. The rates of survival to hospital discharge were similar in the 2 groups, but in certain clinical subgroups, there was a trend toward better outcomes with COCPR.[6] A metaanalysis of randomized trials showed that COCPR was associated with an increased rate of survival to hospital discharge compared with conventional CPR (14% vs 12%; 95% confidence interval [CI], 1.01–1.46).[7] In conclusion, clinical evidence suggests that OHCA layperson CPR should focus on compressions only for most cases of cardiac arrest (drowning and primary respiratory arrest serve as exceptions to this). Of note, there is no evidence supporting the use of COCPR by health care providers or for in-hospital cardiac arrest (IHCA).

Mechanical Cardiopulmonary Resuscitation

The increasing emphasis on the importance of high-quality uninterrupted CPR has led to the development of several mechanical devices that are intended to offer an alternative to manual delivery of chest compressions. There are 2 major categories of devices to deliver mechanical CPR (mCPR), piston-driven devices (eg, LUCAS by Physio-Control, Redmond, WA), and load-distributing band devices (eg, AutoPulse, Zoll Medical, Chemsford, MA). These devices have primarily been studied for OHCA,[8–10] but some data also exist for the use of these devices during IHCA.[11–13] A trial from 2006 randomized 767 subjects to CPR with a load-distributing band or to manual CPR. Although there was no difference in the survival at 4 hours, the study was terminated early when the Cerebral Performance Category (CPC) score of 1 or 2 at hospital discharge was significantly better in the manual CPR group.[9] Several metaanalyses of clinical evidence for mCPR have highlighted the complexity of these data. One metaanalysis of 12 studies for OHCA showed improvement in return of spontaneous circulation (ROSC) rates with mechanical compression devices. However, when the types of mechanical devices were analyzed separately, only load-distributing band mechanical compression devices, not piston-driven mechanical compression devices, significantly improved the likelihood of ROSC.[14] However, a Cochrane review found that there are insufficient data to suggest benefit or harm from mechanical chest compressions compared with manual CPR.[15]

Several recent randomized controlled trials have been performed with both piston-driven and load-bearing band devices. Despite somewhat varying outcomes, overall, these studies have suggested equivalency of mCPR devices with manual CPR in terms of 4-hour survival, survival to hospital discharge, survival at 30 days, and good neurologic outcomes in survivors at 6 months.[16–18] A contemporary metaanalysis of randomized controlled trials, similar to earlier analysis, have failed to show a survival benefit with mCPR.[19,20] Several observational studies suggest lower neurologically favorable survival with mCPR,[21,22] but patients who achieve rapid ROSC are less likely to require mCPR and, therefore, observational studies are difficult to interpret.

These trials do have limitations. One frequent criticism is that the quality of manual CPR in randomized, controlled trials may be better than CPR performed in the community. However, despite certain limitations, the evidence does not demonstrate a consistent benefit from mCPR; the balance of evidence suggests equivalent outcomes with manual CPR or mCPR. Therefore, although there is no evidence to endorse the routine use of these devices, these devices may have a role in particular settings, where it may be difficult to perform high-quality chest compressions.

For example, in the cardiac catheterization laboratory, there may be a specific use for mCPR, given that manual compressions are technically challenging during active catheterization procedures.[23–27] One study showed that, in 32 patients, cardiac interventions during mechanical chest compressions were feasible, and there was a