

# The Pharmacologic Management of Cardiac Arrest



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## KEYWORDS

• Cardiac arrest medications • Epinephrine • Amiodarone • Lidocaine

## KEY POINTS

- The foundation of cardiac arrest management is high-grade chest compressions.
- The preferred route for medications during cardiac arrest is the peripheral IV. Intraosseous access is acceptable in patients for whom peripheral IV access was unsuccessful.
- The use of epinephrine and the combination of vasopressin-steroids-epinephrine for cardiac arrest have been shown to improve short-term survival. Their effect on survival with favorable neurologic outcomes is less certain.
- Both amiodarone and lidocaine have been shown to increase survival to hospital admission in patients with pulseless ventricular tachycardia or ventricular fibrillation.
- The routine use of calcium, sodium bicarbonate, magnesium, or atropine in cardiac arrest is not supported and may cause harm.

## INTRODUCTION

The cornerstone of cardiac arrest management is high-quality cardiopulmonary resuscitation (CPR) and early defibrillation in patients with pulseless ventricular tachycardia/ventricular fibrillation (pVT/VF) and high-quality CPR alone in patients with pulseless electrical activity (PEA) or asystole. Medications, particularly epinephrine, are nearly universally used in cardiac arrest codes; however, the data supporting their use are limited. These medications typically produce a short-term survival benefit (ie, return of spontaneous circulation [ROSC], survival to hospital admission or hospital discharge) but rarely produce meaningful long-term improvements (ie, survival at 90 days or longer or, more importantly, survival with favorable neurologic outcome).<sup>1</sup> This review will cover vascular access, vasopressors, antiarrhythmics, and other medications such as calcium, sodium

bicarbonate, magnesium, and atropine that are commonly used during cardiac arrest care. Finally, we review the role of  $\beta$ -blockers for refractory pVT/VF and thrombolytics in cardiac arrest and fatal pulmonary embolism.

## VASCULAR ACCESS

The preferred route for medications during cardiac arrest is the peripheral intravenous (IV); however, obtaining IV access can be challenging based on patient characteristics, operator experience, and the emergency nature of the situation. These factors may all contribute to a delay in administering pharmacologic treatments during cardiac arrest. Alternatives to IV access include intraosseous (IO) access, central venous access, and endotracheal routes. Of these choices, IO access has become the preferred second-line, and in some systems, first-line, route based on its relative

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ease and higher first-attempt success than IV cannulation.

Given the observation that advanced cardiac life support (ACLS) medications have not been shown to improve long-term survival or survival with favorable neurologic outcomes, it is unlikely that the choice of vascular route to give these drugs would have any influence on this outcome. Although it has been demonstrated that IO access provides faster vascular access and requires less time to epinephrine administration, trials fail to show improvement in long-term clinically important outcome.<sup>2,3</sup> A recent meta-analysis that included 9 retrospective observational studies and 111,746 patients with out-of-hospital cardiac arrest (OHCA) did not find any association between type of vascular access (IO vs IV) and survival with favorable neurologic outcome.<sup>4</sup> IV access compared with IO access was associated with an improvement in survival to hospital admission but not to hospital discharge. It is important to note that retrospective studies show association, not causation, and that patient selection bias, namely that IO placement may indicate patient or arrest characteristics that are also risk factors for poor outcomes, is a significant confounder in the analyzed trials. Currently, IV access is the preferred route for initial vascular access, providing the most predictable medication response. In scenarios where IV access is not successful or feasible, the IO route can be attempted.<sup>5,6</sup>

## VASOPRESSOR MEDICATIONS DURING CARDIAC ARREST

### *Epinephrine*

Epinephrine is the only medication indicated for cardiac arrest management regardless of initial rhythm. While the  $\alpha$ -adrenergic effects of epinephrine improve aortic diastolic pressure, thereby improving coronary and cerebral perfusion pressure and the likelihood of ROSC, its  $\beta$ -adrenergic effects may increase cardiac rate and contractility, which increase myocardial oxygen demand and may lead to arrhythmias. Furthermore, some animal models have shown that epinephrine may actually decrease cerebral microcirculatory blood flow during CPR leading to worse neurologic outcomes.<sup>7,8</sup>

The use of epinephrine in cardiac arrest has never been supported by high-quality, randomized data until the publication of two trials, The Prehospital Adrenaline for Cardiac Arrest (PACA) trial and The Prehospital Assessment of the Role of Adrenaline: Measuring the Effectiveness of Drug Administration in Cardiac Arrest (PARAMEDIC 2)

trial.<sup>9,10</sup> Prior observational studies on the use of epinephrine in cardiac arrest were subject to patient selection bias, confounding by unmatched or unmeasured variables, and resuscitation time bias.<sup>11</sup>

In the PACA trial, 601 OHCA patients, serviced by a single emergency ambulance company in Western Australia, were randomized in a double-blind manner to receive epinephrine 1 mg every 3 minutes (median total dose 5 mg, interquartile range [IQR] 3.0 mg to 7.0 mg) or normal saline placebo (median total dose 5 mL, IQR 3.0 mL to 8.0 mL). The prehospital administration of epinephrine resulted in improved rates of ROSC, but did not improve survival to hospital discharge.<sup>9</sup>

The PARAMEDIC 2 trial was a randomized, double-blind trial involving 8014 OHCA patients and 5 National Health Service ambulance services in the United Kingdom. The prehospital administration of epinephrine resulted in improved 30-day survival and survival at 3 months.<sup>10</sup> A subsequent analysis of these trial participants reported that this survival benefit persisted at a 1-year time point.<sup>12</sup> Given the poor overall rates of survival in this trial (expected 30-day survival rate 6.0% in placebo group and 7.5% in the epinephrine group; actual trial 30-day survival rate 2.4% in the placebo group and 3.2% in the epinephrine group), PARAMEDIC 2 was underpowered to detect meaningful differences in survival with favorable neurologic outcome. Analysis of the supplemental appendix of this trial reveals that survival with no disability or slight disability (ie, modified Rankin score of 0–2) was similar between the two groups at 3-month and 6-month follow-up.<sup>12</sup> A criticism of PARAMEDIC 2 is that epinephrine resulted in an increase in the proportion of survivors with moderate or severe disability (ie, modified Rankin score 3–5) at the time of hospital discharge. Although a substantial number of cardiac arrest survivors have significant care needs upon hospital discharge, over time, these needs decrease. At 6-month follow-up, the proportion of survivors with moderate or severe disability was similar between the two groups.<sup>12</sup> PARAMEDIC 2 established that epinephrine seems to increase the number of survivors with both a good and poor neurologic outcome. A cost-effectiveness analysis of PARAMEDIC 2 found that epinephrine administration during cardiac arrest is a cost-effective intervention with a societal benefit when organ donation and transplant recipients are taken into account.<sup>13</sup>

When combined, PACA and PARAMEDIC 2 demonstrate improvement in survival to hospital discharge but not in survival with favorable neurologic outcome in patients receiving prehospital

epinephrine. This effect seems most pronounced in patients with nonshockable rhythms but is also seen, albeit with less statistical certainty, in patients with shockable rhythms.<sup>14,15</sup> In both shockable and nonshockable rhythms, survival to hospital discharge is most pronounced when epinephrine is given within the first 5 minutes of emergency medical service (EMS) arrival.<sup>16</sup>

Current guidelines support the use of epinephrine in cardiac arrest at a dose of 1 mg every 3 to 5 minutes.<sup>17–20</sup> For shockable rhythms, epinephrine is recommended to be administered if initial attempts with CPR and defibrillation are unsuccessful. With nonshockable rhythms, it is reasonable to administer epinephrine as soon as feasible.

### ***Vasopressin-Steroids-Epinephrine Therapy***

In 2009, Mentzelopoulos and colleagues hypothesized that the combination of vasopressin-steroids-epinephrine (VSE) given during and after cardiac resuscitation would improve ROSC in patients with cardiac arrest. They enrolled 100 in-hospital cardiac arrest (IHCA) cases into a single-center, prospective, double-blind randomized controlled trial (RCT) where patients received either vasopressin 20 IU plus epinephrine 1 mg per CPR cycle or saline placebo plus epinephrine 1 mg per CPR cycle. On the first CPR cycle, the study group patient received methylprednisolone 40 mg and controls received saline placebo. Following ROSC, postresuscitation shock was treated with stress-dose hydrocortisone 300 mg daily for up to 7 days, with gradual taper or saline placebo. Patients randomized to VSE had higher rates of ROSC and improved survival to hospital discharge compared with patients in the standard care group.<sup>21</sup> This study was followed up in 2013 by the same author group when they randomized 268 IHCA cases across 3 medical centers to either VSE or standard care. Again, rates of ROSC and survival to hospital discharge were higher in the VSE group.<sup>22</sup> Importantly, survival with favorable neurologic outcome was seen in the VSE group compared with standard care. In 2021, a third trial, the Vasopressin and Methylprednisolone for In-Hospital Cardiac Arrest trial, used a multicenter, prospective, double-blind RCT methodology to randomize 501 IHCA patients to VSE or standard care. In this trial, rates of ROSC were higher in the VSE group; however, 30-day survival and survival with favorable neurologic outcome showed no difference between the two groups.<sup>23</sup> Survival at 1 year was not different between the two groups.<sup>24</sup> When combined, these three RCTs with a total of 869 patients show that VSE improves ROSC for IHCA cases.<sup>25</sup> Further high-

quality RCTs are needed to define the role of VSE in OHCA patients and its effect on long-term survival and neurologic outcome.

### **ANTIARRHYTHMIC MEDICATIONS DURING CARDIAC ARREST**

Antiarrhythmic medications are indicated in patients with refractory pVT/VF. Refractory pVT/VF is defined as an initial rhythm of pVT or VF that is still present after three consecutive rhythm analyses and standard defibrillation separated by 2-minute intervals of CPR.

A systematic review in 2018 evaluated the efficacy of amiodarone, procainamide, lidocaine, magnesium, and bretylium for cardiac arrest due to pVT/VF.<sup>26</sup> Overall this review found no supporting evidence for association of these agents to the outcomes or survival to hospital discharge, survival with favorable neurologic outcome, or long-term survival.

#### ***Amiodarone***

An initial bolus of 300 mg of amiodarone is recommended for adult patients in cardiac arrest who showed pVT/VF after three shocks have been administered; an additional 150 mg of amiodarone is recommended after the fifth shock.<sup>5,6</sup> The strength of this recommendation is based on two medium-sized RCTs that demonstrated amiodarone's superiority to placebo<sup>27</sup> and to lidocaine<sup>28</sup> with respect to survival to hospital admission. A follow-up RCT, Amiodarone, Lidocaine, or Placebo in Out-of-Hospital Cardiac Arrest (ALPS) trial, involving 3026 patients comparing amiodarone, lidocaine, and placebo for shock-refractory pVT/VF confirmed antiarrhythmic therapy (either amiodarone or lidocaine) was superior to placebo for survival to hospital admission. In this trial, antiarrhythmic therapy did not show improvement in survival to hospital discharge or survival with favorable neurologic outcome compared with placebo.<sup>29</sup>

Several interesting exploratory analyses of the ALPS trial have been published. One analysis evaluated the efficacy of antiarrhythmic therapy in the subgroup of cardiac arrest patients that initially had a nonshockable rhythm and subsequently developed a shockable rhythm. Although not statistically significant, more patients in the antiarrhythmic-treated group survived to hospital discharge.<sup>30</sup> A second subgroup analysis evaluated the efficacy of antiarrhythmic therapy in the subgroup of patients based on vascular access (ie, IV vs IO administration). When adjusted for common confounders (ie, age, sex, cardiac cause, public location, EMS witnessed, bystander

witnessed, bystander CPR, EMS arrival time, advanced life support (ALS) arrival time, time to study drug, and study site), IV administration of amiodarone was associated with survival to hospital admission, survival to hospital discharge, and survival with favorable neurologic outcome. These associations were less pronounced in patients receiving lidocaine and were not seen in the patients who received IO amiodarone or IO lidocaine.<sup>31</sup> Time to treatment was assessed in a third exploratory analysis. The probability of achieving ROSC was highest in patients that received antiarrhythmic within the first 10 minutes from the time of the 911 call and decreased over time.<sup>32</sup> Finally, a Bayesian reanalysis of the ALPS trial was performed. Bayesian analysis provides a probabilistic estimate of treatment effect by incorporating prior knowledge of the potential effects with the trial data to generate probability distributions that represent the entire range of effect consistent with the prior knowledge and the study data. The Bayesian reanalysis of ALPS concluded that amiodarone is “highly likely” to improve survival and neurologic outcome compared with placebo.<sup>33</sup>

### ***Procainamide***

Procainamide was previously recommended for shock-refractory cardiac arrest; however, its use has fallen out of favor because of its slow infusion rate, side effects profile, and the development of newer agents that initially seemed promising for the treatment of pVT/VF. With the results of the Procainamide versus Amiodarone for the Acute Treatment of Tolerated Wide QRS Tachycardia (PROCAMIO) trial, an RCT that studied stable patients with VT and showed fewer adverse events at 40 minutes after procainamide infusion compared with amiodarone<sup>34</sup> and the failure of amiodarone or lidocaine to show meaningful long-term survival benefit in cardiac arrest patients, there has been some renewed interest in using procainamide for pVT/VF. While no RCTs have evaluated procainamide for shock-refractory cardiac arrest, two retrospective studies have failed to show improved survival outcomes in patients who received procainamide for this indication.<sup>35,36</sup>

### ***Lidocaine***

Lidocaine 100 mg may be used as an alternative to amiodarone for refractory pVT/VF cardiac arrest patients; an additional 50 mg is recommended after the fifth shock.<sup>5,6</sup> Observational data suggest an association between patients that receive lidocaine for refractory pVT/VF and improved 1-year

survival,<sup>37</sup> as well as improved survival with favorable neurologic outcome.<sup>38</sup> When more rigorously tested in RCTs, lidocaine has not been shown to be superior to amiodarone or to placebo with respect to survival to hospital discharge or survival with favorable neurologic outcome.<sup>26,28,29</sup> A Bayesian reanalysis of the ALPS trial concluded that lidocaine is ‘moderately likely’ to improve survival and neurologic outcome compared with placebo.<sup>33</sup>

## **OTHER MEDICATIONS**

### ***Corticosteroids (Without Vasopressin)***

Global ischemia during cardiac arrest triggers the activation of multiple inflammatory systems leading to a sepsis-like syndrome.<sup>39,40</sup> Furthermore, low circulating cortisol and poor adrenocortical reserve complicate the postarrest period.<sup>41,42</sup> Corticosteroid use during and/or after cardiac arrest may help treat these issues<sup>43</sup> and has been studied in a handful of cohort trials and small RCTs. Neither the American Heart Association (AHA) in 2020 nor the European Resuscitation Council in 2021 recommend the routine use of corticosteroids for cardiac arrest<sup>5,6</sup>; however, in the past 2 years, at least four additional RCTs have been published.<sup>23,24,44,45</sup> When combined with the results of prior analyses,<sup>46</sup> corticosteroids given during and after cardiac arrest seem to increase the rate of ROSC but have unclear effects on longer-term survival or survival with favorable neurologic outcomes.

### ***Calcium***

Calcium is an inotropic agent that has vasopressor effects and may counter the proarrhythmic effects of hyperkalemia. Two small trials involving a total of 163 OHCA patients in PEA or asystole identified a trend favoring calcium over placebo with respect to ROSC.<sup>47,48</sup> Calcium is commonly thought to be a benign medication that may help in undifferentiated cardiac arrest. A recent contemporary review of hospitals that participate in the AHA’s Get with the Guidelines Resuscitation database noted that the rate of calcium administration for IHCA has steadily increased over the period of 2001 to 2016.<sup>49</sup> On the basis of these observations, the Calcium for Out-of-Hospital Cardiac Arrest trial randomized 397 OHCA patients to receive either 5 to 10 mmol calcium chloride administered immediately after the first and second dose of epinephrine or saline placebo. The trial was stopped early on the recommendation of the independent safety committee because of safety concerns in the calcium group. Statistically, there was no difference between the groups with respect to the primary outcome of sustained ROSC or the secondary

outcomes of 30-day survival, 90-day survival, or 90-day survival with favorable neurologic outcome—although in all these groups, it appeared that the patients that received calcium did consistently worse.<sup>50</sup> A subsequent analysis of these trial participants reported similar results when analyzing 1-year outcomes.<sup>51</sup> Interestingly, both the subgroup of patients with last known rhythm of PEA and the subgroup of patients with ECG characteristics potentially associated with hyperkalemia and/or ischemia also seemed to show lack of benefit or harm from calcium administration.<sup>52</sup> On the basis of these data, calcium should not be routinely administered for cardiac arrest unless there is high suspicion for arrest due to, or complicated by, hyperkalemia, hypocalcemia, hypermagnesemia, or overdose of calcium-channel-blocking drugs.

### **Sodium Bicarbonate**

Although sodium bicarbonate has been considered an important part of treatment for severe metabolic acidosis in cardiac arrest, recent cardiac arrest guidelines have strongly discouraged its routine use.<sup>53</sup> Despite the lack of compelling data, the use of sodium bicarbonate during IHCA has steadily increased from 2001 to 2016, with nearly 50% of inpatient codes receiving sodium bicarbonate in 2016.<sup>49</sup> Overall, the published data on sodium bicarbonate in cardiac arrest do not support the increased usage over this time. A systematic review and meta-analysis of 4 RCTs and 10 observational trials enrolling 28,412 OHCA patients found that routine administration of sodium bicarbonate was not associated with improved ROSC or survival to hospital discharge.<sup>54</sup> Observational data from one of the included trials suggest an association between administration of sodium bicarbonate and poor neurologic outcome, although interpretation of the data is limited as this medication may be more frequently used in a population of sicker patients as a “last resort” (ie, resuscitation time bias).<sup>55</sup> A similar observation between patients that received sodium bicarbonate and poor neurologic outcome was seen in a data set involving North American patients with OHCA.<sup>56</sup> Currently sodium bicarbonate is specifically recommended only in the following situations: hyperkalemia, sodium channel blocker toxicity. There are limited data to guide therapy with sodium bicarbonate in the population of patients with pre-exiting acidosis<sup>57</sup> and in patients with acidosis due to prolonged resuscitation.<sup>58–60</sup>

### **Magnesium**

Magnesium is an essential electrolyte in regulating sodium, potassium, and calcium flow across cell

membranes and cofactor for a variety of metabolically important reactions, particularly those involving adenosine triphosphate. A handful of small RCTs<sup>61–64</sup> and one observational study<sup>65</sup> have evaluated the role of magnesium infusion versus placebo in a total of 499 OHCA patients with both shockable and nonshockable initial rhythms. No difference was observed between the two groups in terms of ROSC or survival to hospital discharge.<sup>66,67</sup> Empiric treatment with magnesium is, therefore, not recommended for routine use in cardiac arrest.<sup>54,68</sup>

Magnesium is commonly used to treat torsade de pointes (ie, polymorphic VT associated with long QT interval); however, it generally acts to prevent the reinitiation of torsades rather than to pharmacologically convert polymorphic VT. Its use in this setting is based on limited data.<sup>69,70</sup> Episodes of torsades de pointes may be short-lived and self-terminate only to recur or may be sustained. Although defibrillation is the treatment of choice for sustained episodes or episodes associated with hemodynamic instability, magnesium sulfate is recommended to prevent recurrences.<sup>54,68</sup> A reasonable approach to prevent torsade de pointes recurrence is to give 2 to 4 g of MgSO<sub>4</sub> followed by an infusion at 1 g/h titrated to achieve a serum magnesium level of 3.5 to 5.0 mg/dL.

### **Atropine**

Atropine is a potent anticholinergic that reverses cholinergic-mediated decreases in heart rate and blood pressure. No prospective controlled clinical trials have evaluated the role of atropine in asystole or bradycardia PEA cardiac arrest leading to its removal from cardiac arrest guidelines in 2010.<sup>53</sup> In a cohort study involving 7448 patients with either PEA or asystole, the use of atropine in addition to standard therapy when compared to standard therapy alone was not associated with improved 30-day survival with favorable neurologic outcome.<sup>71</sup> An analysis of the AHA's Get with the Guidelines Resuscitation database for IHCAs noted that the removal of atropine from cardiac arrest guidelines in 2010 did not impact ROSC, survival to hospital discharge, or survival with favorable neurologic outcome.<sup>72</sup> Atropine remains a viable option for acute symptomatic bradycardia in the nonarrest situation.

### **Beta-Blockers for Shock-Resistant Pulseless Ventricular Tachycardia/Ventricular Fibrillation**

Although  $\beta$ -blockers have been proposed for the treatment of refractory pVT/VF, there are no high-quality trials that have supported their use in this setting. A systematic review and meta-

analysis on the use of  $\beta$ -blockers for refractory pVT/VF identified 3 observational studies involving a total of 115 patients.<sup>73</sup> When the data from these trials were combined, the addition of  $\beta$ -blockers demonstrated improvements in sustained ROSC, survival to hospital admission, survival to hospital discharge, and survival with favorable neurologic outcome. These trials were judged to be at moderate or serious risk of bias, and the certainty of the overall conclusion is low. A subsequent sequential analysis of these trials concluded that additional studies are required before making a recommendation for the use of  $\beta$ -blockers for refractory pVT/VF.<sup>74</sup>

### ***Thrombolytic Therapy for Cardiac Arrest***

Acute myocardial infarction and pulmonary embolism are potentially reversible causes of cardiac arrest that may benefit from systemic thrombolytic therapy. The use of thrombolytics during cardiac arrest has been examined both in the treatment of undifferentiated cardiac arrest and specifically for patients with fulminant pulmonary embolism.

Three RCTs have evaluated the role of thrombolytics in undifferentiated cardiac arrest.<sup>75–77</sup> When analyzed together, no difference in the rates of ROSC or survival to hospital discharge was seen with the administration of thrombolytics.<sup>78</sup> Thirty-day survival and neurologic outcome was evaluated in one of these trials and similarly showed no difference between patients receiving thrombolytics or placebo.<sup>77</sup>

Approximately 2% to 5% of cardiac arrest cases are due to fulminant pulmonary embolism.<sup>79</sup> Although no RCTs have evaluated the role of thrombolytics in patients with pulmonary embolism, a handful of observational trials have yielded mixed, but generally favorable, results with respect to ROSC.<sup>79–84</sup> A relatively large retrospective study from the French National Cardiac Arrest Registry compared the outcomes in 58 patients with confirmed PE who received thrombolytics during CPR to 188 patients with confirmed PE who did not receive thrombolytics during CPR. Thrombolytic use was associated with an increase in 30-day survival and showed a favorable trend in neurologic outcome.<sup>85</sup> Based on the total of the data, it is reasonable to consider thrombolytic therapy when acute PE is a known or highly suspected cause of cardiac arrest.<sup>5,6</sup> If the patient has arrested or is peri-arrest, thrombolytics should be given promptly during CPR. Although not standardized, it is recommended that CPR be continued for at least 60 to 90 minutes after the thrombolytics are given and before terminating resuscitation efforts.<sup>6,86</sup>

### **SUMMARY**

The pharmacologic management of cardiac arrest is continuing to evolve. Recent trials have increased our understanding of the role of epinephrine, VSE, amiodarone, and lidocaine in cardiac arrest. These agents increase short-term survival, a necessary step on the way to giving patients a chance at long-term survival, and several of them have point estimates slightly favoring survival with favorable neurologic outcome. Adjunct medications commonly used in cardiac arrest management include calcium, sodium bicarbonate, and magnesium. These agents should only be used in specific settings and not routinely in cardiac arrest cases. Atropine has not been established as an effective medication in cases of PEA or asystole. The use of  $\beta$ -blockers for refractory pVT/VF may be used on a case-by-case basis but currently lacks high-quality data supporting its use. Finally, thrombolytics should not be used in undifferentiated cardiac arrest but may have a role in cases where acute PE is known or highly suspected as the cause of cardiac arrest.

### **CLINICS CARE POINTS**

- Medications given during cardiac arrest may be delivered via intravenous (IV) access, intraosseous (IO) access, central venous catheter (CVC), or endotracheal tube (ETT).
- The preferred route for giving medications during cardiac arrest is the peripheral IV. Intraosseous access is acceptable in patients where peripheral IV access has been unsuccessful.
- Epinephrine is commonly used in both shockable and nonshockable arrest situations and has recently been shown to produce a long-term benefit in the number of cardiac arrest survivors with both a good and poor neurologic outcome.
- The combination of vasopressin-steroids-epinephrine has been shown to improve ROSC; however, future high-quality RCTs are needed to define its effect on long-term survival and neurologic outcome.
- Antiarrhythmic therapy with amiodarone and lidocaine for refractory pVT/VF has been shown to improve survival to hospital admission and may result in higher rates of favorable neurologic outcome than placebo.
- The routine use of calcium, sodium bicarbonate, and magnesium cannot be recommended at this time.

- Atropine has not been established as an effective medication in PEA arrest or asystole.
- There is insufficient evidence to make a recommendation on the use of  $\beta$ -blockers in refractory pVT/VF.
- Thrombolytics have not been shown to improve any meaningful outcome in undifferentiated cardiac arrest. Their use can be considered when acute PE is known or highly suspected as the cause of cardiac arrest.

## DISCLOSURE

The authors have nothing to disclose.

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