Circulation

AHA FOCUSED UPDATE

2018 American Heart Association Focused Update on Advanced Cardiovascular Life Support Use of Antiarrhythmic Drugs During and Immediately After Cardiac Arrest

An Update to the American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care

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ABSTRACT: Antiarrhythmic medications are commonly administered during and immediately after a ventricular fibrillation/pulseless ventricular tachycardia cardiac arrest. However, it is unclear whether these medications improve patient outcomes. This 2018 American Heart Association focused update on advanced cardiovascular life support guidelines summarizes the most recent published evidence for and recommendations on the use of antiarrhythmic drugs during and immediately after shock-refractory ventricular fibrillation/pulseless ventricular tachycardia cardiac arrest. This article includes the revised recommendation that providers may consider either amiodarone or lidocaine to treat shock-refractory ventricular fibrillation/pulseless ventricular tachycardia cardiac arrest.

This 2018 American Heart Association (AHA) focused update on the advanced cardiovascular life support (ACLS) guidelines for cardiopulmonary resuscitation (CPR) and emergency cardiovascular care (ECC) is based on the systematic review of antiarrhythmic therapy and the resulting "2018 International Consensus on CPR and ECC Science With Treatment Recommendations" (CoSTR) from the Advanced Life Support (ALS) Task Force of the International Liaison Committee on Resuscitation (ILCOR). The draft ALS CoSTR was posted online for public comment,[1] and a summary containing the final wording of the CoSTR has been published simultaneously with this focused update.[2]

AHA guidelines and focused updates are developed in concert with the ILCOR systematic evidence review process. In 2015, the ILCOR process transitioned to a continuous one, with systematic reviews performed as new published evidence warrants them or when the ILCOR ALS Task Force prioritizes a topic. Once the ILCOR ALS Task Force develops a CoSTR statement, AHA ACLS science experts review the relevant topics and update the AHA's ACLS guidelines as needed, typically on an annual basis. A description of the ILCOR continuous evidence review process is available in the 2017 CoSTR summary.[3]

The ILCOR systematic reviews use the Grading of Recommendations Assessment, Development, and Evaluation methodology and its associated nomenclature to determine the quality of evidence and strength of recommendations in the published CoSTR statement. The expert writing group for this 2018 ACLS guidelines focused update reviewed the studies and analysis of the 2018 CoSTR summary[2] and carefully considered the ILCOR consensus recommendations in light of the structure and resources of the out-of-hospital and in-hospital resuscitation systems and the providers who use AHA guidelines. In addition, the

Key Words: AHA Scientific Statements ■ advanced cardiac life support, adult ■ anti-arrhythmia agents ■ cardiopulmonary resuscitation ■ heart arrest ■ tachycardia, ventricular ■ ventricular fibrillation

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writing group determined Classes of Recommendation and Levels of Evidence according to the most recent recommendations of the American College of Cardiology/AHA Task Force on Clinical Practice Guidelines[4] (Table) by using the process detailed in "Part 2: Evidence Evaluation and Management of Conflicts of Interest" in the "2015 American Heart Association Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care."[5]

This 2018 ACLS guidelines focused update includes updates only to the recommendations for the use of antiarrhythmics during and immediately after adult ventricular fibrillation (VF) and pulseless ventricular tachycardia (pVT) cardiac arrest. All other recommendations and algorithms published in "Part 7: Adult Advanced Cardiovascular Life Support" in the 2015 guidelines update[6] and "Part 8: Adult Advanced Cardiovascular Life Support" in the "2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care"[7] remain the official ACLS recommendations of the AHA ECC Science Subcommittee and writing groups. In addition, the "2017 American Heart Association Focused Update on Adult Basic Life Support and Cardiopulmonary Resuscitation Quality: An Update to the American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care" contains updated AHA recommendations for CPR delivered to adult patients in cardiac arrest.[8] Through this systematic evaluation process, several issues have been identified in related areas that may be the subject of future systematic reviews.

BACKGROUND

Shock-refractory VF/pVT refers to VF or pVT that persists or recurs after ≥1 shocks. An antiarrhythmic drug alone is unlikely to pharmacologically convert VF/pVT to an organized perfusing rhythm. Rather, the primary objective of antiarrhythmic drug therapy in shock-refractory VF/pVT is to facilitate successful defibrillation and to reduce the risk of recurrent arrhythmias. In concert with shock delivery, antiarrhythmics can facilitate the restoration and maintenance of a spontaneous perfusing rhythm. Some antiarrhythmic drugs have been associated with increased rates of return of spontaneous circulation (ROSC) and hospital admission, but none have yet been demonstrated to increase long-term survival or survival with good neurological outcome. Thus, establishing vascular access to enable drug administration should not compromise the performance of CPR or timely defibrillation, both of which are associated with improved survival after cardiac arrest. The optimal sequence of ACLS interventions, including administration of antiarrhythmic drugs during resuscitation, and the preferred manner and timing of drug administration in relation to shock delivery are still not known.

For the 2018 ILCOR systematic review, the ALS Task Force considered new evidence published since the 2015 CoSTR. The review did not specifically address the selection or use of second-line antiarrhythmic drugs or different antiarrhythmic medications given in combination to patients who are unresponsive to the maximum therapeutic dose of the first administered drug, and limited data are available to direct such treatment. In addition, the optimal bundle of care for shock-refractory VF/pVT has not been identified.

USE OF ANTIARRHYTHMIC DRUGS DURING RESUSCITATION FROM ADULT VF/pVT CARDIAC ARREST

2018 Evidence Summary

Amiodarone

Intravenous amiodarone is available in 2 approved formulations in the United States. One formulation contains the diluent polysorbate, which is a vasoactive solvent that can potentially cause hypotension. The other formulation contains captisol, which has no known vasoactive effects. In 2 out-of-hospital, blinded, randomized controlled trials in adults with shock-refractory VF/pVT who received at least 3 shocks and epinephrine, paramedic administration of intravenous amiodarone improved survival to hospital admission. In 1 study, the ARREST trial (Amiodarone in the Out-of-Hospital Resuscitation of Refractory Sustained Ventricular Tachyarrhythmias),[9] amiodarone (300 mg) in polysorbate improved survival to hospital admission compared with a polysorbate placebo. In another study, the ALIVE trial (Amiodarone Versus Lidocaine in Prehospital Ventricular Fibrillation Evaluation),[10] 5 mg/kg amiodarone in polysorbate improved survival to hospital admission compared with 1.5 mg/kg lidocaine with polysorbate. Survival to hospital discharge and survival with favorable neurological outcome were not improved by amiodarone, but neither study was powered for those outcomes.

In ROC-ALPS (Resuscitation Outcomes Consortium–Amiodarone, Lidocaine or Placebo Study), a large out-of-hospital randomized controlled trial that compared captisol-based amiodarone with lidocaine or placebo for patients with VF/pVT refractory after at least 1 shock, there was no overall statistically significant difference in survival with good neurological outcome or survival to hospital discharge.[11] In this study, ROSC was higher in patients receiving lidocaine compared with those receiving placebo but not for those receiving amiodarone compared with patients receiving placebo. Survival to hospital admission was higher in patients receiving ei-

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Table. ACC/AHA Recommendation System: Applying Class of Recommendation and Level of Evidence to Clinical Strategies, Interventions, Treatments, or Diagnostic Testing in Patient Care* (Updated August 2015)

CLASS (STRENGTH) OF RECOMMENDATION

CLASS I (STRONG) — Benefit >>> Risk

Suggested phrases for writing recommendations:
- Is recommended
- Is indicated/useful/effective/beneficial
- Should be performed/administered/other
- Comparative-Effectiveness Phrases†:
  - Treatment/strategy A is recommended/indicated in preference to treatment B
  - Treatment A should be chosen over treatment B

CLASS IIa (MODERATE) — Benefit >> Risk

Suggested phrases for writing recommendations:
- Is reasonable
- Can be useful/effective/beneficial
- Comparative-Effectiveness Phrases†:
  - Treatment/strategy A is probably recommended/indicated in preference to treatment B
  - It is reasonable to choose treatment A over treatment B

CLASS IIb (WEAK) — Benefit ≥ Risk

Suggested phrases for writing recommendations:
- May/might be reasonable
- May/might be considered
- Usefulness/effectiveness is unknown/unclear/uncertain or not well established

CLASS III: No Benefit (MODERATE) — Benefit = Risk

(Generally, LOE A or B use only)

Suggested phrases for writing recommendations:
- Is not recommended
- Is not indicated/useful/effective/beneficial
- Should not be performed/administered/other

CLASS III: Harm (STRONG) — Risk > Benefit

Suggested phrases for writing recommendations:
- Potentially harmful
- Causes harm
- Associated with excess morbidity/mortality
- Should not be performed/administered/other

LEVEL (QUALITY) OF EVIDENCE‡

LEVEL A

- High-quality evidence‡ from more than 1 RCT
- Meta-analyses of high-quality RCTs
- One or more RCTs corroborated by high-quality registry studies

LEVEL B-R (Randomized)

- Moderate-quality evidence‡ from 1 or more RCTs
- Meta-analyses of moderate-quality RCTs

LEVEL B-NR (Nonrandomized)

- Moderate-quality evidence‡ from 1 or more well-designed, well-executed nonrandomized studies, observational studies, or registry studies
- Meta-analyses of such studies

LEVEL C-LD (Limited Data)

- Randomized or nonrandomized observational or registry studies with limitations of design or execution
- Meta-analyses of such studies
- Physiological or mechanistic studies in human subjects

LEVEL C-EO (Expert Opinion)

Consensus of expert opinion based on clinical experience

COR and LOE are determined independently (any COR may be paired with any LOE).

A recommendation with LOE C does not imply that the recommendation is weak. Many important clinical questions addressed in guidelines do not lend themselves to clinical trials. Although RCTs are unavailable, there may be a very clear clinical consensus that a particular test or therapy is useful or effective.

* The outcome or result of the intervention should be specified (an improved clinical outcome or increased diagnostic accuracy or incremental prognostic information).

† For comparative-effectiveness recommendations (COR I and IIa; LOE A and B only), studies that support the use of comparator verbs should involve direct comparisons of the treatments or strategies being evaluated.

‡ The method of assessing quality is evolving, including the application of standardized, widely used, and preferably validated evidence grading tools; and for systematic reviews, the incorporation of an Evidence Review Committee.

COR indicates Class of Recommendation; EO, expert opinion; LD, limited data; LOE, Level of Evidence; NR, nonrandomized; R, randomized; and RCT, randomized controlled trial.

ther amiodarone or lidocaine than in those receiving placebo, and this outcome did not differ between the 2 active drugs.

In a prespecified subgroup analysis of patients with bystander-witnessed out-of-hospital cardiac arrest, a significant survival benefit (a 5% absolute improvement compared with placebo) was observed with either amiodarone or lidocaine. In these patients, time from collapse to drug administration was likely shorter than among patients with an unwitnessed arrest. This underscores the potential importance and effects of early recognition and treatment of out-of-hospital cardiac arrest on outcome. There was no statistically significant difference in survival between the 2 active drugs in this subgroup. Neurological status at discharge was not reported in the subgroup analysis. The captisol-based formulation of amiodarone used in this trial is currently marketed

only as a premixed infusion and is not marketed in the concentrated form that was used for rapid injection in the study.

These randomized trials did not explore the timing or sequence of amiodarone versus epinephrine administration. No randomized trials were identified that address the use of amiodarone during in-hospital cardiac arrest.

Lidocaine

Intravenous lidocaine is an antiarrhythmic drug of long-standing and widespread familiarity. In the large ROC-ALPS out-of-hospital randomized controlled trial comparing captisol-based amiodarone with lidocaine or placebo for patients with VF/pVT cardiac arrest refractory after at least 1 shock, there was no overall statistically significant difference in survival with good neurological outcome or survival to hospital discharge.[11] ROSC was higher in those receiving lidocaine compared with those receiving placebo. Survival to hospital admission was higher in patients receiving either amiodarone or lidocaine than in those receiving placebo, but there was no statistically significant difference between the 2 active drugs. A prespecified subgroup analysis of patients with bystander-witnessed arrest found that survival to hospital discharge was higher in patients receiving either amiodarone or lidocaine than in those receiving placebo. There was no statistically significant difference in patient survival between the 2 active drugs. This randomized trial did not explore the timing or sequence of lidocaine versus epinephrine administration.

No randomized trials were identified that assessed the efficacy of lidocaine for treatment of in-hospital cardiac arrest.

Magnesium

Magnesium acts as a vasodilator and is an important cofactor in regulating sodium, potassium, and calcium flow across cell membranes. In a total of 4 small randomized clinical trials, magnesium administration did not increase ROSC or survival to hospital discharge. Two of the trials compared magnesium with placebo for cardiac arrest with any presenting rhythm,[12,13] and 2 trials compared magnesium with placebo for VF/pVT cardiac arrest.[14,15] Although the 4 trials were underpowered to evaluate long-term outcomes, with a total of only 217 patients randomized to magnesium and 227 randomized to placebo across the 4 studies, the results were consistent in showing no benefit associated with magnesium administration.

Magnesium is commonly used to treat torsades de pointes (ie, polymorphic ventricular tachycardia [VT] associated with long-QT interval), but it actually acts to prevent the reinitiation of torsades rather than to pharmacologically convert polymorphic VT. The use of magnesium for torsades de pointes is supported by only 2 observational studies.[16,17] Magnesium administration was not beneficial in a series of 5 patients with polymorphic VT associated with normal-QT interval.[16] The 2018 ILCOR systematic review identified no published randomized controlled trials of magnesium for torsades de pointes.

2018 Recommendations for Use of Antiarrhythmic Drugs During Resuscitation From Adult VF/pVT Cardiac Arrest

Amiodarone and Lidocaine Recommendation—Updated

1. **Amiodarone or lidocaine may be considered for VF/pVT that is unresponsive to defibrillation. These drugs may be particularly useful for patients with witnessed arrest, for whom time to drug administration may be shorter (*Class IIb; Level of Evidence B-R*).**

Magnesium Recommendation—Updated

1. **The routine use of magnesium for cardiac arrest is not recommended in adult patients (*Class III: No Benefit; Level of Evidence C-LD*). Magnesium may be considered for torsades de pointes (ie, polymorphic VT associated with long-QT interval) (*Class IIb; Level of Evidence C-LD*). The wording of this recommendation is consistent with the AHA's 2010 ACLS guidelines.[7]**

Discussion

The writing group recommends that amiodarone or lidocaine may be considered for VF/pVT that is unresponsive to defibrillation. Although no antiarrhythmic drug has yet been shown to increase long-term survival or to improve neurological outcome after VF/pVT cardiac arrest, the writing group also considered the small increase in the short-term outcome of ROSC in those treated with amiodarone in the 1999 ARREST study[9] and in those treated with lidocaine in the most recent ROC-ALPS trial.[11] In addition, the writing group considered the improved survival to hospital admission in patients receiving either amiodarone or lidocaine (compared with placebo) in the most recent ROC-ALPS trial, as well as the improved survival to hospital discharge among patients with witnessed cardiac arrest who received amiodarone or lidocaine.[11] These considerations contributed to the weak recommendation for consideration of amiodarone or lidocaine in the context of a disease process for which there are limited therapeutic options other than CPR and defibrillation.

Lidocaine is now included with amiodarone in the ACLS algorithm for treatment of shock-refractory VF/pVT

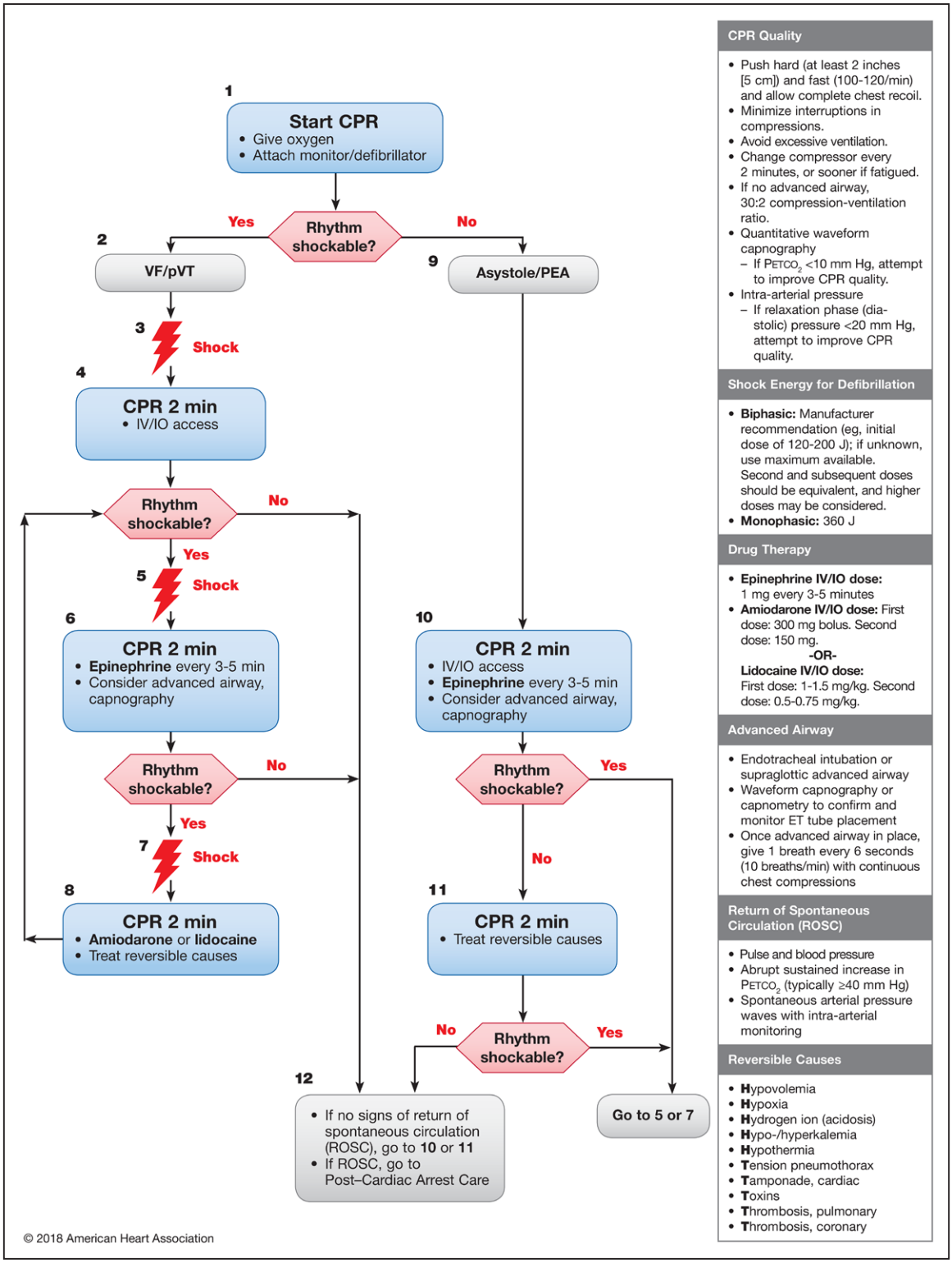

Figure 1. Adult Cardiac Arrest Algorithm—2018 Update.
CPR indicates cardiopulmonary resuscitation; ET, endotracheal; IO, intraosseous; IV, intravenous; PEA, pulseless electrical activity; pVT, pulseless ventricular tachycardia; and VF, ventricular fibrillation.

(Figures 1 and 2). The recommended dose of lidocaine is 1.0 to 1.5 mg/kg IV/IO for the first dose and 0.5 to 0.75 mg/kg IV/IO for a second dose if required. Although the most recent clinical trial of lidocaine used a standardized bolus dose for ease of execution,[11] this 2018 recommended dose is made with a focus on patient safety through weight-based dosing. The recommended dose for amiodarone is unchanged, with randomized tri-

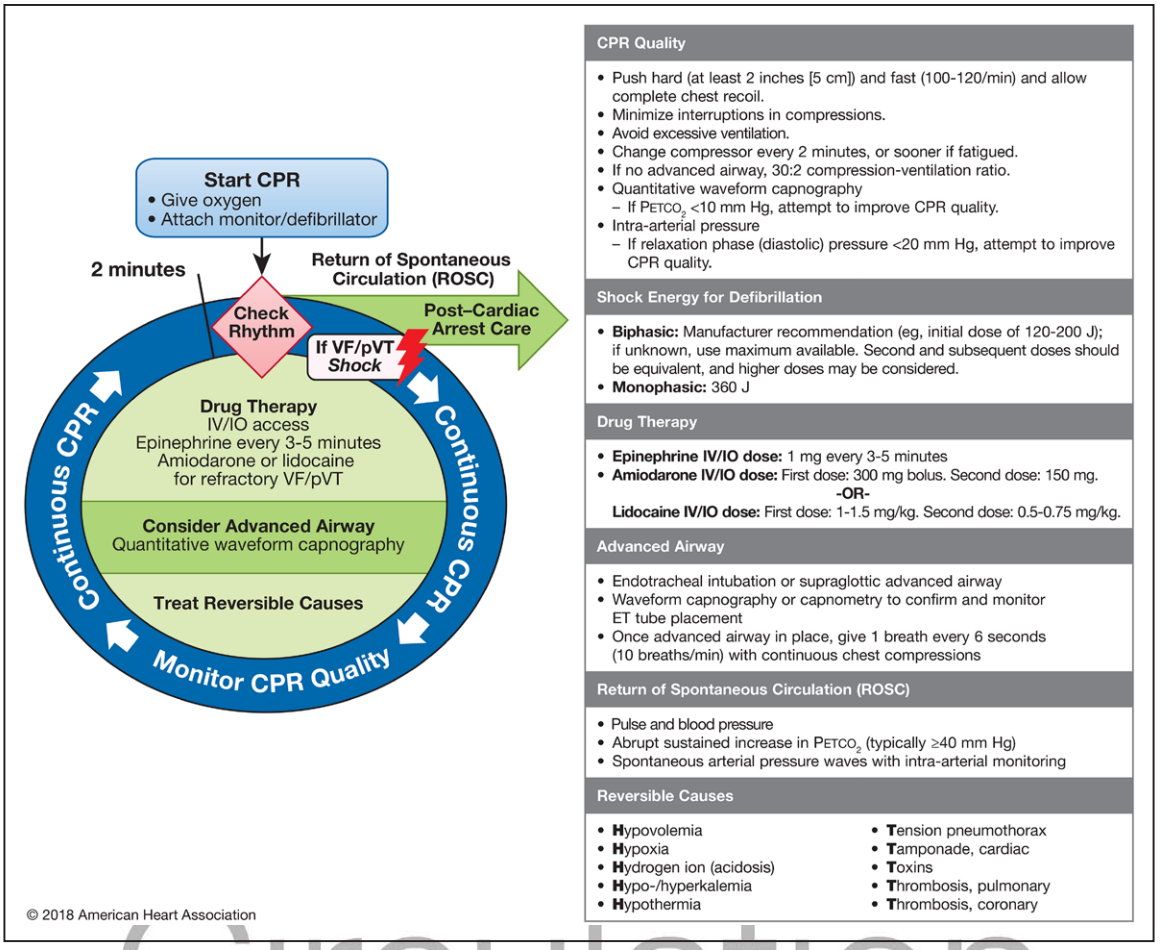

Figure 2. Adult Cardiac Arrest Circular Algorithm—2018 Update.
CPR indicates cardiopulmonary resuscitation; ET, endotracheal; IO, intraosseous; IV, intravenous; pVT, pulseless ventricular tachycardia; and VF, ventricular fibrillation.

als supporting an initial IV/IO dose of 300 mg with a second IV/IO dose of 150 mg if required.[10,11] Both the ROC-ALPS and ALIVE trials permitted dose reductions in lower-weight patients; however, higher cumulative bolus doses of amiodarone have not been studied in cardiac arrest. It is also important to note that the captisol-based formulation of amiodarone is currently marketed only as a premixed infusion, not in concentrated form, making it impractical for rapid administration during cardiac arrest. The polysorbate-based formulation is currently available in concentrated form for rapid administration.

The writing group reaffirms that magnesium should not be used routinely during cardiac arrest management but may be considered for torsades de pointes (ie, polymorphic VT associated with long-QT interval). Unfortunately, these recommendations are based on low-quality evidence, representing a significant knowledge gap concerning the use of magnesium for VF/pVT. Future randomized studies are needed with rigorous evaluation of the impact of magnesium on survival and neurological outcomes to determine the importance of magnesium administration in this condition.

The writing group is aware of increased interest in and early studies of β-adrenergic–blocking drugs used during cardiac arrest.[18,19] The question of the effectiveness of these drugs has been referred to ILCOR for future systematic review.

ANTIARRHYTHMIC DRUGS IMMEDIATELY AFTER ROSC FOLLOWING CARDIAC ARREST

The 2018 ILCOR systematic review sought to determine whether the prophylactic administration of antiarrhythmic drugs after successful termination of VF/pVT cardiac arrest results in better outcome. This prophylaxis includes continuation of an antiarrhythmic medication that was given during the course of resuscitation or the initiation of an antiarrhythmic after ROSC to sustain rhythm stability after VF/pVT cardiac arrest. Although improved survival is the ultimate goal of such treatment, other shorter-term outcomes (even

in the absence of a survival benefit) may still be important. For example, reducing the risk of recurrent arrhythmias with the use of arrhythmia prophylaxis can reduce the risk of recurrent cardiac arrest and its sequelae during transport, which may be particularly important when transport intervals are prolonged. Treatment for this indication is arguably beneficial even if there are as yet no studies showing long-term survival benefit, provided that the intervention itself is not harmful. The only medications studied in this context are β-adrenergic–blocking drugs and lidocaine. Although both drugs have precedent for use during acute myocardial infarction, the evidence for their use in patients immediately after resuscitation from cardiac arrest is limited. The fact that only 2 observational studies addressing this question have been performed to date underscores a sizeable knowledge gap and limits the conclusions that can be drawn from currently available information.

2018 Evidence Summary

β-Adrenergic–Blocking Drugs

β-Adrenergic–blocking drugs blunt the heightened catecholamine activity that can precipitate cardiac arrhythmias. These drugs also reduce ischemic injury and may have membrane-stabilizing effects. Conversely, intravenous β-blockers can cause or worsen hemodynamic instability, exacerbate heart failure, and cause bradyarrhythmias, making their routine administration after cardiac arrest potentially hazardous. There are no new studies that address this topic. In 1 observational study that was evaluated for the ACLS guidelines in the 2015 guidelines update, oral or intravenous metoprolol or bisoprolol administration during hospitalization after VF/pVT cardiac arrest was associated with a significantly higher adjusted survival rate in recipients compared with nonrecipients at 72 hours after ROSC and at 6 months.[20] This study was not considered by ILCOR in the 2018 evidence review because predefined criteria for the evaluation of post-ROSC prophylactic antiarrhythmic drugs included only drug administration within 1 hour (as opposed to within 72 hours) after ROSC. There is no evidence addressing the use of β-blockers after cardiac arrest precipitated by rhythms other than VF/pVT.

Lidocaine

Early studies in patients with acute myocardial infarction found that lidocaine suppressed premature ventricular complexes and nonsustained VT, rhythms that were believed to presage VF/pVT. Later studies noted a disconcerting association between lidocaine and higher mortality after acute myocardial infarction, possibly resulting from a higher incidence of asystole and bradyarrhythmias; thus, the routine practice of administering prophylactic lidocaine during acute myocardial infarction was abandoned.[21,22] One observational study with propensity-matched cohorts[23] found that lidocaine was not associated with increased survival when administered prophylactically after ROSC in adults with VF/pVT cardiac arrest, although it decreased the recurrence of VF/pVT. Thus, evidence supporting a potential role for prophylactic lidocaine after VF/pVT arrest is relatively weak, limited to short-term outcomes, and nonexistent for cardiac arrest presenting with nonshockable rhythms.

2018 Recommendations for Antiarrhythmic Drugs Immediately After ROSC Following Cardiac Arrest

β-Blocker Recommendation—Updated

1. **There is insufficient evidence to support or refute the routine use of a β-blocker early (within the first hour) after ROSC.**

Lidocaine Recommendations—Updated

1. **There is insufficient evidence to support or refute the routine use of lidocaine early (within the first hour) after ROSC.**
2. **In the absence of contraindications, the prophylactic use of lidocaine may be considered in specific circumstances (such as during emergency medical services transport) when treatment of recurrent VF/pVT might prove to be challenging (*Class IIb; Level of Evidence C-LD*).**

Discussion

Evidence supporting the prophylactic use of lidocaine or β-blockers on ROSC after VF/pVT cardiac arrest is insufficient to support or refute their routine use. However, the writing group acknowledges that there are circumstances (eg, during emergency medical services transport of a resuscitated patient after VF/pVT arrest) when recurrence of VF/pVT might prove logistically challenging to treat; in such situations, the use of lidocaine may be considered to prevent recurrence. There is insufficient evidence to recommend for or against the routine initiation or continuation of other antiarrhythmic medications after ROSC following cardiac arrest. For example, no study has considered or evaluated amiodarone for this indication.

SUMMARY

As noted in the ACLS portion of the 2010 guidelines,[7] CPR and defibrillation are the only therapies associated with improved survival in patients with VF/pVT. In this

2018 ACLS guidelines focused update, the updated treatment recommendations include consideration of either amiodarone or lidocaine for shock-refractory VF/pVT, whereas previous guidelines favored amiodarone as the first-line therapy. Because no antiarrhythmic drug has yet been shown to increase long-term survival or survival with good neurological outcome, these treatment recommendations are based primarily on potential benefits in short-term outcomes (such as ROSC or survival to hospital admission) and on a potential survival benefit in patients with witnessed arrest, for whom time to drug administration may be shorter.

Finally, the optimal sequence of ACLS interventions for VF/pVT cardiac arrest, including administration of a vasopressor or antiarrhythmic drug, and the timing of medication administration in relation to shock delivery are not known. The sequence and timing of interventions recommended in the current ACLS Adult Cardiac Arrest Algorithms (Figures 1 and 2) will be affected by the number of providers participating in the resuscitation, their skill levels, and the ability to secure intravenous/intraosseous access in a timely manner.

ARTICLE INFORMATION

The American Heart Association makes every effort to avoid any actual or potential conflicts of interest that may arise as a result of an outside relationship or a personal, professional, or business interest of a member of the writing panel. Specifically, all members of the writing group are required to complete and submit a Disclosure Questionnaire showing all such relationships that might be perceived as real or potential conflicts of interest.

This statement was approved by the American Heart Association Science Advisory and Coordinating Committee on September 5, 2018, and the American Heart Association Executive Committee on September 17, 2018. A copy of the document is available at http://professional.heart.org/statements by using either "Search for Guidelines & Statements" or the "Browse by Topic" area. To purchase additional reprints, call 843-216-2533 or e-mail kelle.ramsay@wolterskluwer.com.

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Disclosures

Writing Group Disclosures

Writing Group Member	Employment	Research Grant	Other Research Support	Speakers' Bureau/ Honoraria	Expert Witness	Ownership Interest	Consultant/ Advisory Board	Other
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José G. Cabañas	Wake County Emergency Medical Services	None	None	None	None	None	None	None
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Marina Del Rios	University of Illinois at Chicago College of Medicine	Medtronic Philanthropy (Heart Rescue Grant)*; NIH (SIREN, site principal investigator)*	None	None	None	None	None	Medtronic Philanthropy (co-investigator, Heart Rescue Grant)*
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Mary Fran Hazinski	Vanderbilt University School of Nursing	None	None	None	None	None	American Heart Association Emergency Cardiovascular Care Programs†	None

(*Continued*)

Writing Group Disclosures Continued

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Peter J. Kudenchuk	University of Washington	NIH/NINDS/NHLBI (PI for ROC and SIREN at University of Washington)†	None	None	None	None	None	None
Michael C. Kurz	University of Alabama at Birmingham	Zoll Medical Corporation (PI for Multicenter International Trial of Predictive Algorithms)†; Society of Critical Care Medicine (grant to examine coagulation after OHCA)†; Emergency Medicine Foundation (grant to examine coagulation after OHCA)†	None	Zoll Medical Corp*	None	Rapid Oxygen Co†	None	None
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Peter T. Morley	University of Melbourne Clinical School, Royal Melbourne Hospital, Australia	None	None	None	None	None	None	None

This table represents the relationships of writing group members that may be perceived as actual or reasonably perceived conflicts of interest as reported on the Disclosure Questionnaire, which all members of the writing group are required to complete and submit. A relationship is considered to be "significant" if (a) the person receives $10 000 or more during any 12-month period, or 5% or more of the person's gross income; or (b) the person owns 5% or more of the voting stock or share of the entity, or owns $10 000 or more of the fair market value of the entity. A relationship is considered to be "modest" if it is less than "significant" under the preceding definition.

*Modest.

†Significant.

Reviewer Disclosures

Reviewer	Employment	Research Grant	Other Research Support	Speakers' Bureau/ Honoraria	Expert Witness	Ownership Interest	Consultant/ Advisory Board	Other
Peng-Sheng Chen	Indiana University	None	None	None	None	None	None	None
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Paul Dorian	St. Michael's Hospital, Canada	None	None	None	None	None	None	None
Saman Nazarian	University of Pennsylvania	Biosense Webster (research grant for ablation lesion imaging)†; Siemens (research grant for real-time MRI guidance)†; ImriCor (research grant for real-time MRI guidance)†	NIH/NHLBI (imaging use for VT ablation)†	None	None	None	Biosense Webster*; CardioSolv*	None
Albert L. Waldo	University Hospitals Cleveland Medical Center	None	None	None	None	None	None	None

This table represents the relationships of reviewers that may be perceived as actual or reasonably perceived conflicts of interest as reported on the Disclosure Questionnaire, which all reviewers are required to complete and submit. A relationship is considered to be "significant" if (a) the person receives $10 000 or more during any 12-month period, or 5% or more of the person's gross income; or (b) the person owns 5% or more of the voting stock or share of the entity, or owns $10 000 or more of the fair market value of the entity. A relationship is considered to be "modest" if it is less than "significant" under the preceding definition.

*Modest.

†Significant.

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