HIGHLIGHTS

of the 2018 Focused Updates to the American Heart Association Guidelines for CPR and ECC: Advanced Cardiovascular Life Support and Pediatric Advanced Life Support - Heart and Stroke Foundation of Canada Edition

The American Heart Association and the Heart & Stroke Foundation of Canada thanks the following people for their contributions to the development of this publication:
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In 2015, the International Liaison Committee on Resuscitation (ILCOR) began a continuous evidence evaluation (CEE) process. This process is designed to enable rapid analysis of peer-reviewed published resuscitation studies and development of International Consensus on Cardiopulmonary Resuscitation (CPR) and Emergency Cardiovascular Care (ECC) Science With Treatment Recommendations (CoSTR) statements. The goal of continuous evidence evaluation is to shorten the interval between publication of resuscitation evidence and translation into guidelines recommendations by ILCOR member councils, such as the American Heart Association (AHA) and Heart & Stroke Foundation of Canada (Heart & Stroke). On the basis of these annual ILCOR CoSTR summary statements, the AHA ECC Committees will publish annual guidelines focused updates on CPR and ECC. They will be republished by Heart and Stroke Foundation of Canada with permission from the American Heart Association. These Highlights summarize the changes included in the 2018 AHA Guidelines Focused Updates published by the advanced cardiovascular life support (ACLS) and pediatric advanced life support (PALS) writing groups.

The ILCOR systematic reviews are performed to answer specific resuscitation questions prioritized by the expert members of the ILCOR task forces. The question prioritized for review this year addressed the use of antiarrhythmic drugs for the treatment of shock-refractory ventricular fibrillation (VF) or pulseless ventricular tachycardia (pVT) during or immediately after cardiac arrest. The ILCOR Advanced Life Support and the Pediatric Task Forces then analyzed, discussed, and debated the studies identified and analyzed by the systematic reviewers. These task forces developed draft CoSTR statements that were posted online for public comment on the ILCOR website (www.ilcor.org), and the final joint ILCOR CoSTR summary was published simultaneously in *Circulation* and *Resuscitation*.

The AHA ACLS and PALS writing groups considered the ILCOR consensus recommendations very carefully to determine the appropriate recommendations in light of the structure and resources of the out-of-hospital and in-hospital resuscitation systems as well as the resources and training of lay rescuers and healthcare providers who use AHA and Heart & Stroke guidelines. Each AHA ECC clinical strategy, intervention, treatment, or testing recommendation was linked with a class of recommendation (Class) and a level of evidence (LOE), using the most recent language approved by the AHA and the American College of Cardiology. The criteria and language are depicted in Figure 1.

AHA and Classification System for Recommendations and Level of Evidence*

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 RCTs
- 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 (CORI 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.

Figure 1. Criteria and language for class of recommendation and level of evidence.

The following question was asked of the systematic reviewers:

In adults and children in any setting (in-hospital or out-of-hospital) with cardiac arrest and a shockable rhythm (VF/pVT) at any time during CPR or immediately after return of spontaneous circulation (ROSC), is there evidence that administering (intravenous or intraosseous) an antiarrhythmic drug during CPR or immediately (within 1 hour) after ROSC compared with administering any other antiarrhythmic drug or placebo or no drug during CPR or immediately (within 1 hour) after ROSC affects outcomes? These outcomes include survival to hospital discharge with good neurologic outcome and survival to hospital discharge; ROSC was rated as an important outcome. For antiarrhythmic drug use within 1 hour after ROSC, rearrest was also evaluated as an important outcome. The literature search included in this systematic review was updated to include all publications identified through August 15, 2017.

It is important for clinicians to note that this review did not examine the optimal sequence of advanced life support interventions for VF/pVT cardiac arrest, such as ideal timing of administering a vasopressor or antiarrhythmic or the timing of medication administration in relation to CPR or shock delivery. The optimal sequence is not known. In addition, the timing of recommended ACLS and PALS interventions should consider the individual patient and the environment of care.

The following content summarizes the updated recommendations and algorithms contained in the 2018 AHA Guidelines Focused Updates and republished by the Heart and Stroke Foundation of Canada on ACLS and PALS.

Advanced Cardiovascular Life Support

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

Amiodarone and Lidocaine Recommendation

2018 (Updated): 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, LOE B-R).

2015 (Old): Amiodarone may be considered for VF/pVT that is unresponsive to CPR, defibrillation, and a vasopressor therapy (Class IIb, LOE B-R).

Lidocaine may be considered as an alternative to amiodarone for VF/pVT that is unresponsive to CPR, defibrillation, and vasopressor therapy (Class IIb, LOE C-LD).

Why: The 2018 CoSTR summary and systematic review considered the use of amiodarone or lidocaine during VF/pVT cardiac arrest refractory after at least 1 shock. The writing group evaluated a new large, out-of-hospital randomized controlled trial that compared a Captisol-based formulation of amiodarone with lidocaine or placebo for patients with refractory VF/pVT. Although the available studies did not demonstrate an improvement in survival to hospital discharge (or neurologically intact survival to discharge) associated with either drug, ROSC was higher in patients receiving lidocaine compared with placebo, and survival to hospital admission was higher with either drug compared with placebo. As a result, lidocaine is now recommended as an alternative to amiodarone and has now been added to the ACLS Cardiac Arrest Algorithm for treatment of shock-refractory VF/pVT (see the Figure 2 and ACLS Cardiac Arrest Algorithm Update section).

Magnesium Recommendations

2018 (Updated): The routine use of magnesium for cardiac arrest is not recommended in adult patients (Class III: No Benefit, LOE C-LD).

Magnesium may be considered for torsades de pointes (ie, polymorphic VT associated with long QT interval) (Class IIb, LOE C-LD). The wording of this recommendation is consistent with the AHA's 2010 ACLS guidelines.

2015 (Old): The routine use of magnesium for VF/pVT is not recommended in adult patients (Class III: No Benefit, LOE B-R).

2010 (Old): When VF/pVT cardiac arrest is associated with torsades de pointes, providers may administer IV/IO bolus of magnesium sulfate at a dose of 1 to 2 g diluted in 10 mL D5W (Class IIb, LOE C).

Why: The 2018 CoSTR summary and systematic review considered the use of magnesium during resuscitation from cardiac arrest. No new studies were reviewed for this topic, and only a handful of small, nonrandomized studies have been identified in past reviews. The current recommendation reaffirms that magnesium should not be routinely used for cardiac arrest and notes that it may be considered for the treatment of torsades de pointes (ie, polymorphic VT associated with long QT interval).

Antiarrhythmic Drugs Immediately After ROSC Following Adult Cardiac Arrest

β-Blocker Recommendation

2018 (Updated): There is insufficient evidence to support or refute the routine use of a β-blocker early (within the first hour) after ROSC.

2015 (Old): There is inadequate evidence to support the routine use of a β-blocker after cardiac arrest. However, the initiation or continuation of an oral or intravenous β-blocker may be considered early after hospitalization from cardiac arrest due to VF/pVT (Class IIb, LOE C-LD).

Why: The 2018 CoSTR summary and systematic review considered the use of prophylactic antiarrhythmic drugs immediately (within the first hour) after ROSC. Although no new studies were reviewed for this topic, detailed evaluation of the literature led to the simplification of the recommendation. There is no Class or LOE listed because the writing group agreed that there was insufficient evidence to make any recommendation.

Lidocaine Recommendations

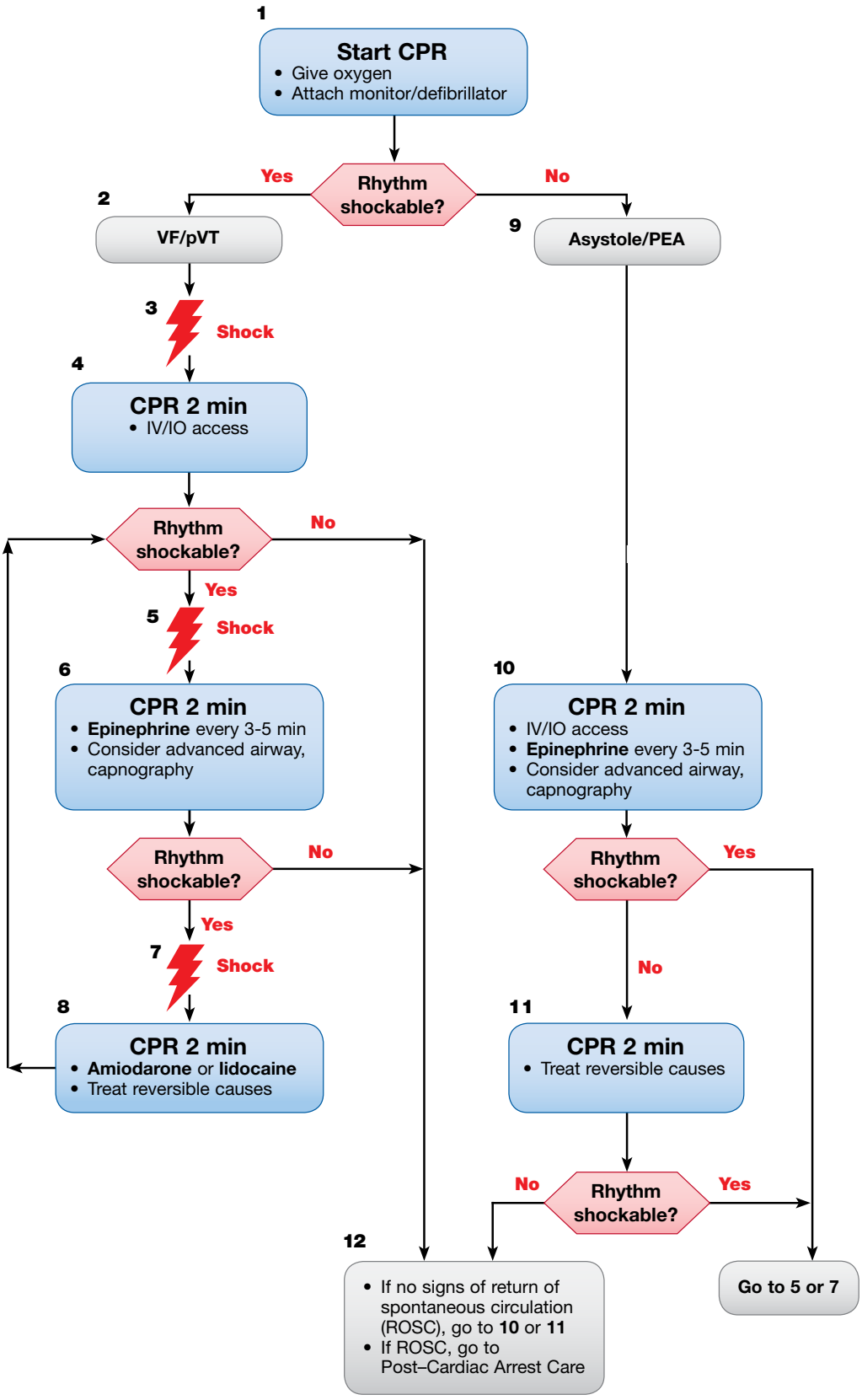
2018 (Updated): There is insufficient evidence to support or refute the routine use of lidocaine early (within the first hour) after ROSC.

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, LOE C-LD).

2015 (Old): There is inadequate evidence to support the routine use of lidocaine after cardiac arrest. However, the initiation or continuation of lidocaine may be considered immediately after ROSC from cardiac arrest due to VF/pVT (Class IIb, LOE C-LD).

Why: The 2018 CoSTR summary and systematic review considered the use of prophylactic antiarrhythmic drugs immediately (within the first hour) after ROSC. Although no new studies were reviewed for this topic, the writing group acknowledged that while there is insufficient evidence to support the routine use of lidocaine, there are situations for which recurrence of VF/pVT would be logistically challenging to manage (eg, during emergency medical services transport); in such situations, lidocaine administration may be considered.

Adult Cardiac Arrest Algorithm—2018 Update



CPR Quality

- Push hard (at least 5 cm [2 inches]) and fast (100-120/min) and allow complete chest recoil.
- Minimize interruptions in compressions.
- Avoid excessive ventilation.
- Change compressor every 2 minutes, or sooner if fatigued.
- If no advanced airway, 30:2 compression-ventilation ratio.
- Quantitative waveform capnography
  - If P_{ETCO_2} <10 mm Hg, attempt to improve CPR quality.
- Intra-arterial pressure
  - If relaxation phase (diastolic) pressure <20 mm Hg, attempt to improve CPR quality.

Shock Energy for Defibrillation

- **Biphasic:** Manufacturer recommendation (eg, initial dose of 120-200 J); if unknown, use maximum available. Second and subsequent doses should be equivalent, and higher doses may be considered.
- **Monophasic:** 360 J

Drug Therapy

- **Epinephrine IV/IO dose:** 1 mg every 3-5 minutes
- **Amiodarone IV/IO dose:** First dose: 300 mg bolus. Second dose: 150 mg.

-OR-

Lidocaine IV/IO dose: First dose: 1-1.5 mg/kg. Second dose: 0.5-0.75 mg/kg.

Advanced Airway

- Endotracheal intubation or supraglottic advanced airway
- Waveform capnography or capnometry to confirm and monitor ET tube placement
- Once advanced airway in place, give 1 breath every 6 seconds (10 breaths/min) with continuous chest compressions

Return of Spontaneous Circulation (ROSC)

- Pulse and blood pressure
- Abrupt sustained increase in P_{ETCO_2} (typically ≥40 mm Hg)
- Spontaneous arterial pressure waves with intra-arterial monitoring

Reversible Causes

- **H**ypovolemia
- **H**ypoxia
- **H**ydrogen ion (acidosis)
- **H**ypo-/hyperkalemia
- **H**ypothermia
- **T**ension pneumothorax
- **T**amponade, cardiac
- **T**oxins
- **T**hrombosis, pulmonary
- **T**hrombosis, coronary

Figure 2. Adult Cardiac Arrest Algorithm.

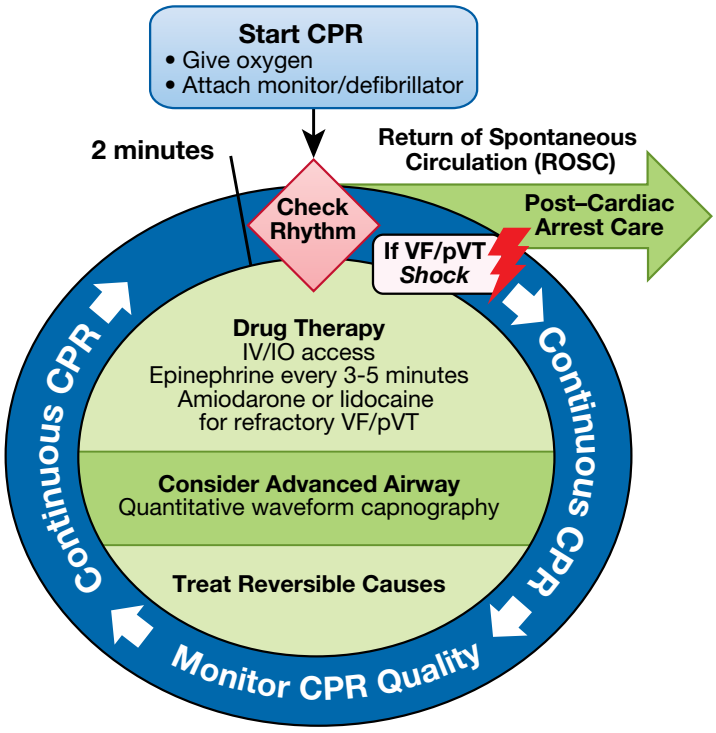
ACLS Cardiac Arrest Algorithm Update

The ACLS Adult Cardiac Arrest Algorithm and the ACLS Adult Cardiac Arrest Circular Algorithm were updated to include lidocaine as an alternative antiarrhythmic to amiodarone for treatment of shock-refractory VF/pVT. The lidocaine dose was added within the algorithm's Drug Therapy box, and a minor edit was made in the CPR Quality box as detailed in the next sections.

Changes to the Adult Cardiac Arrest Algorithm—2018 Update. Within the VF/pVT branch of the algorithm, lidocaine was added as an alternative to amiodarone in Box 8. In the algorithm's CPR Quality box, the fourth bullet text was changed from "Rotate compressor every 2 minutes, or sooner if fatigued" to "Change compressor every 2 minutes, or sooner if fatigued." Within the algorithm's Drug Therapy box, the lidocaine dose was added as an alternative to amiodarone in the second bullet text.

Changes to the Adult Cardiac Arrest Circular Algorithm—2018 Update (Figure 3). Within the circle, under "Drug Therapy," the last drug was changed from "Amiodarone for refractory VF/VT" to "Amiodarone or lidocaine for refractory VF/pVT." Within the algorithm's CPR Quality box, the fourth bullet text was changed from "Rotate compressor every 2 minutes, or sooner if fatigued" to "Change compressor every 2 minutes, or sooner if fatigued." Within the algorithm's Drug Therapy box, the lidocaine dose was added as an alternative to amiodarone in the second bullet text.

Adult Cardiac Arrest Circular Algorithm—2018 Update



CPR Quality

- Push hard (at least 5 cm [2 inches]) and fast (100-120/min) and allow complete chest recoil.
- Minimize interruptions in compressions.
- Avoid excessive ventilation.
- Change compressor every 2 minutes, or sooner if fatigued.
- If no advanced airway, 30:2 compression-ventilation ratio.
- Quantitative waveform capnography
  - If P_{ETCO_2} <10 mm Hg, attempt to improve CPR quality.
- Intra-arterial pressure
  - If relaxation phase (diastolic) pressure <20 mm Hg, attempt to improve CPR quality.

Shock Energy for Defibrillation

- **Biphasic:** Manufacturer recommendation (eg, initial dose of 120-200 J); if unknown, use maximum available. Second and subsequent doses should be equivalent, and higher doses may be considered.
- **Monophasic:** 360 J

Drug Therapy

- **Epinephrine IV/IO dose:** 1 mg every 3-5 minutes
- **Amiodarone IV/IO dose:** First dose: 300 mg bolus. Second dose: 150 mg.

-OR-

Lidocaine IV/IO dose: First dose: 1-1.5 mg/kg. Second dose: 0.5-0.75 mg/kg.

Advanced Airway

- Endotracheal intubation or supraglottic advanced airway
- Waveform capnography or capnometry to confirm and monitor ET tube placement
- Once advanced airway in place, give 1 breath every 6 seconds (10 breaths/min) with continuous chest compressions

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- Pulse and blood pressure
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Reversible Causes

- **H**ypovolemia
- **H**ypoxia
- **H**ydrogen ion (acidosis)
- **H**ypo-/hyperkalemia
- **H**ypothermia
- **T**ension pneumothorax
- **T**amponade, cardiac
- **T**oxins
- **T**hrombosis, pulmonary
- **T**hrombosis, coronary

Figure 3. Adult Cardiac Arrest Circular Algorithm.

The goal of continuous evidence evaluation is to shorten the interval between publication of resuscitation evidence and translation into guidelines recommendations by ILCOR member councils, such as the AHA and Heart & Stroke.

Pediatric Advanced Life Support

Use of Antiarrhythmic Drugs During Resuscitation From Pediatric VF/pVT Cardiac Arrest

Amiodarone and Lidocaine Recommendation

2018 (Unchanged): For shock-refractory VF/pVT, either amiodarone or lidocaine may be used (Class IIb, LOE C-LD).

2015 (Old): For shock-refractory VF/pVT, either amiodarone or lidocaine may be used (Class IIb, LOE C-LD).

Why: The 2018 CoSTR Summary and systematic review considered the use of antiarrhythmic drugs for shock-refractory VF/pVT. Unlike in previous reviews, only pediatric-specific studies were considered in 2018. There were no studies identified to address the use of antiarrhythmic drugs after resuscitation from cardiac arrest. Only one registry study of antiarrhythmic drug administration during resuscitation was identified. This study compared outcomes associated with the use of amiodarone or lidocaine for in-hospital resuscitation from cardiac arrest; it found no significant difference in survival to hospital discharge in patients who received amiodarone vs lidocaine.

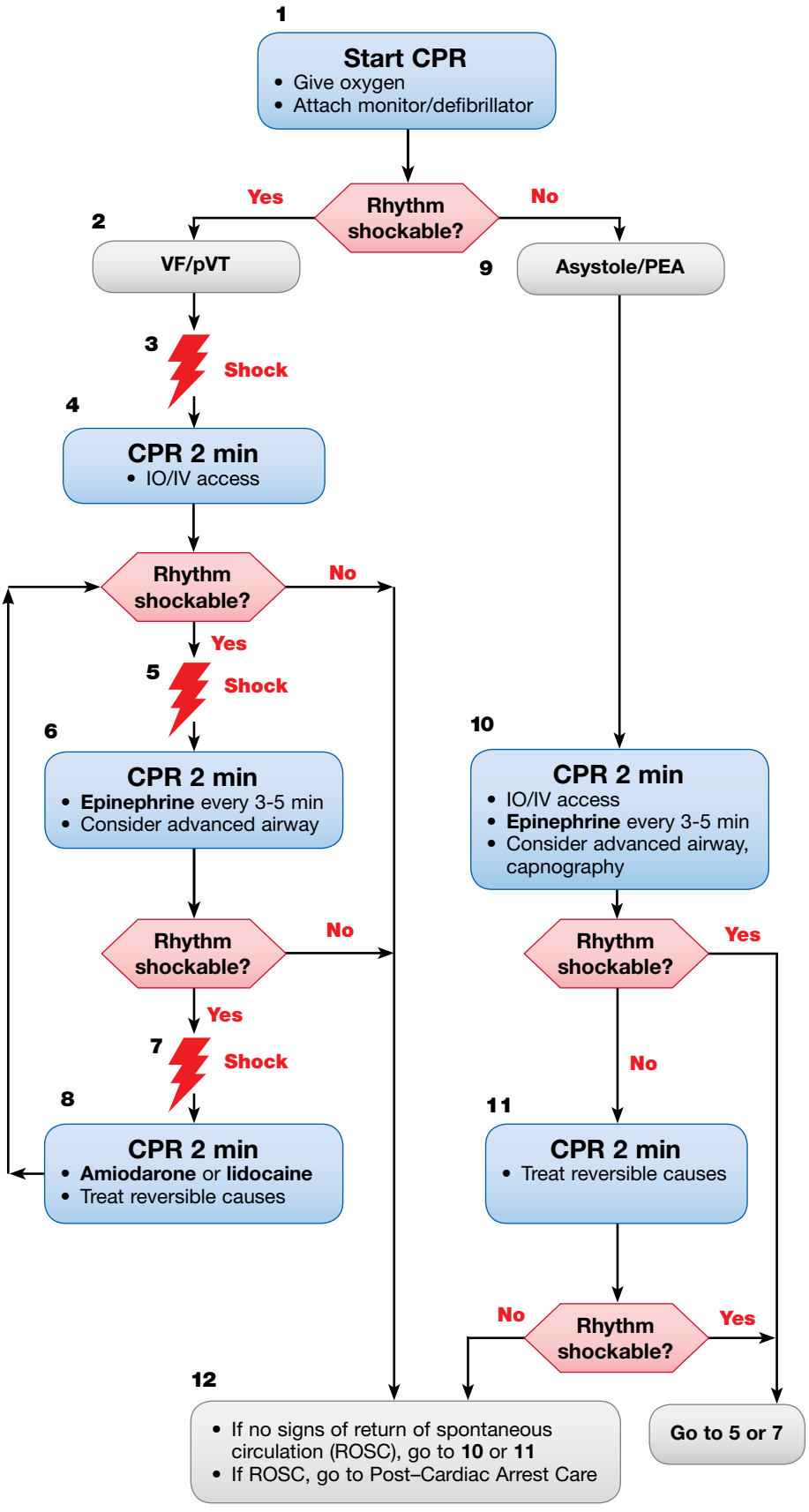
PALS Cardiac Arrest Algorithm Update

The PALS Pediatric Cardiac Arrest Algorithm is unchanged in the depiction of sequences and therapies from the version of the algorithm updated in 2015. The minor edits made are detailed below.

Changes to the Pediatric Cardiac Arrest Algorithm—2018 Update (Figure 4): The only changes within the algorithm itself were minor edits to eliminate wording differences between this algorithm and the ACLS Adult Cardiac Arrest Algorithm. Within the Asystole/PEA branch of the algorithm, in Box 10, the third bullet text was changed from "Consider advanced airway" to "Consider advanced airway, capnography." In Box 12, the first bullet text was changed from "Asystole/PEA → 10 or 11" to "If no signs of return of spontaneous circulation (ROSC), go to 10 or 11." The second and third bullets, "Organized rhythm → check pulse" and "Pulse present (ROSC) → post-cardiac arrest care," were combined into a single bullet reading, "If ROSC, go to Post–Cardiac Arrest Care."

Within the algorithm's CPR Quality box, the fourth bullet text was changed from "Rotate compressor every 2 minutes, or sooner if fatigued" to "Change compressor every 2 minutes, or sooner if fatigued." Within the algorithm's Drug Therapy box, the word *OR* was added between the amiodarone and lidocaine doses, and the 2 bullets were combined to emphasize that either one drug or the other may be used.

Pediatric Cardiac Arrest Algorithm—2018 Update



CPR Quality

- Push hard (≥⅓ of anteroposterior diameter of chest) and fast (100-120/min) and allow complete chest recoil.
- Minimize interruptions in compressions.
- Avoid excessive ventilation.
- Change compressor every 2 minutes, or sooner if fatigued.
- If no advanced airway, 15:2 compression-ventilation ratio.

Shock Energy for Defibrillation

First shock 2 J/kg, second shock 4 J/kg, subsequent shocks ≥4 J/kg, maximum 10 J/kg or adult dose

Drug Therapy

- **Epinephrine IO/IV dose:** 0.01 mg/kg (0.1 mL/kg of the 0.1 mg/mL concentration). Repeat every 3-5 minutes. If no IO/IV access, may give endotracheal dose: 0.1 mg/kg (0.1 mL/kg of the 1 mg/mL concentration).
- **Amiodarone IO/IV dose:** 5 mg/kg bolus during cardiac arrest. May repeat up to 2 times for refractory VF/pulseless VT.

-OR-

Lidocaine IO/IV dose: Initial: 1 mg/kg loading dose. Maintenance: 20-50 mcg/kg per minute infusion (repeat bolus dose if infusion initiated >15 minutes after initial bolus therapy).

Advanced Airway

- Endotracheal intubation or supraglottic advanced airway
- Waveform capnography or capnometry to confirm and monitor ET tube placement
- Once advanced airway in place, give 1 breath every 6 seconds (10 breaths/min) with continuous chest compressions

Return of Spontaneous Circulation (ROSC)

- Pulse and blood pressure
- Spontaneous arterial pressure waves with intra-arterial monitoring

Reversible Causes

- **H**ypovolemia
- **H**ypoxia
- **H**ydrogen ion (acidosis)
- **H**ypoglycemia
- **H**ypo-/hyperkalemia
- **H**ypothermia
- **T**ension pneumothorax
- **T**amponade, cardiac
- **T**oxins
- **T**hrombosis, pulmonary
- **T**hrombosis, coronary

Figure 4. Pediatric Cardiac Arrest Algorithm.

Recommended Reading

Duff JP, Topjian A, Berg MD, et al. 2018 American Heart Association focused update on pediatric advanced life support: an update to the American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care

[published online November 5, 2018]. Circulation. doi: 10.1161/CIR.0000000000000612

International Liaison Committee on Resuscitation website. www.ilcor.org. Accessed July 30, 2018.

Kudenchuk PJ, Brown SP, Daya M, et al; for the Resuscitation Outcomes Consortium Investigators. Amiodarone, lidocaine, or placebo in out-of-hospital cardiac arrest. N Engl J Med. 2016;374:1711-1722.

Panchal AR, Berg KM, Kudenchuk PJ, et al. 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 [published online November 5, 2018]. Circulation. doi: 10.1161/CIR.0000000000000613

Soar J, Donnino MW, Aickin R, et al. 2018 international consensus on cardiopulmonary resuscitation and emergency cardiovascular care science with treatment recommendations summary [published online November 5, 2018]. Circulation. doi: 10.1161/CIR.0000000000000611

Valdes SO, Donoghue AJ, Hoyme DB, et al; for the American Heart Association Get With The Guidelines–Resuscitation Investigators. Outcomes associated with amiodarone and lidocaine in the treatment of in-hospital pediatric cardiac arrest with pulseless ventricular tachycardia or ventricular fibrillation. Resuscitation. 2014;85:381-386.

TM/MC