HIGHLIGHTS

of the **2019 Focused Updates** to the American Heart Association **Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care**

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These Highlights summarize the key issues addressed in the 2019 focused updates to the American Heart Association (AHA) Guidelines for Cardiopulmonary Resuscitation (CPR) and Emergency Cardiovascular Care (ECC). They have been developed for resuscitation providers and for AHA instructors to focus on evidence reviewed and guidelines recommendations that are based on the most recent evidence evaluations sponsored by the International Liaison Committee on Resuscitation (ILCOR). In addition, they provide the rationale for the recommendations.

Process Overview for Developing Guidelines Focused Updates

The 2019 focused updates to the AHA Guidelines for CPR and ECC are based on ILCOR's international continuous evidence evaluation process, which involves hundreds of international resuscitation scientists and experts who evaluate, discuss, and debate thousands of peer-reviewed publications. In this process, ILCOR task forces prioritize topics for review with input from resuscitation councils, including the AHA. Once a topic is approved for evaluation, a systematic review is commissioned and performed by a knowledge synthesis unit or a systematic reviewer, with input from ILCOR content experts. After the systematic review is complete, the ILCOR task forces review the evidence and develop a draft Consensus on Science With Treatment Recommendations (CoSTR) that is posted online for public comment (see the ILCOR website for all draft CoSTRs). Between November 12, 2018, and March 20, 2019, 6 ILCOR task forces posted draft CoSTRs on the following 12 topics:

Basic Life Support Task Force

Emergency Care: Dispatcher Instruction in CPR
https://costr.ilcor.org/document/emergency-care-dispatcher-instruction-in-cpr

Advanced Life Support Task Force

Advanced Airway Management During Adult Cardiac Arrest
https://costr.ilcor.org/document/advanced-airway-management-during-adult-cardiac-arrest

Vasopressors in Adult Cardiac Arrest
https://costr.ilcor.org/document/vasopressors-in-adult-cardiac-arrest

Extracorporeal Cardiopulmonary Resuscitation for Cardiac Arrest—Adults
https://costr.ilcor.org/document/extracorporeal-cardiopulmonary-resuscitation-ecpr-for-cardiac-arrest-adults

Pediatric Task Force

Dispatcher Instruction in CPR—Pediatrics
https://costr.ilcor.org/document/dispatcher-instruction-in-cpr-pediatrics

Advanced Airway Interventions in Pediatric Cardiac Arrest
https://costr.ilcor.org/document/advanced-airway-interventions-in-pediatric-cardiac-arrest

Extracorporeal Cardiopulmonary Resuscitation for Cardiac Arrest—Pediatrics
https://costr.ilcor.org/document/extracorporeal-cardiopulmonary-resuscitation-ecpr-for-cardiac-arrest-pediatrics

Pediatric Targeted Temperature Management Post–Cardiac Arrest
https://costr.ilcor.org/document/pediatric-targeted-temperature-management-post-cardiac-arrest

Neonatal Life Support Task Force

Initial Oxygen Concentration for Preterm Neonatal Resuscitation
https://costr.ilcor.org/document/initial-oxygen-concentration-for-preterm-neonatal-resuscitation

Initial Oxygen Concentration for Term Neonatal Resuscitation
https://costr.ilcor.org/document/initial-oxygen-concentration-for-term-neonatal-resuscitation

Education, Implementation, and Teams and Basic Life Support Task Forces

Cardiac Arrest Centers vs Noncardiac Arrest Centers—Adults
https://costr.ilcor.org/document/cardiac-arrest-centers-versus-non-cardiac-arrest-centers-adults

First Aid Task Force

First Aid Interventions for Presyncope
https://costr.ilcor.org/document/first-aid-interventions-for-presyncope

Public feedback, including hundreds of comments from more than 23 000 views of the draft CoSTRs, contributed to the development of the final CoSTRs that the ILCOR task forces included in the 2019 International Consensus on CPR and ECC Science With Treatment Recommendations summary. This summary was published simultaneously in *Circulation* and *Resuscitation* (refer to the Recommended Reading list at the end of these Highlights).

The AHA guidelines writing groups reviewed all of the evidence identified by the ILCOR systematic reviews and carefully considered the ILCOR CoSTRs when they created the 2019 focused updates, published in *Circulation* in November 2019. The summary of the sequence of production and unique content for each ILCOR and AHA document is illustrated in Figure 1.

Figure 1. Sequence and process for the development of the focused updates to the AHA Guidelines for CPR and ECC with the use of the ILCOR systematic review and ILCOR task force CoSTR.

Knowledge synthesis unit or systematic reviewer (with participation of ILCOR content experts) completes a **systematic review** and develops the manuscript for journal publication. This review includes

- **GRADE bias assessment tables and terminology**
- **Forest plots**
- **No treatment recommendations**

↓

ILCOR task forces discuss and debate the evidence and develop an **online draft CoSTR** for posting on the ILCOR website, containing

- **No GRADE tables or forest plots (reference the systematic review)**
- **Sections**
  - Introduction that includes a brief description of the evidence evaluation process
  - Population, Intervention, Comparator, Outcome, Study Designs, and Time Frame
  - Consensus on science with treatment recommendations
  - GRADE wording used for certainty of evidence for interventions and for strength (strong vs weak) of recommendation
  - Values and preferences
  - Evidence-to-decision tables
  - Knowledge gaps

↓

ILCOR task force writing groups develop a **CoSTR summary** for journal publication simultaneously in *Circulation* and *Resuscitation*. The final wording is approved by all ILCOR member resuscitation councils. This document contains

- **No GRADE tables, no forest plots, and no evidence-to-decision tables**
- **Final wording of consensus on science**
- **Final treatment recommendations**
- **More detail about task force insights on values and preferences**

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Resuscitation councils such as the AHA develop council-specific **guidelines** and any necessary training materials consistent with the ILCOR CoSTR but appropriate to council resources, training, and structure of the healthcare system.

Abbreviations: AHA, American Heart Association; CoSTR, Consensus on Science With Treatment Recommendations; GRADE, Grading of Recommendations, Assessment, Development, and Evaluation; ILCOR, International Liaison Committee on Resuscitation.

These AHA focused updates serve to update specific parts of the 2010 Guidelines, the 2015 Guidelines Update, and the 2017 and 2018 focused updates. An integrated version of the guidelines is available online, and a complete update of the AHA Guidelines for CPR and ECC is planned for 2020.

As in previous years, the 2019 focused updates use the AHA/American College of Cardiology recommendation system and taxonomy for class of recommendation and level of evidence (Table 1). Because these Highlights are designed as a summary, they do not cite the supporting published studies and do not list the associated classes of recommendation or levels of evidence. Readers are strongly encouraged to visit the CPR and ECC guidelines website to read the 2019 focused updates and to visit the ILCOR CoSTR website for further details.

Table 1. 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 1 (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 2a (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 2b (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 3: 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 3: 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 1 and 2a; 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.

Highlights of the 2019 Focused Updates to the AHA Guidelines for CPR and ECC

The 2019 focused updates to the AHA Guidelines for CPR and ECC include revisions to the following parts of the 2015 Guidelines Update:

Part 4: Systems of Care and Continuous Quality Improvement: dispatcher-assisted CPR (DA-CPR) for adults and the potential role of cardiac arrest centers (CACs)

Part 7: Adult Advanced Cardiovascular Life Support: use of advanced airways, vasopressors, and extracorporeal CPR (ECPR) during resuscitation. Note that the ECPR content also serves to update a section with the same name in Part 6: Alternative Techniques and Ancillary Devices for Cardiopulmonary Resuscitation.

Part 11: Pediatric Basic Life Support and Cardiopulmonary Resuscitation Quality: DA-CPR in infants and children

Part 12: Pediatric Advanced Life Support: use of advanced airway interventions in pediatric cardiac arrest, ECPR for in-hospital cardiac arrest (IHCA), and post–cardiac arrest targeted temperature management (TTM)

Part 13: Neonatal Resuscitation: initial oxygen concentration for term and late-preterm newborns (35 weeks of gestation or more) and initial oxygen concentration for preterm newborns (less than 35 weeks of gestation)

The 2019 American Heart Association and American Red Cross focused update to the first aid guidelines includes a new set of interventions for the following:

Part 15: First Aid: 2015 American Heart Association and American Red Cross Guidelines Update for First Aid: presyncope

Part 4: Systems of Care and Continuous Quality Improvement

The AHA Adult writing group reviewed evidence and recommendations for the following topics in 2019:

Dispatcher-assisted CPR: DA-CPR has been integrated into many emergency medical services (EMS) systems of care across the nation and is viewed as an important link between the community of bystanders and EMS care. In this update, the writing group addressed the question of whether the provision of DA-CPR is associated with improved outcomes from adult out-of-hospital cardiac arrest (OHCA).

Cardiac arrest centers: CACs are specialized centers that provide contemporary and comprehensive evidence-based resuscitation and post–cardiac arrest care. This review addressed whether transport of patients with OHCA to a specialized CAC, compared with treatment at an undesignated center, improves patient outcomes.

Dispatcher-Assisted CPR

There are a variety of terms to describe the process that a dispatcher uses to provide real-time CPR instructions to bystanders who are at the scene of an OHCA. For consistency, in this review, the term *dispatcher-assisted CPR* is used to describe such coaching. However, other terms, such as *telecommunicator CPR* and *telephone CPR*, could be substituted.

The provision of DA-CPR is thought to increase the rates of bystander CPR for victims of OHCA and thereby improve outcomes. Since 2015, a number of published studies have evaluated the use of DA-CPR for adult OHCA. This review examined the effectiveness of DA-CPR through multiple perspectives and assessed its association with outcomes from OHCA.

2019 (Updated): We recommend that emergency dispatch centers offer CPR instructions and empower dispatchers to provide such instructions for adult patients in cardiac arrest.

2019 (Updated): Dispatchers should instruct callers to initiate CPR for adults with suspected out-of-hospital cardiac arrest.

2017 (Old): We recommend that when dispatchers' instructions are needed, dispatchers should provide chest compression–only CPR instructions to callers for adults with suspected OHCA.

2015 (Old): Dispatchers should instruct callers to perform CPR in cases of suspected cardiac arrest. Dispatchers should provide chest compression–only CPR instructions to callers for adults with suspected OHCA.

Why: Although clear outcome benefits from DA-CPR were not demonstrated in all reviewed studies, this change in the AHA guidelines reflects the preponderance of the existing evidence, involving tens of thousands of patients from a number of countries. These outcomes indicated an association between DA-CPR and improved clinical outcomes after OHCA. Furthermore, the association of DA-CPR with a more than 5-fold likelihood of bystander CPR led to the conclusion that the overall benefit from DA-CPR merits a strong endorsement.

This review did not evaluate the effects of the type of CPR instruction given by the dispatchers. As a result, the 2015 recommendation for dispatchers to provide chest compression–only CPR instructions to callers for adults with suspected OHCA remains unchanged.

Cardiac Arrest Centers

CACs are specialized centers where post–cardiac arrest care—at a minimum—includes emergent cardiac catheterization, TTM, and multimodal prognostication. Although there are a variety of terms to define these centers (eg, *cardiac arrest receiving centers*, *comprehensive cardiac centers*, *cardiac resuscitation centers*), for consistency in these guidelines, the term cardiac arrest centers is used. The benefit of a regional system of care model has been successful in improving outcomes in other time-critical diseases (eg, trauma, ST-segment elevation myocardial infarction, stroke) in which comprehensive management is not possible at all institutions. This topic was prioritized for review to determine if similar benefit is imparted to victims of OHCA through the use of CACs.

2019 (Updated): A regionalized approach to post–cardiac arrest care that includes transport of resuscitated patients directly to specialized cardiac arrest centers is reasonable when comprehensive post–cardiac arrest care is not available at local facilities.

2015 (Old): A regionalized approach to OHCA resuscitation that includes the use of cardiac resuscitation centers may be considered.

Why: Evidence-based, comprehensive post–cardiac arrest care, including the availability of emergent cardiac catheterization, TTM, hemodynamic support, and neurologic expertise is critically important for resuscitated victims of cardiac arrest. These interventions may represent a logical clinical link between successful resuscitation (ie, return of spontaneous circulation [ROSC]) and ultimate survival. When a suitable complement of post–cardiac arrest services is not available locally, direct transport of the resuscitated patient to a regional center offering such support may be beneficial and is a reasonable approach to ongoing care, when it is feasible and possible to accomplish in a timely manner.

Part 7: Adult Advanced Cardiovascular Life Support

The AHA Adult writing group considered the following key issues and major changes for the 2019 focused update to the adult advanced cardiovascular life support (ACLS) guidelines:

Use of advanced airways during CPR: Providers frequently place advanced airway devices during CPR to support adequate ventilation and reduce the risk of pulmonary aspiration of orogastric secretions. This update addressed the use of 3 possible airway management strategies during resuscitation: bag-mask ventilation, supraglottic airway placement, and endotracheal intubation strategies.

Use of vasopressors: The goal of pharmacotherapy for cardiac arrest is to facilitate restoration and maintenance of a perfusing spontaneous rhythm. This 2019 focused update addresses the use of the vasopressors epinephrine and vasopressin during cardiac arrest.

Role of extracorporeal membrane oxygenation (ECMO) in CPR: ECMO may be used as rescue therapy during CPR; this use is then termed extracorporeal CPR. The writing group examined the studies that reported outcome of ECPR for IHCA.

Use of Advanced Airways During CPR

To use advanced airways effectively, healthcare providers must maintain their knowledge and skills through frequent practice. Airway management during cardiac arrest usually starts with a basic strategy, such as bag-mask ventilation, and it may progress to an advanced airway strategy (eg, supraglottic airway placement or endotracheal intubation strategy). Since 2015, a number of randomized controlled trials (RCTs) have provided new information on the use and choice of airway strategies during resuscitation for OHCA. These included comparing bag-mask ventilation to an endotracheal intubation strategy and supraglottic airway strategy to an endotracheal placement strategy. Refer to Figure 2 for a schematic representation of the following 6 updated recommendations:

2019 (Updated): Either bag-mask ventilation or an advanced airway strategy may be considered during CPR for adult cardiac arrest in any setting.

2019 (Updated): If an advanced airway is used, the supraglottic airway can be used for adults with out-of-hospital cardiac arrest in settings with low tracheal intubation success rate or minimal training opportunities for endotracheal tube placement.

2019 (Updated): If an advanced airway is used, either the supraglottic airway or endotracheal tube can be used for adults with out-of-hospital cardiac arrest in settings with high tracheal intubation success rates or optimal training opportunities for endotracheal tube placement.

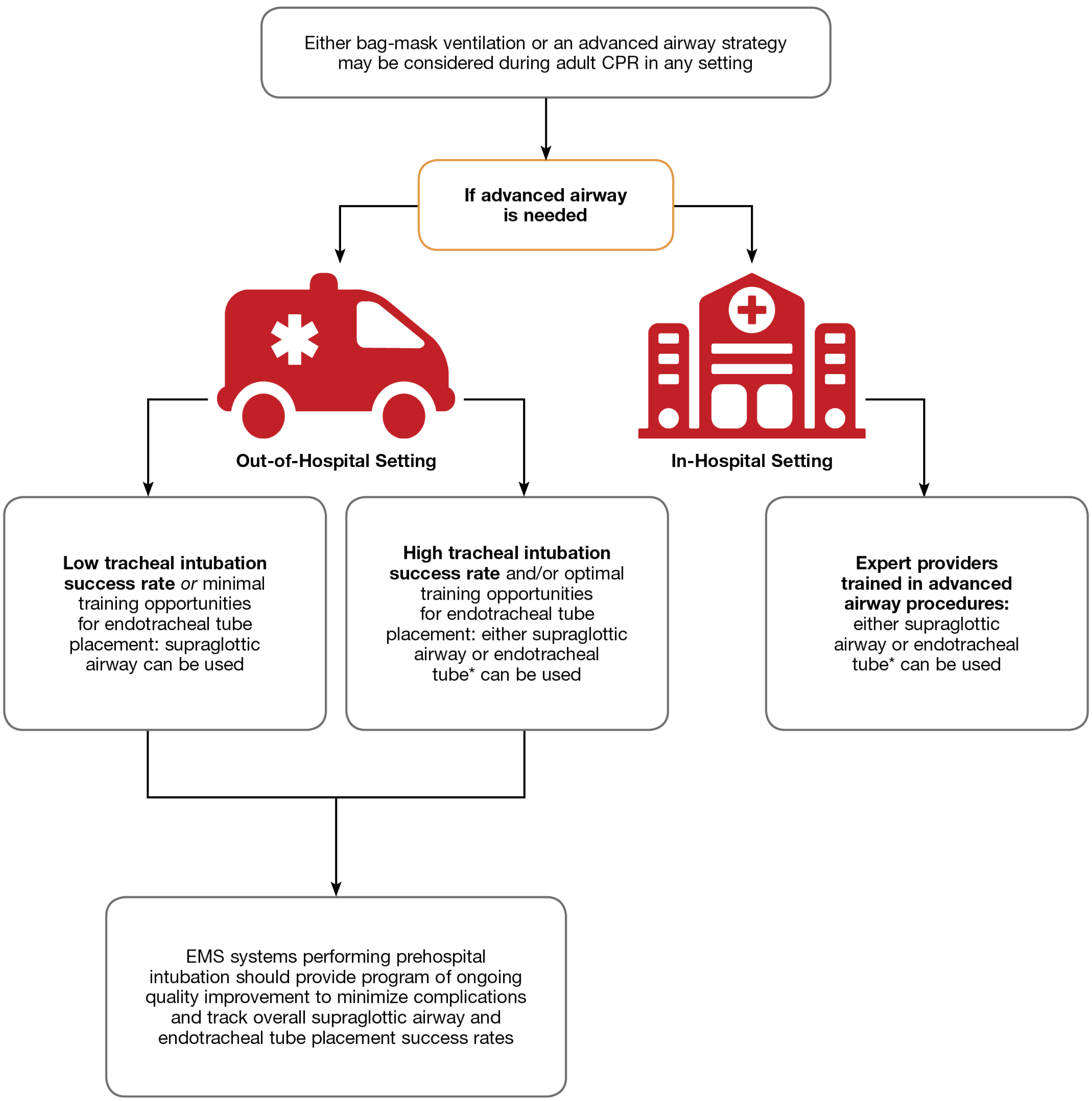
2019 (Updated): If an advanced airway is used in the in-hospital setting by expert providers trained in these procedures, either the supraglottic airway or endotracheal tube can be used.

2019 (Updated): Frequent experience or frequent retraining is recommended for providers who perform endotracheal intubation.

2019 (Updated): Emergency medical services systems that perform prehospital intubation should provide a program of ongoing quality improvement to minimize complications and to track overall supraglottic airway and endotracheal tube placement success rates.

2010 and 2015 (Old): Either a bag-mask device or an advanced airway may be used for oxygenation and ventilation during CPR in both IHCA and OHCA. For healthcare providers trained in their use, either a supraglottic airway device

Figure 2. Schematic representation of ACLS recommendations for use of advanced airways during CPR.



Abbreviations: ACLS, advanced cardiovascular life support; CPR, cardiopulmonary resuscitation; EMS, emergency medical services.

*Frequent experience or frequent retraining is recommended for providers who perform endotracheal intubation.

or an endotracheal tube may be used as the initial advanced airway during CPR. Frequent experience or frequent retraining is recommended for providers who perform endotracheal intubation. EMS systems that perform prehospital intubation should provide a program of ongoing quality improvement to minimize complications.

Why: Recommendations for advanced airway placement during cardiac arrest presume that the provider has the initial training and skills as well as the ongoing experience to insert the airway and verify proper position while minimizing interruption in chest compressions. The choice of bag-mask ventilation vs advanced airway insertion, then, will be determined by the skill and experience of the provider and the patient needs. Frequent experience and training are an important aspect of maintaining high overall success rates for airway management and should be part of ongoing quality improvement. As a result, an informed decision on the choice of an airway strategy for OHCA cannot be made without tracking airway management success rates. From these data, informed decisions on airway strategy choices can be made for patients with OHCA.

Use of Vasopressors During CPR

The writing group reviewed the published evidence on the use of the standard epinephrine dose, standard- vs high-dose epinephrine, vasopressin vs epinephrine, vasopressin plus epinephrine compared with epinephrine alone, and the timing of epinephrine administration. The writing group focused only on the use of vasopressors for cardiac arrest and did not review vasopressor use before or after cardiac arrest.

Standard-Dose Epinephrine

The writing group reviewed the published evidence about the effectiveness of the standard dose (1 mg) of epinephrine, as reported in 2 RCTs, as well as a pooled subgroup analysis of outcomes based on patient presenting rhythm. Only one of the RCTs looked at long-term outcome, and the small number of survivors in that study limits the certainty of any conclusions based on the results.

2019 (Updated): We recommend that epinephrine be administered to patients in cardiac arrest. On the basis of the protocol used in clinical trials, it is reasonable to administer 1 mg every 3 to 5 minutes.

2015 (Old): Standard-dose epinephrine (1 mg every 3 to 5 minutes) may be reasonable for patients in cardiac arrest.

Why: Randomized controlled studies have demonstrated that the use of epinephrine is associated with improved 30-day survival and survival to hospital discharge as well as the short-term outcomes of ROSC and survival to hospital admission. These results also suggested a possible benefit in favorable neurologic outcome, particularly for patients with initial nonshockable rhythm. Epinephrine was not shown to increase rates of survival with favorable neurologic outcome, and one evaluation demonstrated an increase in short-term survivors with unfavorable neurologic outcome. However, the significant improvement in ROSC, short-term and long-term survival, and potential for good neurologic outcome (especially for those with initial nonshockable rhythm) support a strong recommendation for epinephrine, despite some remaining uncertainty about the overall impact on neurologic outcome.

Standard Dose Epinephrine vs High-Dose Epinephrine

In the 2010 ACLS guidelines, high-dose epinephrine was not recommended except in special circumstances, such as β-blocker overdose, or when titrated to monitored parameters. In 2015, the use of high-dose epinephrine was not recommended because it was not thought to be beneficial (Class 3: No Benefit). Although there were no new studies of high-dose epinephrine identified since 2015, the evidence of the effects of standard-dose vs high-dose epinephrine was reanalyzed for the 2019 focused update as part of the comprehensive review of the use of vasopressors for the treatment of cardiac arrest.

2019 (Unchanged): High-dose epinephrine is not recommended for routine use in cardiac arrest.

2015 (Old): High-dose epinephrine is not recommended for routine use in cardiac arrest.

Why: Since 2015, no new studies were identified through a systematic search, so the 2015 recommendation remains unchanged.

Vasopressin vs Epinephrine

The results of 3 RCTs were evaluated in a meta-analysis, and the writing group considered an additional study to evaluate the effects of initial vasopressin vs initial epinephrine on outcomes from cardiac arrest. The studies were all considered to be of low certainty, and all had small sample sizes.

2019 (Updated): Vasopressin may be considered in a cardiac arrest but offers no advantage as a substitute for epinephrine in cardiac arrest.

2015 (Old): Vasopressin offers no advantage as a substitute for epinephrine in cardiac arrest.

Why: The RCTs comparing initial vasopressin to initial epinephrine failed to show any outcome benefit from the use of vasopressin compared with epinephrine. In addition, epinephrine has been shown to improve survival when compared with placebo, while there has been no similar placebo-controlled trial of vasopressin. Because there is also no evidence that vasopressin is superior to epinephrine, the writing group agreed that it is appropriate to use only epinephrine during cardiac arrest to maintain simplicity in the cardiac arrest treatment algorithm and in the drugs required.

Epinephrine in Combination With Vasopressin vs Epinephrine Only

The writing group analyzed the results of 3 small RCTs that compared the use of initial epinephrine plus vasopressin with initial epinephrine only during resuscitation.

> **Although immediate bystander CPR improves survival from cardiac arrest, too few victims of OHCA receive bystander CPR… The likelihood of bystander CPR nearly tripled if DA-CPR was offered to callers.**

2019 (Updated): Vasopressin in combination with epinephrine may be considered during cardiac arrest but offers no advantage as a substitute for epinephrine alone.

2015 (Old): Vasopressin in combination with epinephrine offers no advantage as a substitute for standard-dose epinephrine in cardiac arrest.

Why: The RCTs comparing the combination of vasopressin and epinephrine with epinephrine alone did not demonstrate a beneficial effect from the addition of vasopressin to epinephrine. Although the RCTs involved only a small number of patients, the writing group agreed that the use of epinephrine alone as a vasopressor during cardiac arrest would maintain simplicity in the cardiac arrest treatment algorithm and minimize the number of different drugs required for the treatment of cardiac arrest.

Timing of Administration of Epinephrine

The writing group analyzed data from 16 observational studies, including 10 that compared early vs late epinephrine administration. There were significant differences in the studies, which precluded use of meta-analysis, and multiple variables may have affected the outcomes of the studies.

2019 (Updated): With respect to timing, for cardiac arrest with a nonshockable rhythm, it is reasonable to administer epinephrine as soon as feasible.

2019 (Updated): With respect to timing, for cardiac arrest with a shockable rhythm, it may be reasonable to administer epinephrine after initial defibrillation attempts have failed.

2015 (Old): It may be reasonable to administer epinephrine as soon as feasible after the onset of cardiac arrest due to an initial nonshockable rhythm.

Why: No RCTs have directly investigated the effect of the timing of epinephrine administration on outcomes from cardiac arrest. Available data from the 16 observational studies used a variety of definitions of *early epinephrine administration*. However, all studies demonstrated higher rates of ROSC in association with early administration of epinephrine. The lack of other competing beneficial interventions for cardiac arrest with nonshockable rhythms as well as higher rates of ROSC and survival with epinephrine use for these arrests provided the basis for recommending epinephrine administration as soon as feasible for arrest with nonshockable rhythms. For cardiac arrest with shockable rhythms, the provision of high-quality CPR and defibrillation should be the immediate care priorities, with the use of epinephrine and antiarrhythmics for shock-resistant ventricular fibrillation/pulseless ventricular tachycardia cardiac arrest (Box).

Extracorporeal CPR

ECPR refers to the initiation of cardiopulmonary bypass during the resuscitation of a patient in cardiac arrest, with the goal of supporting end-organ perfusion while potentially reversible conditions are addressed. ECPR is a complex intervention that requires a highly trained team, specialized equipment, and multidisciplinary support within a health-care system (Figure 3).

The writing group analyzed the data from 15 observational studies that differed in study design, definitions of outcomes, and patient selection.

2019 (New): There is insufficient evidence to recommend the routine use of extracorporeal CPR for patients with cardiac arrest.

2019 (Updated): Extracorporeal CPR may be considered for selected patients as rescue therapy when conventional CPR efforts are failing in settings in which it can be expeditiously implemented and supported by skilled providers.

2015 (Old): There is insufficient evidence to recommend the routine use of ECPR for patients with cardiac arrest. In settings where it can be rapidly implemented, ECPR may be considered for select patients for whom the suspected etiology of the cardiac arrest is potentially reversible during a limited period of mechanical cardiorespiratory support.

Why: Currently, there are no published RCTs evaluating the use of ECPR for OHCA or IHCA. However, a number of observational studies suggest improved survival with good neurologic outcome when ECPR is used for select patient populations. While there is currently no evidence to clearly identify the ideal patients to select, most of the studies analyzed in the systematic review included relatively young patients with few comorbidities. Data are needed to address patient selection as well as to evaluate the cost-effectiveness of this therapy, the consequences of resource allocation, and the ethical issues surrounding the use of ECPR as a mode of resuscitation therapy.

Box. Timing and sequence of drug administration during cardiac arrest—the knowns and unknowns.

There is insufficient evidence to identify the optimal timing of epinephrine and antiarrhythmic drug delivery during cardiac arrest. As a result, the recommended sequence of resuscitation including drug delivery depicted in the AHA ACLS Adult Cardiac Arrest Algorithm and guidelines has been determined by expert consensus. The following includes the considerations that contributed to the development of the consensus recommendations.

Epinephrine for Cardiac Arrest With Nonshockable Rhythm (PEA/Asystole)

For nonshockable rhythms, the AHA recommends providing high-quality CPR and administering epinephrine as soon as feasible. The rationale is based on the need to optimize CPP, because an ischemic ventricle without a spontaneous rhythm is likely to remain in this condition unless coronary (myocardial) perfusion improves. The α-adrenergic (vasoconstrictive) effects of epinephrine help to improve CPP. At this time, there is little else to offer those with nonshockable rhythms other than high-quality CPR and epinephrine and a search for and treatment of reversible causes.

Epinephrine for Cardiac Arrest With Shockable Rhythm (VF or pVT)

For shockable rhythms, the initial priority is providing high-quality CPR plus delivering a shock as soon as possible. This may result in elimination of VF and resumption of an organized and then a perfusing rhythm, even before drugs are administered. Epinephrine administration is depicted in the VF/pVT pathway of the ACLS Adult Cardiac Arrest Algorithm after the second shock; at this point, it is likely that administration of epinephrine may improve CPP sufficiently to improve myocardial energetics, enabling a subsequent (third) shock, if needed, to terminate the VF/pVT. All resuscitation councils (worldwide) recommend at least 1 shock (and most recommend several shocks) before administering epinephrine.

The AHA does not recommend epinephrine administration before the first shock because CPR plus the shock alone may result in elimination of VF/pVT and resumption of an organized and ultimately perfusing rhythm. The AHA does not recommend epinephrine administration immediately after the first shock (ie, during the 2 minutes of CPR after the first shock) because providers won't know if VF/pVT has been eliminated. If the first shock was successful (ie, eliminates VF/pVT), a bolus of epinephrine may provoke recurrence of VF/pVT (or other arrhythmias) and can increase oxygen demand just when resumption of spontaneous rhythm is occurring. On the other hand, if VF/pVT persists at the next rhythm check (ie, after delivery of the first shock plus 2 minutes of high-quality CPR), the AHA recommends a second shock, with immediate resumption of CPR and administration of epinephrine. The rationale is that, by this time the myocardium is likely to be ischemic, so even if the second shock terminates VF/pVT, the epinephrine and high-quality CPR may improve CPP and myocardial perfusion and will potentially enable the heart to resume and maintain a spontaneous, perfusing rhythm. On the other hand, if the second shock did not eliminate the VF/pVT, the epinephrine and high-quality CPR may help improve CPP and increase the likelihood that the third shock will be successful.

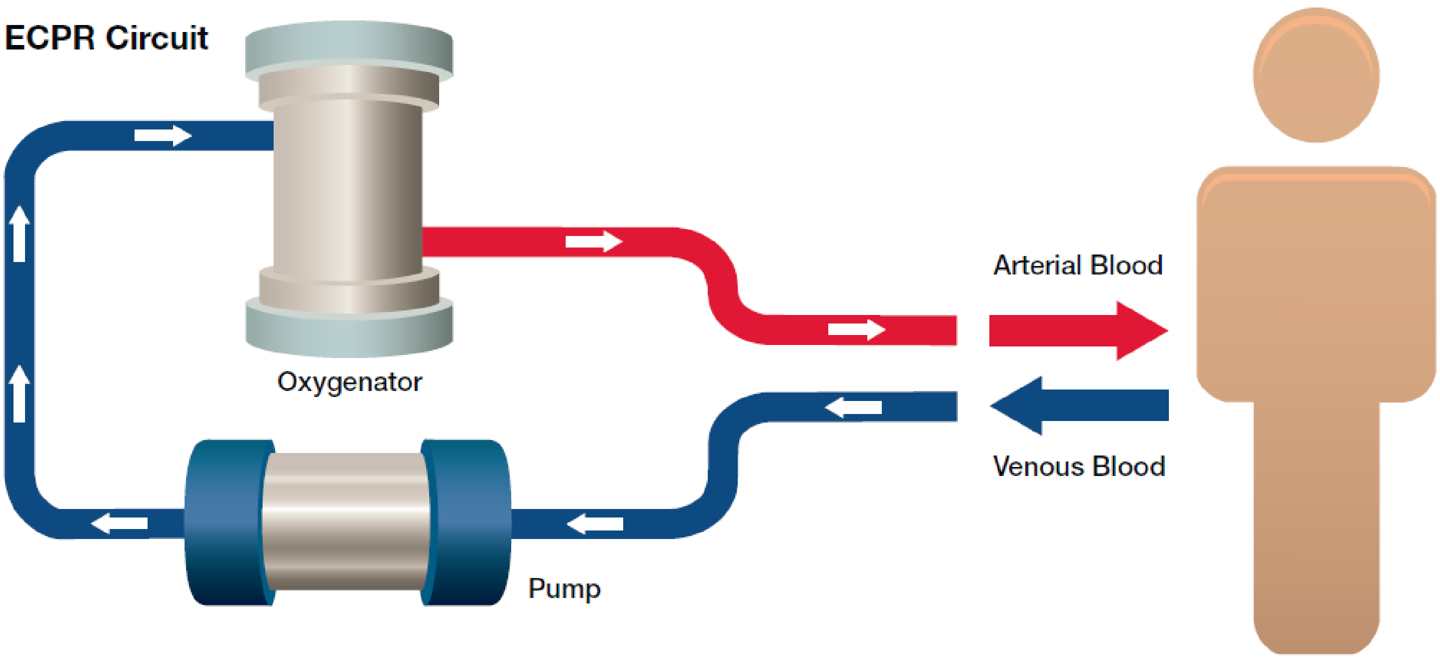
Antiarrhythmic and Epinephrine Administration for Cardiac Arrest With Shockable Rhythm (VF or pVT)

There is no evidence to determine if an antiarrhythmic agent is best given before or after epinephrine, or even when the antiarrhythmic should be administered; such a decision may depend on the acute circumstances. Experienced providers may tailor the sequence of drug delivery to individual patient needs. For example, patients with recurring episodes of VF may derive greater benefit from the rhythm-stabilizing effects of an antiarrhythmic drug like amiodarone or lidocaine than from epinephrine (which may even be proarrhythmic under such circumstances). Conversely, persistent VF may require improving CPP before any other drug will be adequately delivered to the heart via the coronary arteries. That is, epinephrine plus high-quality CPR might improve coronary and myocardial perfusion and increase the likelihood of successful rhythm conversion when amiodarone or lidocaine is given.

More evidence is needed in the form of prospective randomized studies to identify optimal timing of drug administration in cardiac arrest.

Abbreviations: ACLS, advanced cardiovascular life support; AHA, American Heart Association; CPP, coronary perfusion pressure; CPR, cardiopulmonary resuscitation; PEA, pulseless electrical activity; pVT, pulseless ventricular tachycardia; VF, ventricular fibrillation.

Figure 3. Schematic depiction of components of ECMO circuit as used for ECPR. Components include venous cannula, a pump, an oxygenator, and arterial cannula.



Abbreviations: ECMO, extracorporeal membrane oxygenation; ECPR, extracorporeal cardiopulmonary resuscitation.

Part 11: Pediatric Basic Life Support and Cardiopulmonary Resuscitation Quality

In 2019, the AHA Pediatric writing group reviewed the outcomes associated with the use of DA-CPR in pediatric OHCA. The evidence and recommendations for pediatric DA-CPR differ somewhat from the recommendations for DA-CPR and adult victims of OHCA. However, as in the adult population, DA-CPR is associated with increased bystander CPR rates and improved outcomes for infants and children with OHCA.

DA-CPR for Pediatric OHCA

Although immediate bystander CPR improves survival from cardiac arrest, too few victims of OHCA receive bystander CPR. The writing group reviewed the evidence of outcomes associated with DA-CPR for pediatric OHCA based on registry data from EMS systems in Korea and Japan. Note that the review did not include evaluation of the specific protocols or language used by the dispatchers to support bystander CPR.

2019 (New): We recommend that emergency medical dispatch centers offer dispatcher-assisted CPR instructions for presumed pediatric cardiac arrest.

2019 (New): We recommend that emergency dispatchers provide CPR instructions or pediatric cardiac arrest when no bystander CPR is in progress.

2019 (New): There is insufficient evidence to make a recommendation for or against dispatcher-assisted CPR instructions for pediatric cardiac arrest when bystander CPR is already in progress.

Previous: There is no previous recommendation on this topic.

Why: DA-CPR is associated with increased survival in children with OHCA. The likelihood of bystander CPR nearly tripled if DA-CPR was offered to callers, and 30-day survival improved. Bystander CPR—with or without dispatcher assistance—was associated with improved survival with favorable neurologic outcome at 1 month.

Part 12: Pediatric Advanced Life Support

The AHA Pediatric writing group identified and analyzed new evidence about the use of advanced airways during CPR, ECMO resuscitation (ie, ECPR), and TTM after resuscitation from cardiac arrest in infants and children. Analysis of this evidence resulted in refinement of existing recommendations about the use of these therapies.

Advanced airways: Most pediatric cardiac arrests are triggered by a deterioration of respiratory function. Bag-mask ventilation can be a reasonable alternative to an advanced airway (such as endotracheal intubation or a supraglottic airway).

ECPR: The rapid deployment of venoarterial ECMO during active CPR (ECPR) or for patients with intermittent ROSC may be considered in pediatric patients with cardiac diagnoses and IHCA in settings with providers who have ECMO experience.

TTM: A large randomized trial of therapeutic hypothermia for children with IHCA showed no difference in outcomes whether a period of moderate therapeutic hypothermia (32°C to 34°C) or the strict maintenance of normothermia (36°C to 37.5°C) was provided.

Use of Advanced Airways During Pediatric Resuscitation

The effectiveness of the use of advanced airways in pediatric cardiac arrest was last reviewed by ILCOR and the AHA pediatric experts in 2010. This 2019 review sought to analyze the evidence associated with bag-mask ventilation, endotracheal intubation, and the use of the supraglottic airway. The most recent evidence is largely derived from observational studies (ie, registry data) involving only OHCA.

2019 (Updated): Bag-mask ventilation is reasonable compared with advanced airway interventions (endotracheal intubation or supraglottic airway) in the management of children during cardiac arrest in the out-of-hospital setting.

2019 (New): We cannot make a recommendation for or against the use of an advanced airway for in-hospital cardiac arrest management. In addition, no recommendation can be made about which advanced airway intervention is superior in either out-of-hospital or in-hospital cardiac arrest.

2010 (Old): In the prehospital setting it is reasonable to ventilate and oxygenate infants and children with a bag-mask device, especially if transport time is short.

Why: With proper experience and training, the use of bag-mask ventilation is a reasonable alternative to an advanced airway strategy (including endotracheal intubation or use of supraglottic devices) because the use of advanced airways may require more specific training and equipment. However, if bag-mask ventilation is ineffective despite appropriate optimization, the use of advanced airway interventions should be considered.

Extracorporeal CPR

If ECMO is used as a rescue therapy when conventional CPR fails, it is referred to as extracorporeal CPR (or ECPR). The writing group reviewed in-hospital registry data about outcomes from ECPR. These data were derived predominantly from infants and children who developed cardiac arrest after surgery for congenital heart defects.

2019 (Updated): Extracorporeal CPR may be considered for pediatric patients with cardiac diagnoses who have in-hospital cardiac arrest in settings with existing extracorporeal membrane oxygenation protocols, expertise, and equipment.

2019 (Updated): There is insufficient evidence to recommend for or against the use of extracorporeal CPR for pediatric patients experiencing out-of-hospital cardiac arrest or for pediatric patients with noncardiac disease experiencing in-hospital cardiac arrest refractory to conventional CPR.

2015 (Old): ECPR may be considered for pediatric patients with cardiac diagnoses who have IHCA in settings with existing ECMO protocols, expertise, and equipment.

Why: Data from large multicenter registries and retrospective propensity-scored analyses suggest that ECPR may provide a survival benefit when used for refractory cardiac arrest. However, most data are derived from young infants with cardiac diagnoses who develop IHCA. As a result, the recommendation addresses that patient population and continues to include the caveat that ECPR is a resource-intense, multidisciplinary therapy that requires appropriate protocols, expertise, and equipment.

Targeted Temperature Management

TTM refers to the continuous maintenance of patient temperature within a narrowly prescribed range. This pediatric review was triggered by the publication of the results of the THAPCA-IH trial (Therapeutic Hypothermia After Pediatric Cardiac Arrest In-Hospital), an RCT of TTM 32°C to 34°C vs TTM 36°C to 37.5°C for children who remained comatose after IHCA. The writing group re-evaluated the evidence of the effectiveness of TTM for both IHCA and OHCA.

2019 (Updated): Continuous measurement of core temperature during targeted temperature management is recommended.

2019 (Updated): For infants and children between 24 hours and 18 years of age who remain comatose after out-of-hospital or in-hospital cardiac arrest, it is reasonable to use either targeted temperature management 32°C to 34°C followed by targeted temperature management 36°C to 37.5°C or to use targeted temperature management 36°C to 37.5°C.

2019 (New): There is insufficient evidence to support a recommendation about treatment duration. The THAPCA trials (Therapeutic Hypothermia After Pediatric Cardiac Arrest) used 2 days of targeted temperature management 32°C to 34°C followed by 3 days of targeted temperature management 36°C to 37.5°C or used 5 days of targeted temperature management 36°C to 37.5°C.

2015 (Old): For infants and children remaining comatose in the first several days after cardiac arrest (in-hospital or out-of-hospital), continuous measurement of temperature during this time period is recommended. Fever (temperature 38°C or higher) should be aggressively treated after ROSC.

2015 (Old): For infants and children remaining comatose after OHCA, it is reasonable either to maintain 5 days of continuous normothermia (36°C to 37.5°C) or to maintain 2 days of initial continuous hypothermia (32°C to

34°C) followed by 3 days of continuous normothermia.

For infants and children remaining comatose after IHCA, there is insufficient evidence to recommend cooling over normothermia.

Why: The publication about a large multicenter RCT of TTM for children who remain comatose after IHCA triggered the 2019 evidence evaluation and recommendation on the topic of pediatric post–cardiac arrest TTM. This in-hospital study, from the same investigational team and using the same treatment protocol as the previously published study of children after OHCA, compared post–cardiac arrest TTM 32°C to 34°C with TTM 36°C to 37.5°C. Together, these trials form the basis of the current guidelines recommendations.

Fever is common after a hypoxic-ischemic event such as cardiac arrest, and registry data have shown an association between fever and poor outcomes after cardiac arrest. The 2019 recommendation allows for either TTM with moderate hypothermia or TTM with strict maintenance of normothermia after cardiac arrest. With either strategy, monitoring of core body temperature and the avoidance of fever are paramount.

Part 13: Neonatal Resuscitation

Because neonatal cardiac arrest is predominantly asphyxial, initiation of ventilation remains the focus of initial resuscitation. Major topics for evidence evaluation and the 2019 focused update to the neonatal resuscitation guidelines include the following:

- The use of an initial oxygen concentration of 21% for term and late-preterm newborns (35 weeks or more of gestation) receiving respiratory support at birth remains reasonable. Studies showing that the use of 100% oxygen could be harmful prompted the recommendation against its use as the initial oxygen concentration. This issue was last reviewed by ILCOR in 2010.
- The initial oxygen concentration to use for preterm newborns (less than 35 weeks of gestation) receiving respiratory support at birth remains 21% to 30% with subsequent oxygen titration based on oxygen saturation targets.

Administration of Oxygen to Initiate Ventilation Support for Term or Near-Term Newborns (35 Weeks or More of Gestation)

Although it is well known that hypoxia and ischemia can cause organ injury, even brief exposure to hyperoxia in newborns is now believed to be harmful. As a result, it is important to identify the optimal initial oxygen concentration to use when providing initial respiratory support of the newborn, to avoid both hypoxemia and hyperoxia.

2019 (Updated): In term and late-preterm newborns (35 weeks or more of gestation) receiving respiratory support at birth, the initial use of 21% oxygen is reasonable.

2019 (Updated): One hundred percent oxygen should not be used to initiate resuscitation because it is associated with excess mortality.

2015 (Old): It is reasonable to initiate resuscitation with air (21% oxygen at sea level). Supplementary oxygen may be administered and titrated to achieve a preductal saturation approximating the interquartile range measured in healthy term infants after vaginal birth at sea level.

Why: The ILCOR systematic review and meta-analysis of 10 original studies and 2 follow-up studies confirmed a significant reduction in the critically important outcome of short-term mortality—without statistically significant differences in short- and long-term neurologic outcomes—with the use of 21% oxygen compared with 100% oxygen for term and late-preterm newborns receiving respiratory support at birth. It was estimated that 46/1000 fewer babies died when respiratory support at birth was started with 21% oxygen instead of 100% oxygen. This evidence of higher mortality with the initial use of 100% oxygen resulted in the Class 3: Harm recommendation against use of 100% oxygen when initiating respiratory support for the term or late-preterm newborn.

Although evidence is still lacking about the optimal methods of oxygen titration to achieve oxygen saturation targets, the use of preductal oxygen saturation targeting that approximates the interquartile range measured in healthy term infants after vaginal birth at sea level is consistent with the high value placed on avoiding both hypoxemia and hyperoxemia.

Many subpopulations of newborns have not been studied adequately to determine if they require a different initial oxygen concentration during respiratory support at birth. Newborns with congenital heart disease and other malformations may be harmed by either hypoxemia or hyperoxemia, and studies enrolling these newborns are needed.

Administration of Oxygen to Initiate Ventilation Support for Preterm Newborns (Less Than 35 Weeks of Gestation)

Preterm newborns may be even more susceptible than term neonates to complications of excessive oxygen exposure (eg, bronchopulmonary dysplasia, retinopathy of prematurity). As a result, it is important to determine the optimal oxygen concentration to use for initial respiratory support, with the need for titration based on monitored preductal oxygen saturation.

2019 (Revised): In preterm newborns (less than 35 weeks of gestation) receiving respiratory support at birth, it may be reasonable to begin with 21% to 30% oxygen with subsequent oxygen titration based on pulse oximetry.

2015 (Old): Resuscitation of preterm newborns of less than 35 weeks of gestation should be initiated with low oxygen (21% to 30%), and the oxygen concentration should be titrated to achieve preductal oxygen saturation approximating the interquartile range measured in healthy term infants after vaginal birth at sea level. Initiating resuscitation of preterm newborns with high oxygen (65% or greater) is not recommended. This recommendation reflects a preference for not exposing preterm newborns to additional oxygen without data demonstrating a proven benefit for important outcomes.

Why: New data published since 2015, including 16 studies (10 randomized trials, 2 follow-up studies, and 4 observational trials), prompted an ILCOR systematic review of outcomes of preterm newborns (less than 35 weeks of gestation) who received respiratory support immediately after birth with the use of low initial oxygen compared with those who received support with higher initial oxygen concentration. The systematic review showed no statistically significant differences in short-term mortality or in any of the prespecified secondary outcomes between the 2 groups. Oxygen saturation targeting, used as a cointervention in 8 randomized trials, resulted in nearly all newborns in the initial 21% group receiving supplementary oxygen. Many of the studies were downgraded for possibility of bias, imprecision, inconsistency, and small numbers. Many subpopulations and outcomes have not been adequately evaluated. Despite these weaknesses and uncertainty of the evidence, the recommendation to start with 21% to 30% oxygen with subsequent titration of supplementary oxygen is based on the high value of avoiding additional oxygen exposure to this vulnerable population without evidence of benefit for critical or important outcomes.

Part 15: First Aid

The 2019 American Heart Association and American Red Cross focused update to the first aid guidelines reaffirms goals to reduce morbidity and mortality by alleviating suffering, preventing further illness or injury, and promoting recovery. First aid can be initiated by anyone and supports the Chain of Survival.

The 2019 topic addressed by the First Aid Task Force is first aid treatment of presyncope.

Treatment of Presyncope

Presyncope, with recognizable signs and symptoms preceding loss of consciousness, can last for a few seconds before onset of vasovagal and orthostatic syncope. Associated signs and symptoms include pallor, sweating, light-headedness, visual changes, and weakness (Table 2). Presyncope is a period during which rapid first aid intervention can improve symptoms or prevent syncope from occurring.

Physical counterpressure maneuvers include contraction of muscles in the upper or lower body (or both) to elevate blood pressure and alleviate symptoms of presyncope. Examples of these physical counterpressure maneuvers include leg crossing with muscle tensing, squatting, arm tensing, isometric handgrip, and neck flexion. The First Aid Task Force examined the published evidence about the effectiveness of these physical counterpressure maneuvers for presyncope of vasovagal or orthostatic origin.

2019 (New): If a person experiences signs or symptoms of presyncope (including pallor, sweating, light-headedness, visual changes, and weakness) of vasovagal or orthostatic origin, the priority for that person is to maintain or assume a safe position, such as sitting or lying down. Once the person is in a safe position, it can be beneficial for that person to use physical counterpressure maneuvers to avoid syncope.

2019 (New): If a first aid provider recognizes presyncope of suspected vasovagal or orthostatic origin in another individual, it may be reasonable for the first aid provider to encourage that person to perform physical counterpressure maneuvers until symptoms resolve or syncope occurs. If no improvement occurs within 1 to 2 minutes, or if symptoms worsen or reoccur, providers should initiate a call for additional help.

2019 (New): If there are no extenuating circumstances, lower-body physical counterpressure maneuvers are preferable to upper-body and abdominal physical counterpressure maneuvers.

2019 (New): The use of physical counterpressure maneuvers is not suggested when symptoms of a heart attack or stroke accompany presyncope.

Previous: No previous recommendation addressed the treatment of presyncope.

Why: Physical counterpressure maneuvers are simple maneuvers that can reduce syncope and its associated consequences (eg, falls, crashes). As with other first aid care, the priority for safety leads the actions of the individual and first aid provider. Although the available evidence favors lower body over upper body physical counterpressure maneuvers, many methods and even a combination of methods can be beneficial. The evidence suggests that people prone to vasovagal or orthostatic syncope can have improved quality of life by learning and using physical counterpressure maneuvers.

Table 2. Typical Signs and Symptoms of Presyncope

Typical symptoms of presyncope	Faintness, dizziness, nausea, feeling warm/hot or cold, abdominal pain, visual disturbance (black spots, blurred vision)
Typical signs of presyncope	Pallor/paleness, sweating, vomiting, shivering, sighing, diminished postural tone, confusion

Summary

The 2019 focused updates to the AHA Guidelines for CPR and ECC include summaries of evidence reviews and revised recommendations for 11 topics, ranging from DA-CPR and CACs after adult OHCA; advanced airways, vasopressors, and ECPR for ACLS; DA-CPR for pediatric OHCA; advanced airways and ECPR for pediatric cardiac arrest and TTM for pediatric post–cardiac arrest care; and initial oxygen concentration for respiratory support of term or near-term newborns and for preterm newborns. The 2019 American Heart Association and American Red Cross focused update for first aid guidelines includes evidence summaries and new recommendations for interventions for presyncope. These focused updates serve to revise specific parts of previous AHA guidelines for CPR and ECC and American Heart Association and American Red Cross guidelines for first aid. Readers are encouraged to review the complete 2019 focused updates, the online integrated AHA Guidelines for CPR and ECC, the published 2019 CoSTR summary, and the 2018-2019 online draft CoSTRs for summaries of the published evidence and for detailed insights and analysis from the expert ILCOR and AHA writing groups.

Recommended Reading

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