ILCOR Summary Statement

2026 International Liaison Committee on Resuscitation Consensus on Science With Treatment Recommendations: Summary from the Basic Life Support; Advanced Life Support; Pediatric Life Support; Neonatal Life Support; Education, Implementation, and Teams; and First Aid Task Forces

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ABSTRACT

This is the annual summary of the *International Liaison Committee on Resuscitation Consensus on Science With Treatment Recommendations*; a comprehensive review was completed in 2025. This latest summary addresses the most recent published resuscitation evidence reviewed by International Liaison Committee on Resuscitation task forces, including Basic Life Support; Advanced Life Support; Pediatric Life Support; Neonatal Life Support; Education, Implementation, and Teams; and First Aid. Members from these 6 task forces assessed the certainty of the evidence using Grading of Recommendations Assessment, Development, and Evaluation criteria, and their statements include consensus treatment recommendations. Highlights from task force discussions and insights into how decisions regarding treatment recommendations were made are provided in the Justification and Evidence-to-Decision Framework Highlights sections. The task forces also listed priority knowledge gaps for further research.

Key Words: ILCOR, resuscitation, cardiac arrest, basic life support, advanced life support, neonatal, first aid

INTRODUCTION

This is the ninth in a series of annual *International Liaison Committee on Resuscitation* (ILCOR) *Consensus on Science With Treatment Recommendations* (CoSTR) publications summarizing the ILCOR task forces' analyses of published resuscitation evidence since ILCOR began the continuous process of evidence evaluation in 2015. Comprehensive updates are provided on a 5-year cycle, last completed in 2025. Summarizing the work from the 6 task forces over the past year, this year's review includes 16 systematic reviews (SysRevs) with new or updated treatment recommendations. Although only SysRevs can generate a full CoSTR and new treatment recommendations, 9 scoping reviews (ScopRevs) and 21 evidence updates (EvUps) are also included.

Draft CoSTRs for all topics evaluated with SysRevs are posted on a rolling basis on the ILCOR website.[1] Each draft CoSTR includes the data reviewed and draft treatment recommendations, with public comments accepted for at least 2 weeks after posting. Task forces consider public feedback and provide responses. All CoSTRs and ScopRev reports are now available online.

This summary statement contains the final treatment recommendations and good practice statements created by the ILCOR task forces but differs in several respects from the online documents. The language used to describe the evidence is not restricted to standard Grading of Recommendations Assessment, Development, and Evaluation (GRADE) terminology,[2] making it more accessible to a wider audience, and often only the high-priority outcomes are reported. The Justification and Evidence-to-Decision Framework Highlights sections (for SysRevs and any ScopRevs that produce good practice statements) are generally shortened but aim to provide a transparent rationale for treatment recommendations and good practice statements. The complete evidence-to-decision tables are provided in Appendix A. Finally, the task forces have prioritized knowledge gaps for future research to address. Links to the published reviews and full online CoSTRs and ScopRev reports are provided in the corresponding sections.

The CoSTRs are based on analysis of the data using the GRADE approach.[2] SysRevs are conducted by task force members or collaborating expert systematic reviewers, always with the involvement of ILCOR content experts. Reviews within the scope of more than one task force ("nodal reviews") included one or more members from the relevant task forces. The GRADE approach guides the rating of the certainty of evidence that supports the intervention effects (predefined by the population, intervention, comparator, outcome, study design and time frame [PICOST] question). Certainty is categorized as high, moderate, low, or very low. Randomized controlled trials (RCTs) begin the analysis as high-certainty evidence, and observational studies begin the analysis as low-certainty evidence. Certainty of evidence can be downgraded for risk of bias, inconsistency, indirectness, imprecision, or publication bias; it can be upgraded for a large effect, for a dose-response effect, or if any residual confounding would be thought to decrease the detected effect.

The format for outcome data reporting varies by the type and amount of evidence identified but ideally includes both relative risk and the absolute risk difference, both with 95% confidence intervals. The absolute risk difference enables a more clinically useful assessment of the magnitude of the effect of an intervention and enables calculation of the number needed to treat (number needed to treat = 1/absolute risk difference). When the data do not enable absolute effect estimates, alternative measures of effect like odds ratios (ORs) are reported. Treatment recommendations are generated by the task forces after discussion of the systematically evaluated evidence. The strength of a recommendation does not depend solely on the certainty of evidence but also on the clinical importance and potential impact, as determined by task force members. Historically, ILCOR has categorized treatment recommendations as either strong or weak, but GRADE allows for alternate terms for weak recommendations, including *conditional*. The terms *conditional* and *weak* do not represent different categories of recommendation strength, but *conditional* can be selected in cases where a recommendation may be contextual (eg, recommendations based on health care setting).

ILCOR's goal is to review at least 20% of all PICOSTs each year so that all topics are reviewed within a 5-year cycle. Acknowledging that many topics will not have sufficient new evidence to warrant a SysRev, ILCOR implemented 2 additional levels of evidence review in 2020. ScopRevs are undertaken when the amount and type of evidence on a broader topic is unclear. Search strategies are similar in rigor to those of SysRevs, but ScopRevs do not include bias assessments or meta-analyses. In some cases, if a recently published SysRev is identified that meets ILCOR criteria for methodologic quality and addresses the topic that the task force is reviewing, that review is leveraged by using the adolopment process. Adolopment involves using the results of a published SysRev, updating the search to identify any new studies meeting inclusion criteria, and adding any new data to that identified in the published SysRev.[3] An evidence-to-decision table is also completed.

Although ILCOR does not create or alter treatment recommendations without sufficient evidence evaluated with a SysRev, if the task force thinks that providing some guidance on the topic has the potential to have a large clinical impact, good practice statements can be made. Good practice statements are generally created using linked, indirect evidence and are justified based on the following prespecified criteria: (1) There is a high confidence in net benefit, (2) a body of relevant linked indirect evidence exists, (3) it is unethical or impractical to conduct a relevant RCT, and (4) the treatment or investigation under consideration is already considered a standard of practice and formal review is not necessary. Creation of good practice statements does not follow GRADE methodology and, therefore, these statements are considered ungraded.

The third and least rigorous form of evidence evaluation is the EvUp, in which a minimum of a PubMed search is carried out to screen for significant new data and assess whether there is sufficient new science to warrant a more extensive review and an updated CoSTR. EvUps can inform a decision about whether a SysRev should be undertaken but are not used to generate new or updated treatment recommendations because they do not include bias assessment, GRADE evidence evaluation, or meta-analysis. In this document, ScopRevs are summarized in the relevant task force section, with references to the more complete online review. EvUps are listed at the end of each task force section in table form, with information including the prior treatment recommendation(s) related to the population, intervention, comparator, outcome, study design, time frame, how many new studies were identified, key findings, and whether an updated SysRev is recommended. Complete EvUps are provided in Appendix B.

The following topics are addressed in this CoSTR summary:

- **Basic Life Support (BLS)**
  - Harms to rescuers (BLS 2001: ScopRev)
  - Supraglottic airway (SGA) insertion in BLS (BLS 2301: SysRev)
  - Ventilation parameters during adult cardiopulmonary resuscitation (CPR) (BLS 2401: SysRev)
  - Bag size for manual ventilation for adult CPR (BLS 2404: SysRev)

  - Compression rate, depth, and recoil for adult, child, and infant CPR (BLS 2501: ScopRev)
  - Rhythm analysis during compressions (BLS 2211: SysRev)
  - Anticipatory charging of the defibrillator (BLS 2605, ALS 3105: SysRev)
  - Immediate resuscitation in water or on boat in drowning (BLS 2702/2703: EvUp)
  - Circulation, airway, breathing versus airway, breathing, circulation in drowning (BLS 2704: EvUp)
  - Chest compression–only CPR in cardiac arrest in drowning (BLS 2705: EvUp)
  - Ventilation equipment in cardiac arrest following drowning (BLS 2706: EvUp)
  - Prehospital oxygen administration following drowning (BLS 2707: EvUp)
  - Automated external defibrillator (AED) use first versus CPR first in cardiac arrest in drowning (BLS 2708: EvUp)
  - Public access defibrillation programs for drowning (BLS 2709: EvUp)
- **Advanced Life Support (ALS)**
  - Thrombolytics during cardiac arrest (ALS 3203: SysRev)
  - Intramuscular (IM) epinephrine for cardiac arrest (ALS 3212: SysRev adolopment)
  - Intravascular volume administration during and after cardiac arrest (ALS 3207, 3518: SysRev)
  - Video laryngoscopy versus direct laryngoscopy for tracheal intubation during cardiac arrest (ALS 3308: SysRev)
  - Supplemental oxygen during CPR (ALS 3305: SysRev)
  - Anticipatory charging for defibrillation during cardiac arrest (ALS 3105, BLS 2605: nodal SysRev with BLS)

  - Ventilation rate and volume during cardiac arrest (BLS 2401: nodal SysRev with BLS)
  - Transesophageal echocardiography (TEE) during CPR (ALS 3609: ScopRev)
  - Prognostication of unfavorable neurological outcome: electrophysiology (somatosensory evoked potentials and electroencephalogram) (ALS 3511: EvUp)
  - Prognostication of unfavorable neurological outcome: physical examination (ALS 3513: EvUp)
  - Prognostication of unfavorable neurological outcome: biomarkers (neuron-specific enolase, neurofilament light chain) (ALS 3512: EvUp)
  - Prognostication of unfavorable neurological outcome: imaging (computed tomography [CT] scan or magnetic resonance imaging [MRI]) (ALS 3510: EvUp)
- **Pediatric Life Support (PLS)**
  - Defining chest compression components for children: rate, depth, recoil (BLS 2501: ScopRev)
  - Ventilation parameters during cardiac arrest in children (PLS 4120.02 and 4080.28: SysRev)
  - IM epinephrine during cardiac arrest in children (PLS 4090.05: SysRev adolopment)
  - Vasopressor use during cardiac arrest in children (PLS 4080.21: SysRev)
  - Temperature control after cardiac arrest in children: temperature target and duration (PLS 4210.03: SysRev)
  - Treatment of hypotension following cardiac arrest in children (PLS 4190.02: EvUp)
- **Neonatal Life Support (NLS)**
  - Initial vascular access for neonatal resuscitation (NLS 5652: SysRev)

  - Respiratory function monitor (RFM) feedback devices during training (NLS 5854: SysRev)
  - Strategies for positive-pressure ventilation (PPV) (NLS 5325: ScopRev)
- **Education, Implementation, and Teams (EIT)**
  - Targeted BLS training for likely rescuers of high-risk populations (EIT 6105: SysRev adolopment)
  - Terminology for individuals or teams attending patients in cardiac arrest (EIT 6312: ScopRev)
  - Best practices for in-hospital cardiac arrest (IHCA) team composition (EIT 6317: ScopRev)
  - CPR self-instruction versus instructor-guided training (EIT 6406: EvUp)
  - Spaced learning (EIT 6408: EvUp)
  - Gamified learning versus nongamified learning (EIT 6412: EvUp)
  - Deliberate practice design versus non–deliberate practice training (EIT 6414: EvUp)
- **First Aid (FA)**
  - Virtual opioid poisoning education and naloxone distribution (OPEND) (FA 7443: ScopRev adolopment)
  - FA interventions for a caustic agent attack in adults and children (FA 7445: ScopRev)
  - Simple single-stage concussion scoring system(s) in the FA setting (FA 7341: ScopRev)
  - Pulse oximetry (FA 7010: EvUp)
  - Recovery position (FA 7040: EvUp)
  - Resuscitation care for suspected opioid-associated emergencies (FA 7442: EvUp)

- Types of pediatric tourniquets (FA 7333: EvUp)
- Duration of cooling of burns (FA 7371: EvUp)

Readers are encouraged to monitor the ILCOR website[4] to provide feedback on planned SysRevs and to provide comments when additional draft reviews are posted.

BASIC LIFE SUPPORT

Each BLS Task Force ILCOR CoSTR uses the nomenclature recommended by the Utstein Out-of-Hospital Cardiac Arrest Resuscitation Registry Template when referring to different types of out-of-hospital cardiac arrest (OHCA) responders (Table 1).[5,6]

Table 1. BLS Task Force Nomenclature for OHCA Responder Types as Recommended by the Utstein OHCA Template

Term	Definition
Volunteer community responder	A person who is alerted to the scene but who has a choice as to whether they attend (eg, a volunteer alerted by a smartphone app or text message)
First responder	A person who is dispatched as part of the emergency response but who is part of an organization that does not have the ability to transport patients (eg, a firefighter or police officer)
Emergency medical services responder	A person who is dispatched as part of the emergency response and belongs to an organization with the ability to transport patients (eg, a paramedic or an emergency medical technician)

BLS indicates Basic Life Support; and OHCA, out-of-hospital cardiac arrest.

Harms to Rescuers (BLS 2001: ScopRev)

Rationale for Review

The safety of rescuers, including bystanders and those responding to a cardiac arrest, is an important consideration that may influence both willingness to intervene and the quality of resuscitation provided. The previous review on this topic conducted in 2019 covered only physical harm to rescuers during CPR.[7,8] The BLS Task Force undertook this review to understand the potential harms that may be encountered during BLS rescue, response, and treatment of a person in cardiac arrest. The full details of this review are available in the

ScopRev[9] and on the ILCOR website.[10] This review excludes fatigue and psychological harm as well as the use of personal protective equipment (PPE) in minimizing infection risk, which is covered in the 2023 CoSTR publication[11,12] and SysRev.[13]

Population, Exposure, Comparator, Outcome, Study Design, and Time Frame

- Population: Individuals rescuing adults or children in OHCA or IHCA or performing resuscitation
- Exposure: Responding to children or adults in cardiac arrest or performing resuscitation (ie, ventilations, compressions, defibrillation) out-of-hospital and in-hospital
- Outcomes: Any reported outcome and number of cases of unintentional physical harm (eg, infection, morbidity, death)
- Study designs: RCTs and nonrandomized studies (non-RCTs, interrupted time series, controlled before-and-after studies, cohort studies), surveys, and case series were included. Unpublished studies (eg, conference abstracts, trial protocols), simulation and animal studies, studies with an outcome of fatigue or psychological harm, and studies investigating PPE use and rescue in extreme environments (eg, mountain rescue, low gravity, military deployment) were excluded. All languages were included provided that there was an English abstract.
- Time frame: All years to November 6, 2025

Summary of Evidence

Evidence of harm to rescuers during cardiac arrest response from 20 studies indicates that serious harm is uncommon but context dependent, with risk varying by activity and setting (Table 2).[14-34] Infection transmission has been reported for multiple pathogens, particularly in early outbreak settings, with some studies suggesting higher risk during chest compressions and bag-mask ventilation (BMV), although findings are heterogeneous and several studies demonstrate no increased risk when appropriate PPE is used.[14-21] One study reported that equipment contamination with one tested pathogen was common, supporting a plausible indirect transmission pathway and reinforcing the importance of decontamination procedures.[22] Electrical harm from defibrillation is very rare, with controlled clinical testing consistently demonstrating current leakage below safety thresholds.[23-26] Notably, higher current leakage and one case report of nerve injury were reported when the person performing CPR was positioned on the same side of the body as the implantable cardioverter defibrillator.[26,27] Two surveys of community volunteer responders showed that injuries sustained while responding were typically minor[29] and often preventable (eg, cuts from breaking cabinet glass during AED retrieval).[30] In contrast, attempted rescues in aquatic environments (eg, open water, natural waterways, swimming pools) carry a low-frequency but high-severity risk, with reports of rescuers fatally drowning, particularly when they were rescuing family members.[31-33]

Prior Treatment Recommendation (2020, Withdrawn)

Evidence supporting rescuer safety during CPR is limited. The few isolated reports of adverse effects resulting from the widespread and frequent use of CPR suggest that performing CPR is relatively safe. Delivery of a defibrillator shock with an AED during BLS is also safe. The incidence and morbidity of defibrillator-related injuries in rescuers are low.

2026 Good Practice Statement

The treatment recommendation published in 2020 is withdrawn.

Harms to rescuers during cardiac arrest response or resuscitation are rare. However, harms have been reported in specific situations, including water rescue, unsafe AED removal, chest contact during implantable cardioverter defibrillator shock delivery, performing CPR without appropriate PPE, and during transport to a cardiac arrest (good practice statement).

Justification and Evidence-to-Decision Framework Highlights

The complete evidence-to-decision table is provided in Appendix A.

The risk of harm to rescuers during CPR, including defibrillation, appears to be very low on the basis of the limited available evidence. Reported adverse events are rare and are primarily associated with activities like removing patients from bodies of water, retrieving AEDs from cabinets, and performing CPR without PPE. Overall, the evidence suggests that rescue-related harms are uncommon relative to the numerous resuscitation attempts performed globally. Although the evidence base is insufficient to support a formal SysRev, it does identify specific and largely preventable risks that the task force considered appropriate to address through a good practice statement.

Knowledge Gaps

- Large, well-designed studies evaluating the transmission of infectious agents during resuscitation procedures
- Appropriately powered RCTs comparing the safety of hands-on defibrillation with hands-off defibrillation
- The routine collection of rescuer resuscitation-related injuries in OHCA and IHCA registries to provide assurance for the potential rescuer and the system of care

Table 2. Summary of Evidence for Harms to Rescuers

Category of harm	Evidence type (number of studies)	Key findings	Overall risk to rescuers*
Infection during CPR	9 studies: 3 retrospective	Transmission of infection to rescuers has been reported for multiple pathogens (eg, SARS-CoV,	Low but uncertain,

Category of harm	Evidence type (number of studies)	Key findings	Overall risk to rescuers*
	cohorts,[16,20,21] 5 case reports,[14,17-19,34] 1 survey[15]	COVID-19, SFTS, CCHF).[14-21,34] Several studies suggest higher risk is associated with chest compressions and BMV.[14,16,17,19-21] One study found no increased risk when PPE was used during CPR.[15]	modified by PPE use and pathogen
Defibrillator-related electrical harm	6 studies: 5 prospective clinical testing[23-25,27,28] and 1 case report[26]	Controlled clinical testing of hands-on defibrillation consistently demonstrated leakage currents below international safety thresholds, with no shocks perceived by rescuers.[23-25,28] Rare potential for harm has been reported in specific contexts involving ICDs, including 1 case of nerve injury[26] and higher leakage currents during subcutaneous ICD testing when the person performing CPR was on the same side as the ICD.[27]	Very low overall risk; rare, context-specific risk with ICDs
Harms in responding to patient	1 retrospective survey of responders[29]	Large community-based data demonstrate an extremely low incidence of injury among citizen responders traveling to OHCA, with less than 1% reporting any injury and only 1 hospitalization.	Very low risk
Harms during AED retrieval	1 retrospective survey of responders[30]	Minor injuries were common among responders retrieving AEDs, with over half reporting cuts, largely due to breaking glass in locked cabinets. Injuries were minor and did not require medical care.	Low risk of serious harm; moderate risk of minor injury
Harms in aquatic rescue	3 population-based retrospective cohort studies[31-33]	Fatal rescuer drownings were consistently reported in national and media-based datasets from Australia and Turkey. Bodies of water included open water, natural waterways, and swimming pools. Although population rates were low (approximately 0.02–0.08 per 100 000 per y), deaths were recurrent and predominantly involved male persons aged 15–44 y attempting to rescue family members.[31-33]	Low-frequency but high-severity risk

AED indicates automated external defibrillator; BMV, bag-mask ventilation; CCHF, Crimean-Congo hemorrhagic fever; CPR, cardiopulmonary resuscitation; ICD, implantable cardioverter defibrillator; OHCA, out-of-hospital cardiac arrest; PPE, personal protective equipment; and SFTS, severe fever with thrombocytopenia syndrome.
*Substantial heterogeneity and small sample sizes limit inference.

SGA Insertion in BLS (BLS 2301: SysRev)

Rationale for Review

Previous SysRevs by the ALS[35] and PLS Task Forces[36] did not address airway management by BLS-trained responders independently. The BLS Task Force prioritized a new

SysRev on this topic in response to increasing use of SGAs by BLS-trained first responders and emergency medical services (EMS) and the absence of a specific ILCOR evidence review or treatment recommendation addressing this practice. The SysRev[37] was registered on the International Prospective Register of Systematic Reviews (PROSPERO) (CRD42024592988) before initiation. The full online CoSTR can be found on the ILCOR website.[38]

Population, Intervention, Comparator, Outcome, Study Design, and Time Frame

- Population: Adults in any setting (out-of-hospital or in-hospital) in cardiac arrest managed by first responders (eg, firefighters, police officers) or EMS BLS providers
- Intervention: Airway management with an SGA during resuscitation by BLS provider(s)
- Comparator: Face mask airway management with or without oropharyngeal or nasopharyngeal airway
- Outcomes
    - Critical: Survival to hospital discharge with good neurological outcome and survival to hospital discharge or 30 days
    - Important: Survival to any time interval after discharge or 30 days, survival to hospital admission, return of spontaneous circulation (ROSC), first pass success, time to successful insertion, CPR quality (chest compression fraction (CCF), successful ventilation, respiratory rate, tidal volume), the need for further airway interventions, regurgitation, and aspiration pneumonia
- Study designs: RCTs and nonrandomized studies (non-RCTs, interrupted time series, controlled before-and-after studies, cohort studies) were eligible for inclusion. Animal studies, manikin or simulation studies, cadaver studies, and unpublished studies (eg,

conference abstracts, trial protocols) were excluded. All languages were included provided that there was an English abstract.

- Time frame: All years to October 20, 2025

Consensus on Science

Sixteen studies (3 RCTs,[39-41] 13 observational studies[42-54]) compared use of an SGA with BMV during adult OHCA, predominantly in EMS settings (including BLS-trained emergency medical technicians [EMTs] and paramedics). No evidence was identified for community volunteer responders or dispatched first responders (eg, firefighters, police officers). Two studies involved BLS-trained nurses without prior training in tracheal intubation.[40,54] An in-hospital study was included because of the lack of evidence in the EMS studies for the outcome of regurgitation.[54] Meta-analysis was not possible for the outcomes reported in the observational studies because of methodological and statistical heterogeneity.

In 7 studies, there was either a mix of airway devices (laryngeal mask, laryngeal tube, esophageal-tracheal twin-lumen airway) included or the type of airway device used was not specified.[39,42,45,46,48,49,51] Four studies specifically investigated use of a laryngeal tube by EMTs,[40,41,43,53] and 5 studied a laryngeal mask.[44,47,50,52,54] All studies compared use of an SGA with BMV, but most studies did not detail oropharyngeal airway use. In several studies, BMV was used before insertion of an SGA.[40,42-46,48,50-52,54]

For the critical outcome of survival to discharge or 30 days, moderate-certainty evidence from 3 RCTs showed no benefit from an SGA compared with BMV (risk ratio [RR], 1.28; 95% CI, 0.46–3.55).[39-41] Across critical patient-centered outcomes (survival with favorable neurological outcome and survival to discharge or 30 d), the observational studies produced inconsistent findings (Table 3).

The definition of the important outcome of ROSC varied across the 11 observational studies or was not described. For prehospital ROSC, very low–certainty evidence from 2 small RCTs showed no benefit from an SGA compared with BMV (RR, 1.08; 95% CI, 0.58–2.00).[40,41] Very low–certainty evidence from 11 heterogeneous observational studies was inconsistent and often reported without adjustment for confounders.[42-44,46-53]

For important process outcomes, limited RCT and observational evidence suggests that SGAs may increase CCF[40,53] and ventilation success[43] compared with BMV, but evidence for regurgitation showed no clear difference in RCTs[40,41] and mixed results in observational studies.[43,54]

Table 3. Summary of Evidence for SGAs in BLS-Trained EMS Personnel

Outcome	Evidence type	Key findings (SGA versus BMV)	Certainty of evidence (GRADE)
Survival to hospital discharge with favorable neurological outcome	8 observational studies (n = 754 697)[42-44,46,48,49,51,53]	Adjusted data: *Decreased outcome* with SGA in 3 studies[46,48,49] *No difference* in 3 studies[42-44] Unadjusted data: *Decreased outcome* with SGA in 4 studies[42,48,49,53] *No difference* in 4 studies[43,44,46,51]	Very low (risk of bias, very serious inconsistency, imprecision)
Survival to hospital discharge or 30 d	2 RCTs[39,41] and 1 quasi-RCT[40] (n = 628)	*No difference* in 3 RCTs[39-41]	Moderate (risk of bias)
	9 observational studies (n = 688 339)[42-46,48,50,52,53]	Adjusted data: *Decreased outcome* with SGA in 3 studies[44,48,53] *Increased outcome* with SGA in 1 study[46] *No difference* in 3 studies[42,43,45] Unadjusted data: *Increased outcome* with SGA in 1 study[52] *Decreased outcome* with SGA in 3 studies[45,48,53] *No difference* in 5 studies[42-44,46,50]	Very low (risk of bias, very serious inconsistency, imprecision)
ROSC	1 RCT[41] and 1 quasi-RCT[40] (n = 628)	*No difference* in 2 RCTs[40,41]	Very low (very serious risk of bias, imprecision)

Outcome	Evidence type	Key findings (SGA versus BMV)	Certainty of evidence (GRADE)
	11 observational studies (n = 756 174)[42-44,46-53]	Adjusted data: *Decreased outcome* with SGA in 1 study[48] *No difference* in any ROSC or sustained ROSC or survival to hospital admission: 2 studies[43,44] Unadjusted data: *Increased outcome* with SGA in 1 study[46] *Decreased outcome* with SGA in 3 studies[48,49,53] *No difference* in ROSC on arrival at hospital in 2 studies[43,52] *No difference* in sustained ROSC in 3 studies[44,50,51] *No difference* in prehospital ROSC in 3 studies[42,43,52] *No difference* in undefined ROSC: 2 studies[47,48]	Very low (risk of bias, very serious inconsistency, imprecision)
Regurgitation	1 RCT[41] and 1 quasi-RCT[40] (n = 628)	*No difference* in regurgitation in 2 RCTs[40,41]	Very low (risk of bias, imprecision)
	2 observational studies (n = 1191)[43,54]	*Decreased* regurgitation with SGA in 1 study[54] *No difference* in 1 study[43]	Very low (risk of bias, indirectness)
CCF	1 quasi-RCT* (n = 82)[40]	*Increased* CCF with SGA	Very low (risk of bias, imprecision)
	1 observational study (n = 1220)[53]	*Increased* CCF with SGA	Very low (risk of bias)
Ventilation success (visually assessed chest rise)	1 observational study (n = 469)[43]	*Increased* ventilation success with SGA	Very low (risk of bias, imprecision)

*Prospective study with intervention changing by month

BMV indicates bag-mask ventilation; CCF, chest compression fraction; GRADE, Grading of Recommendations Assessment, Development, and Evaluation; RCT, randomized controlled trial; ROSC, return of spontaneous circulation; and SGA, supraglottic airway.

2026 Treatment Recommendations

For appropriately trained BLS-trained EMS personnel (ie, paramedics, nurses, EMTs), we suggest providing ventilation with an SGA or bag mask with or without oropharyngeal/nasopharyngeal airway (weak recommendation, very low–certainty evidence).

For appropriately trained volunteer community BLS responders or dispatched first responders (eg, firefighters, police, lifeguards), we support the use of an SGA or bag mask with or without oropharyngeal/nasopharyngeal airway to provide ventilation (good practice statement).

We support a competency-based training program with regular retraining for both BMV and airway insertion (good practice statement).

Justification and Evidence-to-Decision Framework Highlights

The complete evidence-to-decision table is included in Appendix A.

The task force considered evidence primarily derived from BLS-trained EMTs, BLS- and ALS-trained paramedics, and ALS-trained nurses without training in tracheal intubation, with no direct evidence in volunteer community responders or first responders. The overall certainty of evidence was very low, and most studies did not describe the type of airway used with BMV. RCTs showed no difference in survival outcomes between SGA and BMV, while observational studies yielded inconsistent findings across all outcomes. Observational studies were limited by serious risk of bias, heterogeneity, and resuscitation time bias[55] (ie, SGAs were more likely to be used in prolonged resuscitations), and BMV often preceded SGA insertion, further limiting attribution of effects to the airway strategy alone.

Indirect evidence from feasibility, simulation, cadaver, and implementation studies was also considered.[56-61] These studies suggest that SGAs can be safely and effectively used by BLS-trained responders, including firefighters and volunteer responders, when supported by appropriate competency-based training with regular retraining.

Evidence comparing specific SGA devices in BLS-trained responders was insufficient to support a preference for one device over another. However, the impact of individual SGA devices may vary. Several observational studies in EMS have compared i-gel with King Laryngeal Tubes, reporting higher first-pass insertion success[62-64] and improved OHCA patient outcomes[62,65] with the i-gel.

While effective BMV is technically challenging[66,67] and highly dependent on skill, SGAs may offer practical advantages by providing a more secure seal and requiring fewer hands once inserted and limited evidence suggests potential improvements in CCF and mitigation of regurgitation. Balancing very low–certainty evidence, uncertainty in clinical benefit, feasibility considerations, and the importance of competence, the task force issued a weak recommendation supporting either bag-mask device or SGA use by BLS-trained EMS personnel, alongside good practice statements endorsing their use by BLS-trained first responders and emphasizing the need for competency-based training with regular retraining.

Knowledge Gaps

- RCTs comparing SGA devices
- RCTs assessing critical outcomes, such as favorable neurological outcome
- Studies assessing ventilation success and quality with uniform definitions
- Consistent reporting of adverse effects (eg, regurgitation and aspiration)
- Observational studies comparing specific types of airways and adjusting for resuscitation time bias[55]

Ventilation Parameters During Adult CPR (BLS 2401: SysRev)

Rationale for Review

This topic was last systematically reviewed by ILCOR in 2010, at which time the treatment recommendation was based only on observational studies and extrapolation from animal studies and healthy volunteers.[68,69] This topic was prioritized by the BLS, ALS, and PLS Task Forces as a nodal review based on multiple recent observational studies demonstrating an association between ventilation parameters and patient outcomes as well as several small randomized trials.[67,70] The SysRev[71] was registered on PROSPERO (CRD420251070065) before initiation. The PLS Task Force considered the identified pediatric data and generated a separate CoSTR for children, which can be found in the PLS section. Only the adult evidence is included here. The full online CoSTR for adults, as well as the one for children, can be found on the ILCOR website.[72,73]

Population, Intervention, Comparator, Outcome, Study Design, and Time Frame

- Population: Adults and children receiving assisted ventilation during cardiac arrest
- Intervention: Ventilation with a specific tidal volume, respiratory rate, inspiratory time, or positive end-expiratory pressure (PEEP)
- Comparators: Any other tidal volume, respiratory rate, inspiratory time, or PEEP or combination of these parameters
- Outcomes
  - Critical: Survival to hospital discharge with favorable neurological outcome and survival to hospital discharge or 30 days
  - Important: ROSC, blood gas parameters, progression to acute respiratory distress syndrome, barotrauma, and intensive care unit (ICU) and hospital length of stay
- Study designs: RCTs and nonrandomized studies (non-RCTs, interrupted time series, controlled before-and-after studies, cohort studies) were eligible for inclusion. Only studies

that included a study comparator were included. Manikin and animal studies were excluded. All languages were included provided that there was an English abstract.

- Time frame: As the search strategy was updated, the search included all years to November 10, 2025.

Consensus on Science

Across 11 included adult studies (3 small pilot RCTs,[74-76] 3 post hoc analyses of RCTs,[67,70,77] 5 observational studies[78-82]) the evidence was sparse, heterogeneous, and of very low certainty (with reasons for downgrading including inconsistency, imprecision risk of bias, and indirectness), precluding meta-analysis. Studies varied widely in design, populations, airway strategies, and measurement methods, and most were limited by serious risk of bias, indirectness, and imprecision. Evidence was derived predominantly from observational studies and small randomized trials and was graded as very low certainty (Table 4). No studies evaluated different levels of PEEP or inspiratory time.

For ventilation rate, there was no consistent association overall between ventilation rate and favorable neurological outcome or survival in 2 studies.[77,80] One post hoc analysis showed decreased outcomes with <6 breaths per minute.[77] ROSC was reported in 4 studies,[74,77,80,81] with inconsistent findings.

For tidal volume, favorable neurological outcome and survival to hospital discharge or 30 days were each reported in 2 observational studies, with no significant differences between smaller and larger tidal volumes.[78,79] ROSC was reported in 4 studies,[75,76,78,79] with no consistent benefit from higher or lower tidal volumes.[75,76,78,79]

For impedance-detected ventilations during 30:2 CPR without advanced airways, 2 studies reported that favorable neurological outcome and ROSC occurred more among patients with impedance-detected lung inflation in at least 50% of chest compression pauses.[67,70]

Table 4. Summary of Evidence for Ventilation Parameters During CPR

Component	Outcome	Evidence type	Key findings	Certainty of evidence (GRADE)
Ventilation rate	Survival to hospital discharge with favorable neurological outcome	1 observational study[80] and 1 post hoc analysis of an RCT[77]	*Increased outcome* with >12–16/min compared with 6-12/min in 1 study[77] *No difference* between higher and lower rates in 2 studies: >10 and ≤10/min[80] or <6 and 6–12/min[77]	Very low
	Survival to hospital discharge or 30 d	1 observational study,[80] 1 post hoc RCT analysis[77]	*Increased outcome* with >12–16/min compared with 6–12/min in 1 study[77] *Decreased outcome* with <6/min compared with 6–12/min in 1 study[77] *No difference* between >10 and ≤10 /min in 1 study[80]	Very low
	ROSC	1 RCT,[74] 2 observational studies,[80,81] 1 post hoc RCT analysis[77]	*Increased outcome* with >12–16/min compared with 6–12/min in 1 study[77] *No difference* between 10 and 20/min in 1 pilot RCT using mechanical ventilation[74] *No difference* between >10 and ≤10/min[80] *Increased unadjusted outcome* with 1 IHCA cohort with >12/min compared with 6–12/min, with a dose-response relationship up to ~26.7/min before decline[81] *Decreased outcome* with <6/min compared with 6–12/min in 1 study[77]	Very low
	Physiological outcomes (pH)	1 small RCT[74] (n = 46)	*No difference* between 10 and 20/min[74]	Very low
Tidal volume	Survival to hospital discharge with favorable	2 observational studies[78,79] (n = 2026)	*No difference* between smaller and larger tidal volumes in 2 studies[78,79]	Very low

Component	Outcome	Evidence type	Key findings	Certainty of evidence (GRADE)
	neurological outcome			
	Survival to hospital discharge or 30 d	2 observational studies[78,79] (n = 2026)	*No difference* between smaller and larger tidal volumes in 2 studies[78,79]	Very low
	ROSC	2 RCTs,[75,76] 2 observational studies[78,79] (n = 2103)	*Increased outcome* with a small ventilation bag compared with a larger bag in 1 observational study[78] and with 500 mL compared with 1000 mL in 1 pilot RCT reporting unadjusted ROSC[76] *No difference* between smaller and larger volumes in 2 studies[75,79]	Very low
Impedance-detected ventilations	Survival to hospital discharge with favorable neurological outcome	2 post hoc analyses of RCTs[67,70] (n = 2528)	*Increased outcome* when impedance-detected lung inflation occurred in ≥50% of chest compression pauses compared with <50% in 2 studies[67,70]	Very low
	Survival to hospital discharge or 30 d	2 post hoc analyses of RCTs[67,70] (n = 2528)	*Increased outcome* when impedance-detected lung inflation occurred in ≥50% of chest compression pauses in 1 study[67] *No difference* when impedance-detected lung inflation occurred between ≥50% of chest compression pauses compared with <50% in 1 study[70]	Very low
	ROSC	2 post hoc analyses of RCTs[67,70] (n = 2528)	*Increased outcome* when impedance-detected lung inflation occurred in ≥50% of chest compression pauses compared with <50% in 2 studies[67,70]	Very low

CPR indicates cardiopulmonary resuscitation; GRADE, Grading of Recommendations Assessment, Development and Evaluation; IHCA, in-hospital cardiac arrest; RCT, randomized controlled trial; and ROSC, return of spontaneous circulation.

Prior Treatment Recommendations (2010)

For mouth-to-mouth ventilation for adult victims using exhaled air or BMV with room air or oxygen, it is reasonable to give each breath within a 1-second inspiratory time and with an approximate volume of 600 mL to achieve chest rise. It is reasonable to use the same initial tidal volume and rate in patients regardless of the cause of the cardiac arrest.

2026 Treatment Recommendations

We suggest delivering 2 ventilations for every 30 compressions or 10 ventilations per minute (1 ventilation every 6 seconds) for continuous compressions in adults with cardiac arrest with or without an advanced airway (weak recommendation, very low–certainty evidence).

When manual ventilation is being provided, it is reasonable to deliver enough volume to produce visible chest rise (good practice statement).

When tidal volume can be measured, we suggest delivering a tidal volume of 400 to 600 mL (or 6–10 mL/kg of ideal or predicted body weight) in adults with cardiac arrest (weak recommendation, very low–certainty evidence).

It is reasonable to ensure effective ventilation and avoid both hyperventilation and hypoventilation (good practice statement).

Justification and Evidence-to-Decision Framework Highlights

The complete evidence-to-decision table is included in Appendix A.

Ventilation during cardiac arrest is multifaceted, encompassing rate, tidal volume, monitoring and feedback, airway devices, and integration with chest compressions. *Minute ventilation*, defined as the product of respiratory rate and tidal volume, is the key determinant of carbon dioxide values (along with dead space), thereby influencing acid-base status during resuscitation. Oxygenation is determined primarily by mean airway pressure and the fraction of inspired oxygen.

Most patients in the included studies were ventilated via advanced airways. Given the limited and physiologically distinct pediatric evidence, the PLS Task Force undertook a separate review and developed pediatric-specific recommendations. This review and its treatment recommendations apply only to adults. Substantial clinical and methodological heterogeneity across studies meant that meta-analysis was not feasible, and the task forces agreed that there was sufficient human evidence to exclude animal, manikin, and experimental studies.

Overall, the evidence remains conflicting and difficult to interpret. Earlier studies highlight harm from hyperventilation, whereas more recent data suggest hypoventilation is common and may be associated with worse outcomes, particularly in the absence of an advanced airway.[67,70,83,84] These discrepancies likely reflect heterogeneity in patient populations, ventilation methods (manual versus mechanical), and study design. The absence of large, multicenter randomized trials was a major limitation; existing trials are small, single center, and underpowered, underscoring the urgent need for adequately powered trials examining ventilation rate, tidal volume, inspiratory time, airway pressures, and PEEP.[74,75] Although newer devices can measure ventilation rate and tidal volume, a recent ILCOR review found insufficient evidence that ventilation feedback devices improve ventilation quality or clinical outcomes, and whether training with such devices improves real-world performance is unknown.[85] Current recommendations align with prior guidance in recognizing potential harm from hypoventilation but do not support strong recommendations for higher ventilation rates or an upper limit, given limited contemporary evidence. Physiological principles support using tidal volumes sufficient for oxygenation and carbon dioxide clearance while avoiding excessive intrathoracic pressure. Observational data suggest harm from very low volumes, while randomized and observational studies show no survival benefit from larger volumes. Important knowledge gaps remain, including pulmonary-specific outcomes and subgroup effects, which could not be explored because of limited sample sizes and study design constraints.

Knowledge Gaps

- RCTs assessing the impact of ventilation parameters, including minute ventilation, on critical outcomes, such as favorable neurological outcome
- Precise thresholds for higher and lower ventilation rates across different patient populations and settings (eg, IHCA and OHCA)
- The ideal tidal or minute volume for ventilation during cardiac arrest; while animal and historical studies suggested smaller tidal volumes to avoid barotrauma and intrathoracic pressure elevation, recent findings[78] are inconsistent
- Optimal ventilatory parameters in special populations, such as pregnant patients
- Whether ventilation rate or tidal or expiratory volume differ between advanced airways and basic airway techniques (eg, BMV or 30:2 CPR without airway insertion)
- The impact of intrathoracic airway closure during CPR on clinical outcomes
- Mechanistic data (eg, effect of ventilation variables on intra-arrest blood gases)
- Whether ventilation practices and their associated outcomes differ based on etiology, initial arrest rhythm, or other patient-specific factors

Bag Size for Manual Ventilation for Adult CPR (BLS 2404: SysRev)

Rationale for Review

The BLS Task Force prioritized a new SysRev on this topic on the basis of emerging observational clinical studies evaluating the impact of manual resuscitation bag size on ventilation delivery during cardiac arrest. The SysRev[86] was registered on PROSPERO (CRD420251266387) before initiation. The full online CoSTR can be found on the ILCOR website.[87]

Population, Intervention, Comparator, Outcome, Study Design, and Time Frame

- Population: Adults in any setting (out-of-hospital or in-hospital) receiving manual ventilation during CPR
- Intervention: Use of a smaller manual resuscitation bag than standard size (ie, using a pediatric bag for adult patients) for the patient to limit delivered tidal volume
- Comparator: Use of a standard or larger bag (ie, ≈1500 mL)
- Outcomes
  - Critical: Survival to hospital discharge with good neurological outcome and survival to hospital discharge or 30 days
  - Important: Survival to hospital admission, survival to any time interval after discharge or 30 days survival, ROSC, delivered tidal volume, ventilation rate, barotrauma
- Study designs: RCTs and nonrandomized studies (non-RCTs, interrupted time series, controlled before-and-after studies, cohort studies) were eligible for inclusion. Studies reporting the development or validation of artifact-filtering algorithms were excluded. Unpublished studies (eg, conference abstracts, trial protocols) were excluded. As prespecified, simulation studies were included because of insufficient clinical studies identified. All languages were included provided that there was an English abstract.
- Time frame: All years to October 13, 2025

Consensus on Science

No RCTs were identified. We identified 1 before-and-after observational study[78] and 2 crossover simulation manikin studies.[88,89] Across all outcomes, the certainty of evidence was ranked as very low. Results are summarized in the following text and in Table 5.

The before-and-after observational clinical study examined 1994 OHCA patients with advanced airways (SGA or tracheal tube) and ventilations provided by EMTs and ALS intensive-care paramedics.[78] The introduction of the small-volume adult bag reduced the maximum volume from 1685 mL to 1000 mL and expected delivered tidal volume from 700 mL to 450 mL. The period in which the smaller-volume bag was used was associated with significantly lower rates of favorable neurological outcome (5% versus 7%; adjusted OR [aOR], 0.65; 95% CI, 0.43–0.99; *P* = 0.05) and survival to hospital admission (35% versus 42%; aOR, 0.73; 95% CI, 0.60–0.90; *P* = 0.002) and no difference in survival to discharge (9% versus 12%; aOR, 0.79; 95% CI, 0.57−1.09; *P* = 0.16). No difference was seen in mean respiratory rates between the periods using the larger bag size and the smaller bag size (11.9 ± 5.3 versus 12.0 ± 4.8; *P* = 0.60).

In crossover simulation studies, delivery of guideline-recommended tidal volumes was suboptimal, with a 500-mL bag producing excessively low volumes (<400 mL)[88] and larger, 1600-mL bags showing wide variability, including excessive volumes (>600 mL) in a substantial proportion of breaths.[88,89]

Table 5. Results of Crossover Simulation Studies Comparing Large and Small Ventilation Bag Sizes During CPR

Ventilation parameters	Riyapan (2021)[88] Bag volume (1600 mL versus 500 mL)	Nehme (2009)[89] Bag volume (1600 mL versus 1000 mL)
Guideline-compliant tidal volumes (400–600 mL [6–7 mL/kg])	52% versus 0% (*P* < 0.001)	4% versus 30% (*P* = 0.02)
Tidal volume <400 mL	36.5% versus 100% (*P* < 0.001)	13% versus 33% (*P* = 0.02)
Tidal volume >600 mL	11.4% versus 0% (*P* < 0.001)	83% versus 37% (*P* = 0.02)
Guideline-compliant ventilation rate (8–10/min)	–	30% versus 27% (*P* = 0.77)
>10 ventilations per minute	–	50% versus 47% (*P* = 0.77)
<8 ventilations per minute	–	27% versus 23% (*P* = 0.77)

CPR indicates cardiopulmonary resuscitation.

2026 Treatment Recommendations

We suggest the use of a standard adult size bag (maximum volume, 1500–1600 mL) for manual ventilation of adults during CPR (weak recommendation, very low–certainty evidence).

Justification and Evidence-to-Decision Framework Highlights

The complete evidence-to-decision table is included in Appendix A.

Given the very low certainty of evidence for critical outcomes and substantial uncertainty regarding the balance of benefits and harms, the task force judged that the balance of effects does not clearly favor a change in practice at this time. The observational findings suggesting potential harm with the use of smaller bags should be interpreted cautiously, particularly as the period during which smaller-volume bags were used coincided with the COVID-19 pandemic.[78] Although an increasing body of simulation evidence indicates that standard adult resuscitation bags are associated with more frequent delivery of excessive tidal volumes,[88-91] the emerging evidence suggests that using a pediatric size bag in adult resuscitation may result in the delivery of tidal volumes consistently below recommended targets when ventilations are delivered via a face mask.[88]

Knowledge Gaps

- RCTs comparing smaller-volume with standard adult size, self-inflating ventilation bags during CPR on critical or important clinical outcomes
- High-quality observational studies with contemporary control groups comparing smaller-volume with standard adult size, self-inflating ventilation bags during CPR for critical or important patient outcomes
- Research that documents and accounts for ventilation strategies used after ROSC

- Adverse events from use of smaller and larger self-inflating ventilation bags, such as regurgitation and aspiration
- Data describing ventilation quality during CPR according to ventilation bag size in real-world clinical settings

Compression Rate, Depth, and Recoil for Adult, Child, and Infant CPR (BLS 2501: ScopRev)

Rationale for Review

The 3 core components of chest compressions—rate, depth, and recoil—were originally reviewed as separate SysRevs in the 2015 ILCOR CoSTR.[92,93] The BLS Task Force revisited this topic as a combined ScopRev in 2020.[94] This 2025 update is a nodal ScopRev in which the PLS Task Force aimed to broaden the prior search strategies to create an evidence map examining the individual and interactive effects of these components on outcomes. The full online ScopRev report for adults and children can be found on the ILCOR website.[95]

Population, Intervention, Comparator, Outcome, Study Design, and Time Frame

- Population: Adults, children, and infants (excluding newborns) in any setting (in-hospital or out-of-hospital) with cardiac arrest
- Intervention: Alternative chest compression rate, depth, or chest wall recoil during CPR
- Comparator: Standard chest compression rate, depth, or chest wall recoil during CPR
- Outcomes
  - Critical: Survival to hospital discharge or 30 days with favorable neurological outcome and survival to hospital discharge or 30 days

  - Important: ROSC and any physiological outcome, including blood pressure, end-tidal carbon dioxide, and clinical outcomes as defined in the P-COSCA (Pediatric Core Outcome Set for Cardiac Arrest) for children[96,97]
- Study designs: RCTs and nonrandomized studies (non-RCTs, interrupted time series, controlled before-and-after studies, cohort studies) were eligible for inclusion. Included studies must report a comparison between 2 or more chest compression rates or chest compression depths or measures of chest wall recoil or measures of chest wall leaning. We excluded studies that provided continuous data linking a chest compression component to an outcome unless 2 or more specific and comparable epochs were presented. We excluded manikin studies and animal studies as well as studies that reported on pre- and postshock pause in chest compressions and CCF and chest compression release velocity. All languages were included provided that there was an English abstract.
- Time frame: All years to August 5, 2025

Summary of Evidence

We included 39 studies in this review: 29 in adults[98-126] and 10 in infants and children.[127-136] We excluded 2 studies included in the 2019 ScopRev that focused on chest compression release velocity.[137,138] We did not identify any studies in adults, infants, or children that reported patient outcomes for recoil or leaning. Physiological outcomes in adults are reported in Table 6.

Adults

Compression rate

Evidence examining adult patient outcomes includes 1 OHCA RCT[108] and 16 observational studies (13 OHCA,[99,101,103,104,109-111,114,117,123-126] 2 IHCA,[98,113] and 1 OHCA or

IHCA[122]) comparing continuous or categorical compression rates (Table 6). The OHCA RCT found no difference in survival with favorable neurological outcome, survival to hospital discharge or 30 days, or ROSC for 100 versus 120 compressions per minute.[108] The majority of the OHCA observational studies reported no association between patient outcomes across varying compression rate comparisons (Table 6). One large study reported higher favorable neurological outcome at compression rates within 100 to 120/min compared with lower rates.[99] Two small observational studies in adult IHCAs suggest higher ROSC[98] or sustained ROSC[113] with higher compression rates.

Compression depth

Evidence examining adult patient outcomes for chest compression depth include 1 RCT of feedback[101] and 7 observational studies.[100,111,114,117,123-125] The evidence is inconsistent, however, with the largest study reporting worse survival to discharge with depths <38 mm compared with >51 mm[124] and continuous analyses suggesting improved outcomes with greater depth.[124,125]

Combination of depth and rate

In studies of adults, which were predominantly OHCA studies, observational evidence assessing interactions between chest compression rate and depth or overall CPR quality shows no consistent overall association with favorable neurological outcome when using guideline-compliant or combined “high-quality” CPR metrics[102,105,119,120] or with survival to hospital discharge or 30 days.[102,117,119,120] However, improved favorable neurological outcome and survival were reported in specific subgroups, including in patients achieving ROSC only after prolonged CPR,[102] in those receiving compressions within empirically defined *optimal* rate-depth ranges,[105] and in those receiving high-quality bystander CPR.[119]

Table 6. Summary of Evidence for Chest Compressions in Adults

Component	Outcome	Evidence base	Key findings
Rate	Survival with good neurological outcome	1 OHCA RCT[108] (N = 292)	*No difference:* 100/min versus 120/min
		2 OHCA observational studies[99,125] (N ≈ 23 009)	*Increased outcome* with 100–120/min versus 50–99/min[99] *No difference*: 50–99/min versus >120/min[99] Mean rate[125]
		1 IHCA observational study[113] (N = 222)	*No difference:* 100–120/min versus outside range
	Survival to hospital discharge or 30 d	1 OHCA RCT[108] (N = 292)	*No difference:* 100/min versus 120/min
		8 OHCA observational studies,[109-111,117,123-126] 1 OHCA/IHCA observational study[122] (N ≈ 45 000)	*Increased outcome* with 100–110/min versus <100/min[111] *Decreased outcome* with 80–99/min and 120–139/min versus 100–119/min (after adjustment for compression depth and fraction)[110] *No clinically important difference:* Mean rate[123,124] *No difference*: <100/min versus 110–120/min[111] 80–140/min versus outside range[109] 80–120/min versus outside range[126] Per 10/min increase[117] Mean/median rate[111,122,125]
	Survival to hospital arrival or admission	2 OHCA: 1 feedback RCT,[101] 1 observational study[114] (N ≈ 284)	*No difference*: 90–120/min versus outside range[114] Mean rate[101]
	ROSC	1 OHCA RCT[108] (N = 292)	*No difference:* 100/min versus 120/min
		6 OHCA observational studies,[103,104,109,110,117,126] 1 OHCA/IHCA observational study[122] (N ≈ 25 000)	*No difference*: 80–120/min versus outside range[103] 80–140/min versus outside ranges[109] 110–119/min versus outside range[110] Per 10/min increase[117] 80–120/min versus outside range[126] Mean rate[104,122]
		2 IHCA observational studies[98,113] (N ≈ 5000)	*Increased outcome* With sustained ROSC >20 min at rates 121–140/min versus 100–120/min[113] With mean rate in patients who achieved ROSC (90/min versus 79/min)[98] *No difference:* >141/min compared with 100–120/min[113]
	Physiological outcomes ($ETCO_2$, arterial BP)	4 studies: 3 OHCA,[104,116,118] 1 OHCA/IHCA observational study[122] (N ≈ 800)	*$ETCO_2$ increased* per 10/min increase over 76/min[116] and in nonshockable rhythm subgroup[104] *$ETCO_2$ no difference*: 60/min versus higher ranges (80–140/min)[118]

Component	Outcome	Evidence base	Key findings
			Per 10/min increase all rhythms or shockable rhythm subgroup[104] Per 10/min increase between 90–130/min[122] *BP increased*: Mean SBP increased with decreasing rates (highest at 60/min; lowest at 140/min)[118] *DBP no difference:* Mean rate[118]
		1 IHCA observational[112]	*ETCO$_2$ increased* at higher rates[112]
Depth	Survival with good neurological outcome (CPC 1–2/mRS <3)	1 OHCA observational study[125] (N = 418)	*No difference*: 38–50.9 mm versus outside ranges[125] Per 5-mm increase[125]
	Survival to hospital discharge or 30 d	5 OHCA observational studies[111,117,123-125] (N ≈ 16 000)	*Decreased outcome* with depth <38 mm versus >51 mm[124] *Increased outcome* With mean depth (53.6 mm versus 48.8 mm)[125] Per 5-mm increase[124,125] *No difference*: <38 mm versus >51 mm[117,124] <38 mm versus high ranges[123] 38–50.9 mm versus outside ranges[125] >50 mm versus <50 mm[111] Mean or median depth[111,123] Per 5-mm increase[123]
	Survival to ED arrival or hospital admission	5 OHCA studies: 1 feedback RCT,[101] 4 observational studies[114,117,123,124] (N ≈ 12 000)	*Decreased:* 1-d survival <38 mm versus 51 mm[124] or versus 35–51 mm[123] *Increased outcome* With survival to ED >51 mm versus <38 mm[117] Per 1-mm increase[114] or 5-mm increase[124] *No difference*: <38 mm versus 38–51 mm[117,124] <38 mm versus >51 mm[123] <50 mm versus higher ranges[117] Mean depth[101] Per 5-mm increase[123]
	ROSC	4 OHCA observational studies[100,104,123,124] (N ≈ 16 000)	*Decreased outcome* with ranges <51 mm versus >51 mm[124] *Increased outcome* per 5-mm increase[124] *No difference*: <38 mm versus high ranges[123] Mean depth[100,104]
	Physiological outcomes (ETCO$_2$)	2 OHCA studies,[104,116] 1 OHCA/IHCA observational study[122] (N ≈ 800)	*ETCO$_2$ increased* per 10-mm increase[104,116,122]
Recoil and leaning	All outcomes	No studies	–

Component	Outcome	Evidence base	Key findings
Interactions (rate × depth / CPR quality)	Survival with good neurological outcome (CPC 1–2/mRS <3)	4 OHCA observational studies[102,105,119,120] (N ≈ 25 000)	*Increased outcome* In subgroups with high-quality CPR metrics when ROSC achieved after >10 min[102] With compressions within empirically derived "optimal" rate-depth ranges[105] With high-quality bystander CPR[119] *No difference* Using feedback to achieve guideline-compliant CPR metrics[120] With high-quality CPR metrics[102]
	Survival to hospital discharge or 30 d	4 OHCA observational studies[102,117,119,120] (N ≈ 30 000)	*Increased outcome* In subgroups with high-quality CPR metrics when ROSC achieved after >10 min[102] With high-quality bystander CPR[119] *No difference* Using feedback to achieve guideline-compliant CPR metrics[120] With high-quality CPR metrics[102] Across combined rate-depth groupings[117] or real-time feedback implementation[120]
	24-h survival	1 OHCA observational study[120] (N = 32)	*No difference* using feedback to achieve guideline-compliant CPR metrics[120]
	ROSC	2 OHCA observational studies,[119,120] 1 ED observational study[115] (N ≈ 2500)	*Increased outcome with* high-quality bystander CPR[119] *No difference*: Guideline-compliant CPR[115] Using feedback to achieve guideline-compliant CPR metrics[120]
	Physiological outcomes (arterial BP; $ETCO_2$)	2 mixed OHCA/IHCA observational studies[121,122] (N ≈ 600)	*$ETCO_2$ increased* per 10-mm increase in rate; no difference for depth[122] *BP:* Multiple rate-depth combinations associated with higher odds of achieving arterial BP targets versus reference[121]

BP indicates blood pressure; CPC, Cerebral Performance Category; CPR, cardiopulmonary resuscitation; DBP, diastolic blood pressure; ED, emergency department; $ETCO_2$, end-tidal carbon dioxide; IHCA, in-hospital cardiac arrest; mRS, modified Rankin Scale; OHCA, out-of-hospital cardiac arrest; ROSC, return of spontaneous circulation; and SBP, systolic blood pressure.

Infants and Children

Results for studies in children are presented in Table 7. In infants and children, observational evidence shows no consistent association between chest compression rate,[127,131] depth,[128,132,133] and patient or physiological[130,131,134-136] outcomes. No studies in infants and children evaluated interactions between chest compression rate and depth.

Table 7. Summary of Evidence for Chest Compressions in Infants and Children

Component	Outcome	Evidence base	Key findings (comparisons, measures, and references)
Rate	Survival with good neurological outcome	1 IHCA observational study[131] (N = 164)	*Increased outcome* with 80–99/min versus 100–120/min in term infants to 18 y *No difference*: For guideline-compliant versus noncompliant rates 100–120/min versus higher ranges in term infants to 18 y
	Survival to hospital discharge	1 OHCA observational study[132] (N = 383)	*No difference:* 100–120/min versus outside ranges
		2 IHCA observational studies[127,131] (N ≈ 580)	*Increased outcome* with 80–99/min versus 100–120/min *No difference*: 100–120/min versus higher ranges[131] Median rate[127]
	Survival at 24 h	1 OHCA observational study[132] (N = 383)	*No difference:* 100–120/min versus outside ranges
	ROSC	1 OHCA observational study[132] (N = 390)	*No difference:* 100–120/min versus outside ranges
		1 IHCA observational study[131] (N = 164)	*No difference*: 100–120/min versus outside ranges For guideline-compliant versus noncompliant rates
	Physiological outcomes (arterial BP; $ETCO_2$)[131]	5 IHCA observational studies[130,131,134-136] (N ≈ 380)	*$ETCO_2$ decreased:* <15 mm Hg with higher rates[135] *$ETCO_2$ no difference*: Mean $ETCO_2$ with 100/min versus 140/min[130,136] Mean rate[130] *SBP increased:* ≥100/min versus <100/min[134] *SBP decreased*: >120/min versus 100–120/min[131] *No difference*: SBP 100–120/min versus 89–99 or >140/min[131] DBP 100–120/min versus outside ranges[131]
Depth	Survival with good neurological outcome	2 IHCA observational studies[128,133] (N ≈ 192)	*No difference*: Average depth of ≥40 mm for age <1 y and ≥50 mm for age ≥1 y versus other[128] <38 mm versus ≥38 mm (unadjusted)[133]
	Survival to hospital discharge	1 OHCA observational study[132] (N = 153)	*No difference (unadjusted):* <38 mm versus ≥38 mm

Component	Outcome	Evidence base	Key findings (comparisons, measures, and references)
		2 IHCA observational studies[128,133] (N ≈ 192)	*No difference (unadjusted)*[128]*:* <38 mm versus ≥38 mm[133]
	Survival to ED arrival or hospital admission	1 OHCA observational study[132] (N = 153)	*No difference (unadjusted):* <38 mm versus ≥38 mm[132,133]
		1 IHCA observational study[133] (N ≈ 78)	*Increased outcome* with a greater proportion of compressions >51 mm versus <51 mm
	ROSC	1 OHCA observational study[132] (N = 153)	*No difference:* <38 mm versus ≥38 mm
		2 IHCA observational studies[128,133] (N ≈ 192)	*Increased outcome* with >51 mm versus <51 mm[133] *No difference* with average depth of ≥ 40 mm vs <40mm for age < 1 year and ≥ 50 mm or <50mm for age ≥ 1 year [128]
	Physiological outcomes (arterial BP; ETCO$_2$)	3 IHCA observational studies[129,130,134] (N ≈ 200)	*ETCO$_2$ no difference* in mean depth[130] *Increased mean SBP, MAP, and pulse pressure* with deeper compressions[129] *SBP no difference:* <38 mm versus ≥38 mm[134]
Recoil and leaning	All outcomes	No pediatric studies	–
Interactions (rate × depth / CPR quality)	Clinical outcomes	No pediatric studies	–
	Physiological outcomes (arterial BP)	1 IHCA observational study[134] (N = 9)	*SBP and DBP increased* with a combination of rate >100/min and depth >38 mm (versus <100/min and <38 mm)

BP indicates blood pressure; CPR, cardiopulmonary resuscitation; DBP, diastolic blood pressure; ED, emergency department; ETCO$_2$, end-tidal carbon dioxide; IHCA, in-hospital cardiac arrest; MAP, mean arterial pressure; OHCA, out-of-hospital cardiac arrest; ROSC, return of spontaneous circulation; and SBP, systolic blood pressure.

Task Force Insights

This ScopRev demonstrated that most studies focused on a single chest compression component, and several studies suggest the presence of confounding interactions that should prompt caution when any chest compression component is evaluated in isolation. Most adult studies identified in this review were focused on OHCA; in contrast, studies in infants and children were predominantly focused on IHCA. Studies are heterogeneous, and making direct comparisons between studies is difficult. In the RCTs, the chest compression components were not the variables primarily being investigated. There is a lack of consistency in results between studies.

This expanded ScopRev identified sufficient new evidence to prioritize updating the 2015 SysRevs and the CoSTR; however, to ensure continuity and usability of international guidance on the core components of CPR, the existing treatment recommendations remain in place while SysRev updates are undertaken. Based on the results of this ScopRev and the a priori decision of the PLS Task Force to use adult data as indirect evidence for compression rate, the PLS Task Force has prepared a good practice statement in the interim until the SysRev and CoSTR can be updated.

2026 Treatment Recommendations (Unchanged From 2015)

- We recommend a manual chest compression rate of 100 to 120/min (strong recommendation, very low–certainty evidence).
- We recommend a chest compression depth of approximately 5 cm (2 inches) (strong recommendation, low-certainty evidence) while avoiding excessive chest compression depths (>6 cm [>2.4 inches] in an average adult) during manual CPR (weak recommendation, low-certainty evidence).
- We suggest that rescuers performing manual CPR avoid leaning on the chest between compressions to allow full chest wall recoil (weak recommendation, very low–certainty evidence).
- We suggest that rescuers compress the chests of infants by at least one third the anteroposterior dimension, or approximately 1½ inches (4 cm). We suggest that rescuers compress the child’s chest by at least one third of the anteroposterior dimension, or approximately 2 inches (5 cm) (weak recommendation, very low–quality evidence).

2026 Good Practice Statement (New)

- The target for manual chest compression rate may be 100 to 120/min for infants and children in cardiac arrest (good practice statement).

Knowledge Gaps

- Studies in infants and children evaluating clinical outcomes related to chest compression rate, depth, recoil or leaning, or their interactions
- Evidence to define appropriate chest compression depth in infants and children based on patient size or weight
- Clinical outcomes using measured compression depth from feedback devices compared with estimated depth based on anteroposterior chest diameter changes; further clinical studies using dual-sensor technology linked to P-COSCA[96,97]
- Optimal targets for chest compression rate, depth, and recoil in infants and children
- The effect of leaning and recoil on clinical outcomes
- Randomized trials or high-quality observational studies assessing individual compression components and their interactions on critical and important outcomes
- The optimal combination of chest compression rate and depth during CPR

Rhythm Analysis During Compressions (BLS 2211: SysRev)

Rationale for Review

The analysis of rhythm during CPR has the potential to reduce pauses in chest compressions.[139,140] This topic was last reviewed in a SysRev by ILCOR in 2019,[7,8] which found no studies examining patient outcomes. An update on this topic was prioritized following the publication of 2 observational studies in humans.[141,142] The SysRev was registered on

PROSPERO (CRD42024627999) before initiation. The full online CoSTR can be found on the ILCOR website.[143]

Population, Intervention, Comparator, Outcome, Study Design, and Time Frame

- Population: Adults in cardiac arrest in any setting (out-of-hospital or in-hospital)
- Intervention: Analysis of cardiac rhythm during chest compressions
- Comparator: Analysis of cardiac rhythm during pauses in chest compressions
- Outcomes
  - Critical: Survival to hospital discharge with good neurological outcome and survival to hospital discharge or 30 days
  - Important: ROSC and CPR quality metrics (eg, CCF, pauses in compressions, and compressions per minute)
- Study designs: RCTs and nonrandomized studies (non-RCTs, interrupted time series, controlled before-and-after studies, cohort studies) were eligible for inclusion. Studies reporting the development or validation of artifact-filtering algorithms were excluded. Unpublished studies (eg, conference abstracts, trial protocols) were excluded. All languages were included provided that there was an English abstract.
- Time frame: September 23, 2019, to October 24, 2025

Consensus on Science

Two new before-and-after observational studies evaluated the implementation of real-time rhythm analysis during chest compressions in AEDs used by BLS-trained first responders.[141,142] Both studies compared the intervention period to a period using conventional rhythm checks (ie, stopping chest compressions to check rhythm at 2-minute intervals). The certainty of evidence was very low, downgraded for serious risk of bias. One study reported (as a secondary end point) no difference in patient survival between groups (Table 8).[142] Both studies reported small statistically significant improvements in CPR metrics.

Table 8. Summary of New Evidence for Rhythm Analysis During Compressions

Author (year)	Intervention and control	Outcomes (control versus intervention)
Derkenne (2024)[142]	570 OHCA patients were treated with either an AED with the AWC algorithm (n = 285 from 2021–2022) or a conventional AED (n = 285 from 2017). The AWC algorithm allowed real-time rhythm analysis during chest compressions, triggering an earlier rhythm check if ventricular fibrillation was detected. In the control group, rhythm checks occurred during pauses in compressions at fixed 2-min intervals.	*No difference*: Survival to hospital discharge (25.3% versus 28.0% [$P = 0.49$]; adjusted hazard ratio, 0.96 [95% CI, 0.78–1.18]; $P = 0.49$) *No difference*: Survival to hospital admission (62.1% versus 59.6%; $P = 0.55$) *Higher* median (IQR) CCF with AWC algorithm (72% [67%–76%] versus 77% [72%–80%] $P < 0.001$)
De Graaf (2021)[141]	783 OHCA patients were treated with either an AED with the cprINSIGHT algorithm (n = 425 from 2016–2017) or a conventional AED (n = 465 from 2018–2019). The cprINSIGHT algorithm allowed real-time rhythm analysis during chest compressions by using transthoracic impedance filtering to classify rhythms as shockable, nonshockable, or inconclusive. If the rhythm was shockable, the AED precharged and delivered the shock at the end of the 2-min cycle, whereas a nonshockable rhythm resulted in uninterrupted CPR. In the control group, rhythm checks occurred during pauses in compressions at fixed 2-min intervals.	*Higher* median (IQR) CCF with cprINSIGHT algorithm (80% [73%–86%] versus 86% [79%–92%]; $P < 0.001$) *Shorter* median (IQR) preshock pause with cprINSIGHT algorithm (22 s [20–24 s] versus 8 s [7–11 s]; $P < 0.001$) *Shorter* median (IQR) perishock pause with cprINSIGHT algorithm (25 s [22–29 s] versus 12 s [10–16 s]; $P < 0.001$)

AED indicates automated external defibrillator; AWC, Analyze While Compressing; CCF, chest compression fraction; CPR, cardiopulmonary resuscitation; and OHCA, out-of-hospital cardiac arrest.

Prior Treatment Recommendations (2020)

We suggest against the routine use of artifact-filtering algorithms for analysis of electrocardiographic rhythm during CPR (weak recommendation, very low–certainty evidence).

We suggest that the usefulness of artifact-filtering algorithms for analysis of electrocardiographic rhythm during CPR be assessed in clinical trials or research initiatives (weak recommendation, very low–certainty evidence).

2026 Treatment Recommendations

We suggest that the usefulness of artifact-filtering algorithms for analysis of electrocardiographic rhythm during CPR be assessed in clinical trials or research initiatives (good practice statement).

Justification and Evidence-to-Decision Framework Highlights

The complete evidence-to-decision table is included in Appendix A.

Given the absence of RCTs or well-controlled observational studies, the BLS Task Force concluded that the available evidence was insufficient to support a treatment recommendation for routine clinical practice. Additional considerations included the potential costs of implementing new technologies without proven clinical benefit; however, no evidence of harm was identified in the existing studies. Consequently, the 2020 treatment recommendation was replaced with a good practice statement, suggesting that artifact-filtering algorithms for rhythm analysis during CPR should be further evaluated in clinical trials or other research initiatives. The Task Force also encourages EMS systems that already use these technologies to report their experiences to strengthen the evidence base.

Knowledge Gaps

- The effect of artifact-filtering algorithms on critical or important patient outcomes
- High-quality observational studies, with contemporary control groups, evaluating critical or important patient outcomes

Anticipatory Charging of the Defibrillator (BLS 2605, ALS 3105: SysRev)

Rationale for Review

This nodal SysRev, conducted by the BLS and ALS Task Forces, is the first SysRev on anticipatory charging undertaken by ILCOR. A previous ScopRev performed by the ALS Task Force in 2019[144] found simulation evidence that anticipatory charging was feasible, but the lack of clinical studies resulted in no treatment recommendation.[145,146] Since that time, additional clinical studies for patient outcomes have been published.[147-149] The SysRev[150] was registered on PROSPERO (CRD420251068149) before initiation. The full online CoSTR can be found on the ILCOR website.[151]

Population, Intervention, Comparator, Outcome, Study Design, and Time Frame

- Population: Adults in cardiac arrest in any setting (out-of-hospital or in-hospital)
- Intervention: Charging the defibrillator prior to rhythm analysis
- Comparator: Charging the defibrillator after rhythm analysis
- Outcomes
  - Critical: Survival to hospital discharge or ≥30 days with good neurological outcome and survival to hospital discharge or ≥30 days
  - Important: Event survival, ROSC
  - Other: Defibrillation success, preshock pause, hands-off time, postshock pause, perishock pause, CCF, hands-on time, and provider safety (inadvertent shocks)
- Study designs: RCTs and nonrandomized studies (non-RCTs, interrupted time series, controlled before-and-after studies, cohort studies) were eligible for inclusion. Studies reporting the development or validation of artifact-filtering algorithms were excluded.

Unpublished studies (eg, conference abstracts, trial protocols) were excluded. Manikin and animal studies exploring the impact of anticipatory charging on resuscitation quality outcomes (eg, hands-off time) were also considered for inclusion. All languages were included provided that there was an English abstract.

- Time frame: All years to November 24, 2025

Consensus on Science

No RCTs in humans were identified. Eleven studies were included: 5 observational clinical studies in adults or both adults and children (4 out-of-hospital and 1 in-hospital)[147-149,152,153] and 6 simulation studies (5 randomized[154-158] and 1 nonrandomized[159]). *Anticipatory charging*, defined as charging the defibrillator during ongoing chest compressions in anticipation of defibrillation, was compared with *standard charging*, or charging after rhythm analysis with pauses in compressions (Figure, adapted[147]). Additionally, 2 observational studies[147,152] and 2 simulation studies[156,157] compared anticipatory charging with the European Resuscitation Council (ERC) and American Heart Association (AHA) 2010 method (charging immediately after rhythm analysis with minimal interruption to compressions).[160,161] Considerable heterogeneity in study design, bundled interventions, and outcome reporting precluded meta-analysis.

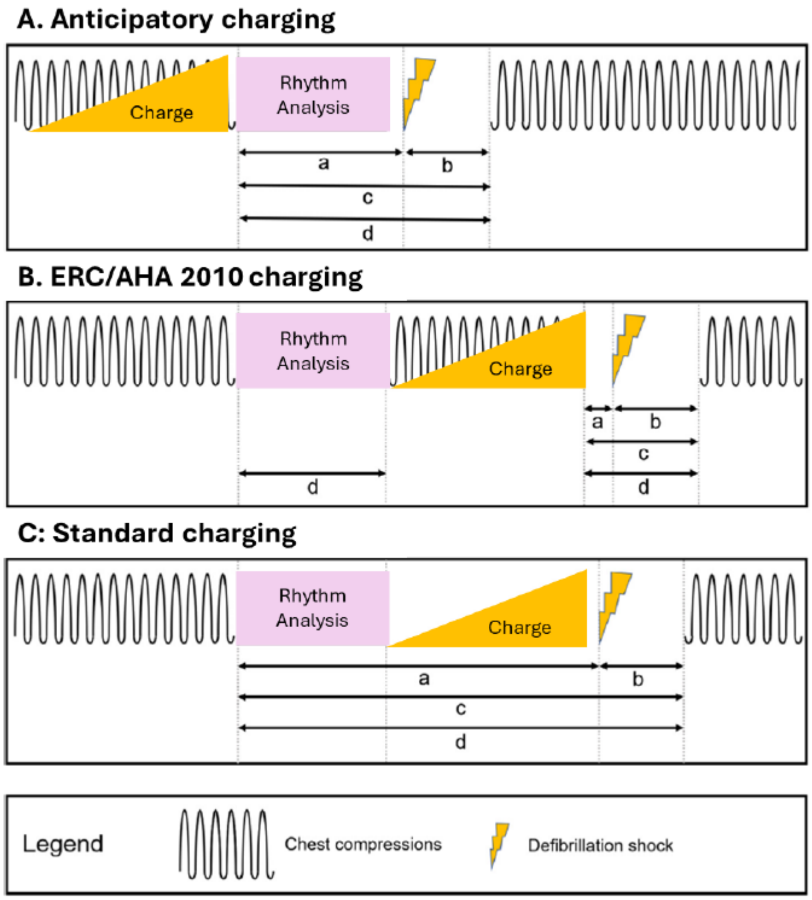

Figure. Methods used to charge the defibrillator. Intervals depicted in the figure represent (a) preshock pause, (b) postshock pause, (c) perishock pause, and (d) hands-off time during defibrillation procedure.
Modified from Iversen BN, Meilandt C, Væggemose U, Terkelsen CJ, Kirkegaard H, Fjølner J. Pre-charging the defibrillator before rhythm analysis reduces hands-off time in patients with out-of-hospital cardiac arrest with shockable rhythm. *Resuscitation*. 2021;169:23–30. doi: 10.1016/j.resuscitation.2021.09.037. This is an Open Access article under the CC BY 4.0 license.

Key study results are presented in Table 9. Across clinical studies, the certainty of evidence for critical outcomes was very low, downgraded for risk of bias indirectness and imprecision. One cohort study found higher neurologically intact survival with a bundled intervention that included anticipatory charging,[147] while survival to discharge or 30 days,[147-149] event survival,[148,149,153] and ROSC[147-149,153] results were inconsistent across studies when anticipatory charging was implemented as part of broader resuscitation bundles.[147-149,153] CPR quality outcomes suggested that anticipatory charging may reduce preshock,[147,148] postshock,[147] and perishock pauses[147] and increase CCF[147] compared with standard charging, though results were mixed when compared with the ERC/AHA 2010 method.[147,152] The effects on compression rate, depth, and recoil were minimal but suggest an improvement with the anticipatory or ERC/AHA 2010 method compared with standard charging.[148,152] One study reported no increase in defibrillation-related safety events between anticipatory charging and the ERC/AHA 2010 method.[147]

Simulation studies generally supported reductions in pauses[154,158] and hands-off time[156] with anticipatory charging compared with standard charging, but findings were inconsistent when compared with the ERC/AHA 2010 method[155,157] and effects on compression rate, depth, and recoil were minimal.[154,156,158]

Table 9. Summary of Evidence for Anticipatory Charging of the Defibrillator During CPR

Outcome	**Evidence type**	**Key findings**	**Certainty of evidence**
Favorable neurological survival (discharge or 30 d)	1 retrospective observational study[153]	*Improved outcome* with anticipatory charging (as part of a bundled intervention) compared with standard charging	Very low
Survival to hospital discharge or 30-d survival	3 retrospective observational studies[147-149]	*Improved outcome* with anticipatory charging (as part of a bundled intervention) compared with standard charging in 2 studies[148,149] *No difference* between anticipatory charging and either standard or ERC/AHA 2010 charging in 1 study[147]	Very low
Event survival	3 retrospective observational studies[148,149,153]	*Improved outcome* with anticipatory charging (as part of a bundled intervention) compared with standard charging in 1 study[148] *No difference* between anticipatory charging and standard charging in 2 studies[149,153]	Very low
ROSC	4 retrospective observational studies[147-149,153]	*Improved outcome* with anticipatory charging (as part of a bundled intervention) compared with standard charging in 2 studies[148,153] *No difference* between anticipatory charging (as part of a bundled intervention in EMS witnessed) and standard charging in 1 study[149] or when compared with a combination of standard and ERC/AHA 2010 charging in 1 study[147]	Very low

Outcome	Evidence type	Key findings	Certainty of evidence
CPR quality: preshock pause	3 retrospective observational studies[147,148,152]	*Reduced* preshock pause with anticipatory charging compared with standard charging in 2 studies,[147,148] and with combined anticipatory and ERC/AHA 2010 charging compared with standard charging in 1 study[152] *No difference* between anticipatory charging and ERC/AHA 2010 charging in 1 study[152]	Very low
	3 simulation RCTs[154,157,158]	*Reduced* preshock pause with anticipatory charging compared with standard charging in 2 studies[154,158] *Increased* with anticipatory charging compared with ERC/AHA 2010 charging in 1 study[157]	Very low
CPR quality: postshock pause	2 retrospective observational studies[147,152]	*Reduced* postshock pause with anticipatory charging compared with standard charging in 1 study[147] *Reduced* postshock pause with combined anticipatory charging and ERC/AHA 2010 charging compared with standard charging in 1 study[152] *No difference* between anticipatory charging and ERC/AHA 2010 charging in 2 studies[147,152]	Very low
	3 simulation RCTs[154,157,158]	*Increased* postshock pause with anticipatory charging compared with ERC/AHA 2010 charging in 1 study[157] *No difference* between anticipatory charging and standard charging in 2 studies[154,158]	Very low
CPR quality: perishock pause	1 retrospective observational study[147]	*Reduced* perishock pause with anticipatory charging compared with standard charging *Increased* perishock pause with anticipatory charging compared with ERC/AHA 2010 charging	Very low
	2 simulation RCTs[157,158] 1 simulation non-RCT[159]	*Reduced* perishock pause with anticipatory charging compared with standard charging in 1 study[158] *Increased* perishock pause with anticipatory charging compared with ERC/AHA 2010 charging in 1 study[157] *Reduced* perishock pause with anticipatory charging compared with standard charging in 1 study[159]	Very low
CPR quality: total pauses	4 simulation RCTs[154,155,157,158]	*Reduced* total pauses with anticipatory charging compared with standard charging in 2 studies[154,158] and compared with ERC/AHA 2010 charging in 1 study[155]	Very low

Outcome	Evidence type	Key findings	Certainty of evidence
		Increased total pauses with anticipatory charging compared with ERC/AHA 2010 charging in 1 study[157]	
CPR quality: CCF, hands-on time	1 retrospective observational study[148]	*Increased* CCF and hands-on time with anticipatory charging compared with standard charging	Very low
	1 simulation RCT[156]	*Reduced* hands-off time with anticipatory charging compared with ERC/AHA 2010 charging	Very low
CPR quality: compression rate and depth	2 retrospective observational studies[148,152]	*Increased* compression depth with anticipatory charging (as part of a bundled intervention) compared with standard charging in 1 study[148] *No difference* in depth between anticipatory charging and ERC/AHA 2010 charging or between combined ERC/AHA 2010 charging and standard charging in 1 study[152] *Increased* compression rates with combined anticipatory charging and ERC/AHA 2010 charging compared with standard charging in 1 study[152] *No difference* in compression rates between anticipatory charging and ERC/AHA 2010 charging[152] or standard charging[148]	Very low
	3 simulation RCTs[154,156,158]	*No meaningful differences* for rate, depth, or recoil between anticipatory charging and standard charging in 3 studies[154,156,158] *Decreased* compression rates with anticipatory charging embedded into AED technology compared with standard charging in 1 study[156]	Very low
Defibrillation safety (inadvertent shocks)	1 retrospective observational study[152]	*No differences* with anticipatory charging compared with standard charging and ERC/AHA 2010 charging	Very low

AED indicates automated external defibrillator; AHA, American Heart Association; CCF, chest compression fraction; CPR, cardiopulmonary resuscitation; EMS, emergency medical services; ERC, European Resuscitation Council; ROSC, return of spontaneous circulation; and RCT, randomized controlled trial.

Prior Treatment Recommendations

None

2026 Treatment Recommendations

We suggest charging a manual defibrillator during chest compressions, either before or after rhythm analysis (weak recommendation, very low–certainty evidence). Both approaches require appropriate training to ensure safe and effective delivery (good practice statement).

Justification and Evidence-to-Decision Framework Highlights

The complete evidence-to-decision table is included in Appendix A.

Pauses in chest compressions during cardiac arrest are consistently associated with poorer defibrillation success and survival, with rhythm analysis and defibrillation representing the most important sources of interruption.[106,162-164] Overall, the evidence suggests potential CPR process benefits with anticipatory charging, but with substantial uncertainty regarding patient-centered outcomes.

The clinical evidence is currently largely limited to observational studies, many of which evaluated anticipatory charging as part of broader resuscitation bundles, introducing indirectness and limiting attribution of benefit to charging strategy alone. These studies were generally underpowered to detect improvements in patient-centered outcomes, and the clinical benefit of anticipatory charging compared with the ERC/AHA 2010 method remains uncertain. Although available data suggest that inadvertent shocks are uncommon,[106] the safety profile of anticipatory charging is not well quantified, particularly with respect to near-miss events and human-factor risks, and its implementation would require additional training and resources.[165,166] Balancing the potential to reduce CPR interruptions against very low–certainty evidence, uncertainty in clinical benefit, limited safety data, and the need for structured team training, the BLS and ALS Task Forces judged that a weak recommendation was appropriate, alongside a good practice statement emphasizing the importance of training to ensure safe and effective charging during chest compressions.

Knowledge Gaps

- The effect of anticipatory charging compared with standard charging or the AHA/ERC 2010 method on critical or important clinical outcomes
- The effect of these 2 charging approaches on outcomes in children
- High-quality data on adverse events (eg, near misses, incorrect shock delivery, and increased exposure to electrical risk)
- The impact of anticipatory charging on inappropriate shocks for asystole and pulseless electrical activity

Evidence Updates

The BLS EvUps for 2026 are summarized in Table 10. The complete EvUps are provided in Appendix B.

Table 10. Topics Reviewed by BLS EvUps

Topic/PICO	Year of last SysRev	Existing treatment recommendation	RCTs since last review	Observational studies since last review	Key findings	Sufficient data to warrant SysRev?
Immediate resuscitation in water or on boat in drowning (BLS 2702/2703)	2023	We suggest in-water resuscitation (ventilations only) may be delivered if rescuers, trained in this technique, determine that it is feasible and safe with the equipment available and the distance to land warrants its use (weak recommendation, very	0	0	N/A	No

Topic/PICO	Year of last SysRev	Existing treatment recommendation	RCTs since last review	Observational studies since last review	Key findings	Sufficient data to warrant SysRev?
		low–certainty evidence). We suggest on-boat CPR may be delivered if rescuers trained in this technique determine that it is feasible and safe to attempt resuscitation (good practice statement). If the rescuers feel that the application of immediate CPR is or becomes too difficult or unsafe, then the rescuers may delay resuscitation until on land (good practice statement).				
CAB versus ABC in drowning (BLS 2704)	2023	We recommend a compression-first strategy (CAB) for laypeople providing resuscitation for adults in cardiac arrest caused by drowning (good practice statement). Health care professionals and those trained and with a duty to respond to drowning (eg, lifeguards) should consider providing rescue breaths or ventilation first (ABC), before chest compressions (good practice statement).	0	0	N/A	No
Chest compression–only CPR in cardiac arrest in	2023	For lay responders, the treatment recommendations for CPR in drowned OHCA patients who	0	1[167]	*Matched analysis:* Improved neurological outcomes	No

Topic/PICO	Year of last SysRev	Existing treatment recommendation	RCTs since last review	Observational studies since last review	Key findings	Sufficient data to warrant SysRev?
drowning (BLS 2705)		have been removed from the water remain consistent with CPR for all patients in cardiac arrest (good practice statement). Adults: We recommend that bystanders perform chest compressions for all patients in cardiac arrest. We suggest that bystanders who are trained, able, and willing to give rescue breaths and chest compressions do so for adults in cardiac arrest. Children: We suggest that bystanders provide CPR with ventilation for infants and children younger than 18 y with OHCA. We recommend that if bystanders cannot provide rescue breaths as part of CPR for infants and children younger than 18 y with OHCA, they should at least provide chest compressions. For health care professionals and those with a duty to respond to drowning (eg, lifeguards), we recommend providing ventilation in addition to chest compressions if they have been trained and are able and willing to do so			with conventional CPR in ages <35 y and accidental drowning OHCA No significant difference ages ≥35 y	

Topic/PICO	Year of last SysRev	Existing treatment recommendation	RCTs since last review	Observational studies since last review	Key findings	Sufficient data to warrant SysRev?
		(good practice statement).				
Ventilation equipment in cardiac arrest following drowning (BLS 2706)	2023	We recommend using mouth-to-mouth, mouth-to-nose, or pocket-mask ventilation by BLS providers and laypeople for adults and children in cardiac arrest caused by drowning (good practice statement). We suggest that BMV can be used by lifeguards or other BLS providers with a duty to respond, on the condition that it is part of a competency-based training program with regular retraining and maintenance of equipment (good practice statement). We recommend that health care professionals follow the ALS treatment recommendations for airway management for adults and children in cardiac arrest caused by drowning.	0	1 retrospective[168]	No difference in 1-mo survival or favorable neurological outcome for ETI versus SGA The ROSC rate was higher in those treated with ETI versus SGA (207/3566 [5.8%] versus 167/3566 [4.7%], respectively; aOR, 1.25; 95% CI, 1.02–1.55).	No
Prehospital oxygen administration following drowning (BLS 2707)	2023	When available, we recommend trained providers use the highest possible inspired oxygen concentration during resuscitation for adults and children in cardiac arrest following drowning (good practice statement).	0	2 retrospective observational studies[169,170]	Increased ROSC with oxygen therapy (unadjusted OR, 3.23 [95% CI, 1.31–7.94]; $P < 0.01$)[169] No difference in survival to	No

Topic/PICO	Year of last SysRev	Existing treatment recommendation	RCTs since last review	Observational studies since last review	Key findings	Sufficient data to warrant SysRev?
					discharge with lifeguard oxygen (included non-OHCA drownings)[170]	
AED use first versus CPR first in cardiac arrest in drowning (BLS 2708)	2023	We recommend that CPR should be started first and continued until an AED has been obtained and is ready for use for adults and children in cardiac arrest caused by drowning (good practice statement). When available, we recommend an AED is used in cardiac arrest caused by drowning in adults and children (good practice statement).	0	1 retrospective observational studies[169]	No difference in ROSC (AED applied in 27%, shock in 4%)	No
PAD programs for drowning (BLS 2709)	2023	This treatment recommendation is unchanged from the standing recommendation for all OHCAs. We recommend implementing PAD programs for all patients with OHCA (strong recommendation, low-certainty evidence).	RCTs since last review			No

ABC indicates airway, breathing, circulation; AED, automated external defibrillator; ALS, advanced life support; aOR, adjusted odd ratio; BLS, basic life support; BMV; bag-mask ventilation; CAB, compressions, airway, breathing; CPR, cardiopulmonary resuscitation; ETI, endotracheal intubation; EvUps, evidence updates; OHCA, out-of-hospital cardiac arrest; OR, odds ratio; PAD, public access defibrillation; PICO, population, intervention, comparator, outcome; RCT, randomized controlled trial; ROSC, return of spontaneous circulation; SGA, supraglottic airway; and SysRev, systematic review.

ADVANCED LIFE SUPPORT

Thrombolytics During Cardiac Arrest (ALS 3203: SysRev)

Rationale for Review

The ALS Task Force has recently reviewed the use of thrombolytics during cardiac arrest suspected to be due to pulmonary embolism.[171-173] Use of thrombolytics for cardiac arrest in cases where pulmonary embolism is not suspected was last reviewed in 2010.[174] This SysRev for 2026 was undertaken to evaluate whether routine administration of thrombolytic therapy during cardiac arrest affects patient outcomes. This review was registered on PROSPERO (CRD420251121194), and the complete ILCOR CoSTR can be found online.[175]

Population, Intervention, Comparator, Outcome, Study Design, and Time Frame

- Population: Adults and children in any setting (in-hospital or out-of-hospital) with cardiac arrest
- Intervention: Administration of thrombolytic medication during CPR
- Comparator: No administration of thrombolytic medication during CPR
- Outcomes
  - Critical: Survival at hospital discharge or 30 days, survival with favorable neurological outcomes at hospital discharge or 30 days
  - Important: ROSC, safety outcomes (eg, bleeding), and postdischarge outcomes, including survival or favorable neurological outcomes or quality-of-life metrics (at any time)
- Study designs: RCTs were eligible for inclusion. Nonrandomized studies (non-RCTs, cohort studies, and case-control studies), animal studies, reviews, abstracts only, conference proceedings, letters, editorials, commentaries, unpublished trials, case reports, and case series

were not included. All languages were included provided that there was an English abstract or full text available.

- Time frame: All years to August 7, 2025

Consensus on Science

Three RCTs enrolling 1299 patients evaluated the use of thrombolytics during cardiac arrest.[176-178] The largest of these trials excluded patients for whom pulmonary embolism was suspected to be the cause of arrest.[177] Moderate-certainty evidence (downgraded for imprecision) showed no benefit from thrombolytic therapy for the critical outcomes of survival to hospital discharge or survival with favorable neurological outcome. There was also no difference in the important outcome of ROSC.

In the same 3 trials, definitions of bleeding outcomes varied but results consistently demonstrated that thrombolysis appeared to increase the risk of bleeding complications. In one of these RCTs,[177] 14/518 (2.7%) patients treated with thrombolytics had an intracranial hemorrhage compared with 2/514 (0.39%) patients not treated with thrombolytics (RR, 6.95; 95% CI, 1.4–30.4). No difference was found in symptomatic intracranial hemorrhage between groups.

Prior Treatment Recommendations (2010)

Routine administration of fibrinolytics for the treatment of IHCA and OHCA is not recommended.

2026 Treatment Recommendations

We recommend against the routine administration of thrombolytics during CPR for the treatment of cardiac arrest (strong recommendation, moderate-certainty evidence).

Justification and Evidence-to-Decision Framework Highlights

The complete evidence-to-decision table is provided in Appendix A.

This recommendation does not replace the existing treatment recommendation specifically for cardiac arrest associated with pulmonary embolism, which remains unchanged.[172,173]

Across randomized trials, thrombolytic therapy administered during cardiac arrest did not improve any critical or important outcomes. Low-certainty evidence also suggests an increased risk of bleeding, including a statistically significant increase in intracranial hemorrhage in 1 RCT.[177] Safety outcomes were judged to be at risk of verification bias, which would likely underestimate harms, given that not all patients underwent systematic evaluation for bleeding.

Resource implications were not trivial because thrombolytic therapy is costly, requires refrigerated storage, and must be prepared during resuscitation. The task force judged that the balance of effects favored avoiding routine thrombolytic use during cardiac arrest, given lack of demonstrated benefit and potential for harm.

Knowledge Gaps

- Identification of patient subgroups for whom thrombolytic therapy during arrest might be beneficial
- Evidence specific to IHCA and pediatric populations
- Long-term outcomes beyond hospital discharge or 30 days

IM Epinephrine for Cardiac Arrest (ALS 3212: SysRev Adolopment)

Rationale for Review

This topic was prioritized by the ALS Task Force because IM epinephrine has not previously been reviewed by ILCOR and has generated interest following a recent publication.[179] The continuous evidence evaluation process began with adolopment of a recently published SysRev that met ILCOR's methodological quality criteria.[180] The complete CoSTR can be found online.[181] The PLS Task Force also conducted an adolopment of this review, which is included in the PLS section of the CoSTR.

Population, Intervention, Comparator, Outcome, Study Design, and Time Frame

- Population: Adult patients in any setting (in-hospital or out-of-hospital) with cardiac arrest
- Intervention: IM route of epinephrine administration
- Comparator: Intravenous (IV) or intraosseous (IO) epinephrine administration
- Outcomes
    - Critical: Survival; survival with a favorable neurological outcome at hospital discharge, 28 days, or longer; and health-related quality of life (HRQOL)
    - Important: ROSC, administration of epinephrine, time to epinephrine, accuracy of dosing, and cost-effectiveness
- Study designs: SysRevs, RCTs, and non-RCTs (interrupted time series, controlled before-and-after studies, cohort studies) were included. Because we expected to find limited human data, animal studies were also included but analyzed separately. Simulation studies were included for process outcomes. All languages were included provided that there was an

English abstract. Unpublished studies (eg, conference abstracts, trial protocols) were excluded.

- Time frame: All years to June 2, 2025

Consensus on Science

Eight studies evaluated IM epinephrine for cardiac arrest, including 2 human observational studies,[179,182] 5 animal studies,[183-187] and 1 SysRev.[188]

The larger of the 2 human studies included all of the patients from the smaller study; therefore, only the larger study was considered.[179] This before-and-after observational study enrolled 1405 adults and compared an IM-first epinephrine protocol (giving an IM dose first, followed by standard IV or IO epinephrine) with standard IV or IO epinephrine. Time from the start of CPR to first epinephrine dose was shorter with the IM-first protocol (median, 4.3 min versus 7.8 min, respectively). Very low–certainty evidence (downgraded for risk of bias and imprecision) from this single study suggests an association between the IM-first protocol and survival to hospital admission (aOR, 1.37; 95% CI, 1.06–1.77), survival to hospital discharge (aOR, 1.73; 95% CI, 1.10–2.71), and favorable neurological outcome at discharge (aOR, 1.72; 95% CI, 1.07–2.76).

Animal studies were heterogeneous and primarily compared IM and IV routes directly, without addressing the clinically relevant question of IM epinephrine as an early adjunct to standard IV or IO therapy. These data were not considered when formulating treatment recommendations.

Prior Treatment Recommendations

None

2026 Treatment Recommendations

There is insufficient evidence to recommend adding intra-arrest IM epinephrine to standard resuscitation care for cardiac arrest (weak recommendation, very low–certainty evidence).

Justification and Evidence-to-Decision Framework Highlights

The complete evidence-to-decision table is provided in Appendix A.

Clinical evidence is limited to a single observational study with serious risk of bias because of confounding inherent in a before-and-after design. The single study evaluated a protocol of administering a first dose of IM epinephrine for adult OHCA patients followed by standard ALS including IV or IO epinephrine administration. No human evidence was identified comparing IM epinephrine only with IV or IO epinephrine or IM epinephrine only with no epinephrine for cardiac arrest. Consequently, the treatment recommendation does not extend to settings where subsequent IV or IO epinephrine administration is not available. The task force discussed the possibility that IM epinephrine could be useful in such settings, but there are no human data comparing IM only with no epinephrine to support a recommendation, and the question was not directly assessed by the PICO in the review used in this adolopment. The task force discussed the long median time to initial drug administration in most OHCA trials (20 min or more after collapse). Although IM epinephrine could possibly be administered earlier, whether this would be beneficial is not clear. In addition, the task force discussed whether focusing on implementation of IM epinephrine could result in delay of standard IV or IO epinephrine, which could inadvertently lead to harm.

The task force discussed that the relevance of IM-first epinephrine for IHCA is very unclear. Drugs are generally administered much earlier during IHCA than for OHCA, and IV access is often present at the time of IHCA.

Although IM epinephrine was associated with earlier drug administration, the effect on patient-centered outcomes remains uncertain. The inherent biases in the single before-and-after clinical research study make it difficult to determine the impact of IM epinephrine. The balance of effects favored further research rather than clinical implementation at this time.

Knowledge Gaps

- Dose response and pharmacokinetics of IM epinephrine in human cardiac arrest
- Whether early IM epinephrine added to standard IV or IO epinephrine improves outcomes
- Effectiveness of IM epinephrine in systems without timely access to IV or IO epinephrine
- Potential role of alternative non-IV routes of administration (eg, intranasal)

IV Volume Administration During and After Cardiac Arrest (ALS 3207, 3518: SysRev)

Rationale for Review

Intravascular volume therapy has long been used during and after cardiac arrest, despite uncertainty regarding its effectiveness and potential for harm. This SysRev[189] was undertaken to evaluate the effects of intravascular volume therapy administered during CPR and after ROSC in both nontraumatic and traumatic cardiac arrest. The review was registered on PROSPERO (CRD420251055283), and the complete CoSTR can be found online.[190]

Population, Intervention, Comparator, Outcome, Study Design, and Time Frame

- Population: Adults with cardiac arrest (traumatic or nontraumatic) in any setting (in-hospital or out-of-hospital)

- Intervention: Intravascular volume therapy during or after CPR
- Comparators: No intravascular volume therapy or a different intravascular volume therapy during or after CPR (a different type, volume, or timing)
- Outcomes: Any clinical outcome—including ROSC, survival, survival with favorable neurological outcome, and HRQOL at any time point—was considered. For post–cardiac arrest studies, we also considered outcomes related to organ support, such as the need for vasopressors, mechanical ventilation, or renal replacement therapy, as well as ICU or hospital length of stay. Studies assessing cost-effectiveness were included for a descriptive summary.
- Study designs: RCTs and nonrandomized studies (non-RCTs, cohort studies, and case-control studies) were included. Animal studies, reviews, abstracts only, conference proceedings, letters, editorials, commentaries, unpublished trials, case reports, and case series (generally defined as <10 nonconsecutive patients) were not included. All languages were included provided that there was an English abstract or full text available.
- Time frame: All years to October 30, 2025

Consensus on Science

Fifty-eight manuscripts representing 14 randomized trials and 44 observational studies were included. Data from randomized trials are presented herein and summarized in Table 11. Additional data, including observational studies, can be found online.[190]

Intra-arrest Volume Therapy (ALS 3207)

For nontraumatic cardiac arrest, randomized trial evidence of low to very low certainty showed no improvement in patient-centered outcomes with routine intravascular fluids of various types.[191-194]

For traumatic cardiac arrest, 1 randomized trial of prehospital blood products in hemorrhagic shock included a cardiac arrest subgroup and showed no difference in a composite outcome of in-hospital mortality or delayed lactate clearance.[195]

Post–Cardiac Arrest Volume Therapy (ALS 3518)

There were 8 RCTs that evaluated intravascular volume resuscitation strategies after ROSC in adults with cardiac arrest.[193,196-202] Low- to very low–certainty evidence showed no benefit of a specific strategy for intravascular volume therapy for survival or favorable neurological outcome.

For in-hospital postarrest care, 1 RCT[202] comparing balanced crystalloids with normal saline for 24 hours showed no difference in favorable neurological outcome at discharge or survival at 6 months. One small RCT[203] (n = 19) comparing hypertonic saline with hydroxyethyl starch with normal saline showed no difference in survival at 1 year.

Table 11. Summary of Results for Intravascular Volume Therapy

Outcome	Number of studies (n)	Relative risk (95% CI)
Nontraumatic, intra-arrest		
Prehospital hypertonic saline and HES versus HES alone		
Favorable neurological outcome at hospital discharge	1 RCT (203)[192]	2.69 (0.99, 7.24)
Survival to hospital discharge	1 RCT (203)[192]	0.99 (0.59, 1.65)
Survival to hospital admission	2 RCTs (269)[191,192]	1.14 (0.89, 1.46)

Outcome	Number of studies (n)	Relative risk (95% CI)
Prehospital cold normal saline versus standard care		
Favorable neurological outcome at hospital discharge	2 RCTs (1443)[193,194]	0.98 (0.72, 1.35)
Survival at 1 y	1 RCT (245)[194]	0.99 (0.29, 3.34)
Survival at hospital discharge	2 RCTs (1443)[193,194]	0.93 (0.68, 1.27)
ROSC	2 RCTs (1443)[193,194]	0.89 (0.78, 1.03)
Traumatic, intra-arrest		
Prehospital blood versus crystalloid		
In-hospital mortality or impaired lactate clearance	1 RCT (409)[195]	1.01 (0.88, 1.17)
Nontraumatic, post–cardiac arrest		
Prehospital cold crystalloid versus standard care		
Favorable neurological outcome at hospital discharge	5 RCTs (2358)[196-199,201]	0.98 (0.87, 1.10)
Shockable rhythm	2 RCTs (812)[196,199]	0.93 (0.82, 1.04)
Nonshockable rhythm	2 RCTs (935)[196,199]	1.11 (0.80, 1.54)
Survival to hospital discharge	6 RCTs (2500)[196-201]	1.00 (0.90, 1.11)
Shockable rhythm	4 RCTs (1126)[196,198,199,201]	1.03 (0.89, 1.18)
Nonshockable rhythm	4 RCTs (1335)[196,198,199,201]	0.88 (0.51, 1.52)
In-hospital balanced crystalloid versus normal saline		
Favorable neurological outcome at 6 mo	1 RCT (364)[202]	0.93 (0.54, 1.59)
Favorable neurological outcome at hospital discharge	1 RCT (364)[202]	1.01 (0.60, 1.71)
Survival at 6 mo	1 RCT (364)[202]	0.83 (0.50, 1.39)
Survival at hospital discharge	1 RCT (364)[202]	1.05 (0.64, 1.71)
In-hospital hypertonic saline and HES versus normal saline		
Survival at 1 y	1 RCT (19)[203]	1.03 (0.64, 1.64)

HES indicates hydroxyethyl starch; ROSC, return of spontaneous circulation; and RCT, randomized controlled trial.

Prior Treatment Recommendations (2010)

There is insufficient evidence to recommend for or against the routine infusion of IV fluids during the treatment of cardiac arrest.

2026 Treatment Recommendations

We suggest against the routine use of intravascular volume therapy during CPR in patients with undifferentiated nontraumatic cardiac arrest (weak recommendation, very low–certainty evidence).

We recommend against the use of hydroxyethyl starch solutions during CPR or after ROSC (strong recommendation, very low–certainty evidence).

If clinical circumstances indicate that the patient was hypovolemic prior to the cardiac arrest, volume therapy may be reasonable (good practice statement).

There is insufficient direct evidence to recommend for or against the use of specific volume therapies immediately after ROSC in patients with undifferentiated nontraumatic cardiac arrest.

There is insufficient direct evidence to recommend for or against the routine use of specific volume therapies during CPR in patients with traumatic cardiac arrest.

Justification and Evidence-to-Decision Framework Highlights

The complete evidence-to-decision table is provided in Appendix A.

The task force decided to use the term *intravascular volume therapy* because the included studies investigated multiple types of volume resuscitation, including various kinds of fluids and blood products via any route. The suggestion against the routine use of intravascular volume therapy during CPR in patients with undifferentiated nontraumatic cardiac arrest was based on several factors. No randomized trials directly compared routine intravascular volume therapy with no volume therapy during CPR; available trials evaluated specific fluid strategies against standard care and showed no consistent benefit for patient-centered outcomes.

Fluid boluses during chest compressions may increase right atrial pressure, reduce venous return, and impair coronary perfusion pressure.

Trials of rapid infusion of cold crystalloids during or after cardiac arrest showed no benefit, and in some studies, this intervention increased pulmonary edema and rearrest.

Hydroxyethyl starch solutions are associated with coagulopathy, acute kidney injury, and increased mortality in critically ill patients, and these established harms apply to the cardiac arrest population. The task force also noted that these solutions are no longer available in some countries.

Evidence for post–cardiac arrest volume therapy was limited and heterogeneous, precluding recommendations for specific volume strategies. Volume therapy in traumatic cardiac arrest was limited to a subgroup analysis from a single study evaluating hemorrhagic shock. We did not find any studies examining volume therapy after traumatic cardiac arrest.

The task force judged that the balance of effects does not support routine intravascular volume therapy during cardiac arrest, while recognizing that volume resuscitation remains appropriate when hypovolemia is suspected.

Knowledge Gaps

- RCTs comparing routine volume therapy with no volume therapy during cardiac arrest in patients presumed to be euvolemic
- Optimal type, timing, rate, and dose of volume therapy during and after cardiac arrest
- Restrictive versus liberal volume strategies in post–cardiac arrest care

- Effect modification by cardiac arrest etiology, rhythm, and resuscitation setting
- Cost-effectiveness of volume therapy strategies

Direct Versus Video Laryngoscopy for Tracheal Intubation During Cardiac Arrest (ALS 3308: SysRev)

Rationale for Review

This topic was prioritized by the ALS Task Force because of the increasing availability and use of video-capable laryngoscopes during cardiac arrest and the absence of prior ILCOR treatment recommendations distinguishing video from direct laryngoscopy during resuscitation. The SysRev[204] was registered on PROSPERO (CRD420251083717), and the complete CoSTR can be found online.[205]

Population, Intervention, Comparator, Outcome, Study Design, and Time Frame

- Population: Adult patients in cardiac arrest in any setting (in-hospital or out-of-hospital) who require tracheal intubation during resuscitation
- Intervention: Video laryngoscopy (tracheal intubation using a laryngoscope with video capability)
- Comparators: Direct laryngoscopy (tracheal intubation using a standard laryngoscope without video capability)
- Outcomes
  - Critical: First-pass intubation success; overall tracheal intubation success; ROSC; short-term survival (24 h to 30 d or hospital survival); medium- and long-term survival (>30 d); HRQOL outcomes; functional and neurological outcomes (Cerebral Performance

    Category or modified Rankin Scale); and process metrics, including CCF, chest compression pause duration, and end-tidal carbon dioxide
  - Important: Complications of tracheal intubation, including esophageal intubation, aspiration, or oropharyngeal or tracheal injury; 2 additional process metric outcomes were added early in the review and included time to tracheal intubation and intubating view

- Study designs: RCTs and nonrandomized studies (non-RCTs, interrupted time series, controlled before-and-after studies, cohort studies) were eligible for inclusion. Case reports or series (<10 patients), conference abstracts, trial protocols, and unpublished studies were excluded. All languages were included provided that there was an English abstract or full text available.
- Time frame: All years to October 2025

Consensus on Science

Sixteen studies (3 randomized trials enrolling 331 patients[206-208] and 13 observational studies[209-221] enrolling >29 000 patients) compared video laryngoscopy with direct laryngoscopy during adult cardiac arrest. Evidence was heterogeneous with respect to devices used, operator experience, and arrest setting. Overall certainty of evidence was very low across critical outcomes, with reasons for downgrading including inconsistency, indirectness, and imprecision.

Three RCTs[206-208] (n = 331) found that video laryngoscopy did not improve first-pass tracheal intubation success compared with direct laryngoscopy (RR, 0.88; 95% CI, 0.63–1.22), corresponding to 94 fewer first-pass successes per 1000 patients (95% CI, 289 fewer to 172 more). The same trials also demonstrated no difference in overall intubation success with video laryngoscopy compared with direct laryngoscopy (RR, 1.00; 95% CI, 0.90–1.12). No RCTs reported ROSC, survival, or neurological outcomes.

Observational studies generally favored video laryngoscopy for procedural outcomes, including higher first-pass and overall intubation success. Observational evidence from 6 studies[209-211,215,219,221] showed no consistent association with ROSC, with RRs clustering around 1.0. For short-term survival, 1 large observational study[219] reported higher survival with video laryngoscopy compared with direct laryngoscopy (RR, 1.14; 95% CI, 1.02–1.28), whereas 2 smaller studies showed no difference.[215,216]

Video laryngoscopy was consistently associated with lower rates of esophageal intubation, including in 1 RCT[208] in which esophageal intubation occurred in 4.3% of direct laryngoscopy cases and 0% of video laryngoscopy cases and 5 observational studies[214,215,217,218,221] reporting rates of approximately 5.6% with direct laryngoscopy versus 1.4% with video laryngoscopy. Improved glottic view was more frequent with video laryngoscopy. Evidence for differences in time to intubation and chest compression interruptions was inconsistent.

Prior Treatment Recommendations

None

2026 Treatment Recommendations

There is insufficient evidence to recommend video laryngoscopy in preference to direct laryngoscopy for tracheal intubation during CPR (weak recommendation, very low–certainty evidence).

To improve tracheal intubation first-pass success and overall success and to reduce rates of inadvertent esophageal intubation, it may be reasonable to select video laryngoscopy during

CPR in settings where this equipment is available and the person performing tracheal intubation is well trained in the use of the device (good practice statement).

Justification and Evidence-to-Decision Framework Highlights

The complete evidence-to-decision table is provided in Appendix A.

RCTs and observational studies conflicted with respect to first-pass success and overall intubation success rates. RCTs found no evidence of improved first-pass success or overall intubation success with video laryngoscopy. Observational studies generally favored video laryngoscopy. First-pass success was prioritized by the task force given its potential to minimize interruptions in chest compressions and reduce airway-related complications. Higher weight was placed on observational studies because they were considered to be more reflective of clinical practice.

The task force discussed that practitioners are likely to favor the use of video laryngoscopy or direct laryngoscopy in their clinical practice on the basis of several factors (eg, availability, training, experience), and there was no evidence identified to suggest that practitioners should abandon their standard practice when it comes to tracheal intubation during cardiac arrest.

The task force also discussed that observational data are more likely to be biased in favor of direct laryngoscopy because video laryngoscopy is often used for more difficult intubation attempts.

Evidence for overall tracheal intubation success was inconsistent, and no benefit was demonstrated for downstream patient-centered outcomes, such as ROSC or survival.

Certainty of evidence was downgraded for risk of bias in observational studies, imprecision, and heterogeneity in study design, clinician experience, device type, and resuscitation setting.

Potential benefits of video laryngoscopy include improved glottic visualization and shared viewing during team-based resuscitation; however, these benefits may be attenuated in high-stress environments or with limited operator familiarity.

The task force considered feasibility and acceptability to be high in systems where video laryngoscopy is already available and clinicians are trained but acknowledged variability in access across settings.

Resource implications were judged to be acceptable in many systems, though costs, device availability, and maintenance may limit implementation in some environments.

Knowledge Gaps

- Whether video laryngoscopy improves patient outcomes from cardiac arrest compared with direct laryngoscopy
- Comparative effectiveness of different video laryngoscope designs
- Effect modification by operator experience and training
- Cost-effectiveness, particularly in prehospital and low-resource settings
- Role of intubation adjuncts (eg, bougie) during cardiac arrest
- Differences in effectiveness by arrest etiology, rhythm, or patient characteristics

Supplemental Oxygen During CPR (ALS 3305: SysRev)

Rationale for Review

This topic was prioritized by the ALS Task Force because the most recent ILCOR review was published in 2020[145,146] and was based on only a few observational studies. Ongoing uncertainty regarding optimal oxygen dosing during CPR, coupled with concerns about hypoxemia during resuscitation and potential hyperoxia-related injury after ROSC, prompted reevaluation of the available evidence. This SysRev was registered on PROSPERO (CRD420251243123), and the complete CoSTR can be found online.[222] The topic of oxygenation after ROSC is addressed in a separate CoSTR and was last updated in 2025.[223,224]

Population, Intervention, Comparator, Outcome, Study Design, and Time Frame

- Population: Adults with cardiac arrest in any setting (in-hospital or out-of-hospital)
- Intervention: Administering a maximal oxygen concentration (eg, 100% by face mask or closed circuit)
- Comparison: No supplemental oxygen (eg, 21%) or a reduced oxygen concentration (eg, 40%–50%)
- Outcomes
    - Critical: Survival with favorable neurological or functional outcome at discharge or later time point, survival at discharge or later time point
    - Important: ROSC
- Study designs: RCTs and nonrandomized studies (non-RCTs, interrupted time series, controlled before-and-after studies, cohort studies, case-control studies, and case series) were included. Unpublished studies, case reports, conference abstracts, trial protocols, editorials,

comments, letters to the editor, and animal studies were excluded. All languages were included provided that there was an English abstract or full-text article available.

- Time frame: All years to November 2025

Consensus on Science

Six observational studies evaluating oxygenation during resuscitation were identified.[225-230] All studies were assessed to be at critical risk of bias. No studies directly compared different administered fractions of inspired oxygen during CPR. In all included studies, patients were treated with the highest available inspired oxygen concentration, typically 100%, and outcomes were analyzed in relation to measured arterial oxygen tension ($Pa{O_2}$).

Across studies, higher $Pa{O_2}$ measured during CPR was consistently associated with improved outcomes, including higher likelihood of ROSC, survival to hospital admission, survival to hospital discharge, and favorable functional outcome. However, because all patients received the same oxygen delivery strategy, differences in $Pa{O_2}$ may reflect patient-related factors, such as pulmonary function and perfusion, rather than modifiable oxygen administration strategies. All included studies were observational and judged to be at critical risk of bias, resulting in very low certainty of evidence.

No study demonstrated worse outcomes associated with higher $Pa{O_2}$ values during CPR, and no evidence was identified suggesting harm from higher intra-arrest oxygen levels.

2026 Treatment Recommendations (Unchanged From 2020)

We suggest using the highest possible inspired oxygen concentration during CPR (weak recommendation, very low–certainty evidence).

Justification and Evidence-to-Decision Framework Highlights

The complete evidence-to-decision table is provided in Appendix A.

In maintaining the existing recommendation, the ALS Task Force considered the absence of studies directly comparing different inspired oxygen fractions during CPR and the reliance on indirect observational evidence. Although higher PaO_2 during CPR was associated with improved outcomes, these findings cannot be attributed to differences in oxygen delivery strategies because all patients received maximal oxygen concentrations.

Despite these limitations, the task force noted a high likelihood of hypoxemia during cardiac arrest, the absence of evidence demonstrating harm from higher intra-arrest oxygen levels, and the lack of contradictory findings. The recommendation to use the highest feasible inspired oxygen concentration refers to the maximum concentration deliverable by the existing ventilation approach and does not specify a particular ventilation strategy. The task force judged that avoiding hypoxemia during CPR remains a priority and that the potential benefits of maximal oxygen delivery outweigh theoretical risks in the absence of evidence of harm.

Knowledge Gaps

- Randomized trials comparing different inspired oxygen fractions during CPR and their effects on ROSC, survival, and neurological outcomes
- Optimal oxygen targets during CPR and the immediate post-ROSC period
- The relationship between high intra-arrest oxygen exposure and reperfusion injury after ROSC
- Reliable methods for monitoring oxygenation during CPR and their clinical utility

- The impact of different ventilation strategies during CPR on oxygenation, including compression-to-ventilation ratios, use of PEEP, and conventional or novel mechanical ventilation approaches

Anticipatory Charging During Defibrillation (ALS 3105, BLS 2605: Nodal SysRev)

This topic was reviewed as a nodal SysRev with the BLS and ALS Task Forces and is presented in the BLS section of this document.

Ventilation Rate and Volume During Cardiac Arrest Resuscitation (BLS 2401: Nodal SysRev)

This topic was reviewed as a nodal SysRev with the BLS and ALS Task Forces and is presented in the BLS section of this document.

TEE During CPR (ALS 3609, ScopRev)

Rationale for Review

The use of TEE during cardiac arrest management has increased; however, the evidence examining intra-arrest TEE is limited. This topic has not previously been reviewed by ILCOR. The complete CoSTR can be found online.[231]

Population, Concept, Context, Outcome, Study Design, and Time Frame

- Population: Adults (>18 y or as defined in individual studies) with cardiac arrest in any setting (in-hospital or out-of-hospital) undergoing CPR
- Concept: The use of TEE during CPR; comparative and noncomparative evaluations were included:

  - Comparative studies: Standard CPR without TEE (comparator may include transthoracic echocardiography alongside standard CPR); studies comparing TEE versus transthoracic echocardiography and TEE versus no ultrasound were both eligible and analyzed separately in a subgroup analysis
  - Noncomparative studies: No comparator (single-arm studies)
- Context: All clinical settings where CPR is performed: Emergency departments, in-hospital environments (ICUs, wards, procedural areas), prehospital systems, operating rooms, or perioperative settings
- Outcomes
  - Critical: Survival with favorable neurological outcome (at hospital discharge, 30 d, or longer); survival (at hospital discharge, 30 d, or longer); HRQOL
  - Important: ROSC, identification of reversible causes of arrest, rhythm identification, any change in resuscitation management or intra-arrest treatments (eg, chest compression location, additional procedures, termination of resuscitation), CCF, time to epinephrine, time to defibrillation, other CPR quality metrics, and adverse events or complications related to TEE use
- Study designs: RCTs and nonrandomized studies (eg, non-RCTs, interrupted time series, controlled before-and-after studies, cohort studies) were eligible for inclusion. Studies without a comparison group (eg, cohort studies, case series) were also included. Case reports, case series with fewer than 5 patients, trial protocols, editorials, commentaries, letters to the editor, and animal studies were excluded. Studies involving TEE use only after ROSC were also excluded. All languages were included provided that there was an English abstract or full text.

- Time frame: All years to October 9, 2025; we searched for gray literature published up to November 18, 2025

Summary of Evidence

Twenty studies[232-251] enrolling a total of 1247 adults with cardiac arrest and published between 1997 and 2025 were included. Approximately 80% of patients (n = 994) experienced OHCA. Most studies were single-center observational investigations[232-236,238-240,242-249,251]; only 2 studies included a comparator group,[237,250] and 1 cluster-randomized trial was available only in abstract form.[250] Most studies (n = 15) evaluated TEE use in emergency departments during ongoing CPR,[233-241,246-249,251] with smaller numbers of studies examining prehospital (n = 3)[232,242,243] and intraoperative (n = 2) cases.[244,245]

Survival and Neurological Outcomes

Four studies enrolling 385 adults reported survival outcomes: 2 reported survival to ICU discharge,[235,250] and 2 reported survival to hospital discharge.[233,239] One cluster RCT (n = 132), available only in abstract form, found no difference in survival to ICU discharge between TEE-guided CPR and conventional CPR (30% in both groups; OR, 1.00 [95% CI, 0.48–2.10]).[250] No study comparing TEE with no TEE reported survival to hospital discharge or longer-term survival. Survival with favorable neurological outcome at hospital discharge or 30 days was reported in 1 RCT (n = 132) comparing TEE-guided resuscitation with conventional CPR without TEE.[250] There were no survivors achieving a favorable neurological outcome (modified Rankin Scale score, <3) in either group. No studies reported neurological outcomes beyond 30 days or HRQOL. Two observational studies[233,235] (n = 95) found higher survival in patients in whom the aortic valve or left ventricular outflow tract remained open during chest compressions.

ROSC

Four studies[233,235,239,250] (n = 385) of adult OHCA arriving at an emergency department with ongoing CPR reported ROSC. One cluster RCT (n = 132) found sustained ROSC in 44% of patients in the TEE-guided CPR group and 39% in the conventional CPR without TEE group (OR, 1.21; 95% CI, 0.60–2.41).[250] Two observational studies[233,235] (n = 95) found higher rates of ROSC in patients in whom the aortic valve or left ventricular outflow tract remained open during chest compressions.

Physiological and Process-of-Care Outcomes

Most studies focused on physiological observations rather than patient-centered outcomes. TEE frequently revealed suboptimal compression location[233-235,238,242,243,246-248,250] and identified reversible causes of cardiac arrest in 20% to 86% of cases.[236,239-241,244-247,249,251] TEE led to changes in therapy in 31% to 48% of cases,[246,248,249] including decisions to terminate resuscitation (12%)[246] and compression repositioning.[243,246,248,250] Available data indicate that TEE was successfully performed with minimal complications, without delaying or obstructing resuscitation.[235,236,240,241,246,247,250,251] Some studies described TEE-guided adjustment of compression location, but evidence that this improves survival or neurological outcomes was inconsistent. One small study[237] comparing TEE, transthoracic echocardiography, and no ultrasound reported shorter compression pauses with TEE, though these findings require confirmation.

Task Force Insights

Only 2 studies directly compared intra-arrest TEE with standard resuscitation, and only 1 randomized study evaluated patient-centered outcomes. Most evidence comprises single-arm observational descriptions, limiting causal inference. Important outcomes, including long-term survival, neurological recovery, quality of life, and sustained ROSC, were rarely or never reported. Evidence regarding feasibility, safety, training requirements, and system-level implementation was sparse and likely affected by selection bias because TEE was typically performed by expert operators in specialized settings.

An ongoing cluster-randomized trial (the TAPCAP [Application of Transesophageal Echocardiography in Prehospital Cardiac Arrest Patients] trial; NCT06672315) will evaluate the feasibility of prehospital TEE-guided chest compression positioning and may help address key evidence gaps.

No good practice statement was generated, and the existing evidence does not support a SysRev at this time.

Knowledge Gaps

- Whether intra-arrest TEE improves survival or neurological outcomes compared with conventional CPR or transthoracic echocardiography
- Feasibility, safety, and training requirements for routine intra-arrest TEE use across diverse systems
- Optimal timing and indications for deploying TEE during resuscitation
- Diagnostic accuracy of intra-arrest TEE and downstream impact on clinical decision-making
- Effect of TEE-guided chest compression adjustment on patient-centered outcome
- Cost-effectiveness and resource implications of implementing intra-arrest TEE

Evidence Updates

The ALS EvUps for 2026 are summarized in Table 12. The complete EvUps are provided in Appendix B.

Table 12. Topics Reviewed by ALS EvUps

Topic/PICO	Year of last SysRev	Existing treatment recommendation	RCTs since last review	Observational studies since last review	Key findings	Sufficient data to warrant SysRev?
Prognostication of unfavorable neurological outcome: electrophysiology (SSEP and EEG) (ALS 3511)	2020	SSEP: We suggest using a bilaterally absent N20 wave of SSEP in combination with other indices to predict poor outcome in adult patients who are comatose after cardiac arrest (weak recommendation, very low–certainty evidence).	0	6	New studies confirm bilateral absence of the N20 SSEP as a reliable predictor of poor outcome, consistent with prior reviews. Low N20 amplitudes and absent N70 waves may improve specificity and sensitivity, but evidence is limited.	Yes, an updated SysRev of neuroprognostication is planned
		EEG: We suggest using highly malignant EEG patterns to predict poor outcome in adult patients who are comatose and who are off sedation after cardiac arrest (weak recommendation, very low–certainty evidence). We suggest against EEG background	0	10	Confirm results of prior SysRev	

Topic/PICO	Year of last SysRev	Existing treatment recommendation	RCTs since last review	Observational studies since last review	Key findings	Sufficient data to warrant SysRev?
		reactivity alone to predict poor outcome in adult patients who are comatose after cardiac arrest (weak recommendation, very low–certainty evidence).				
Prognostication of unfavorable neurological outcome: physical exam (ALS 3513)	2020	We suggest using pupillary light reflex at ≥72 h after ROSC for predicting neurological outcome of adults who are comatose after cardiac arrest (weak recommendation, very low–certainty evidence). We suggest using quantitative pupillometry at ≥72 h after ROSC for predicting neurological outcome of adults who are comatose after cardiac arrest (weak recommendation, low-certainty evidence). We suggest using bilateral absence of corneal reflex at ≥72 h after ROSC for predicting poor neurological outcome in adults who are comatose after cardiac arrest (weak recommendation, very low–certainty evidence). We suggest using presence of myoclonus or status myoclonus within 7 d after ROSC, in combination with other tests, for predicting poor	0	13	Confirm results of prior SysRev	Yes, an updated SysRev of neuroprognostication is planned

Topic/PICO	Year of last SysRev	Existing treatment recommendation	RCTs since last review	Observational studies since last review	Key findings	Sufficient data to warrant SysRev?
		neurological outcome in adults who are comatose after cardiac arrest (weak recommendation, very low–certainty evidence). We also suggest recording EEG in the presence of myoclonic jerks to detect any associated epileptiform activity (weak recommendation, very low–certainty evidence).				
Prognostication of unfavorable neurological outcome: biomarkers (NSE and NfL) (ALS 3512)	2020	NSE: We suggest using NSE within 72 h after ROSC, in combination with other tests, for predicting neurological outcome of adults who are comatose after cardiac arrest (weak recommendation, very low–certainty evidence). There is no consensus on a threshold value.	0	11	Confirm results of prior SysRev	Yes, an updated SysRev of neuroprognostication is planned
		NfL: We suggest against using serum levels of glial fibrillary acidic protein, serum tau protein, or NfL chain for predicting poor neurological outcome of adults who are comatose after cardiac arrest (weak recommendation, very low–certainty evidence).	0	3	Confirm results of prior SysRev	
Prognostication of unfavorable neurological outcome:		CT: We suggest using GWR on brain CT for predicting neurological outcome of adults who	0	24	Confirm results of prior SysRev	Yes, an updated SysRev of neuroprogno

Topic/PICO	Year of last SysRev	Existing treatment recommendation	RCTs since last review	Observational studies since last review	Key findings	Sufficient data to warrant SysRev?
imaging (CT scan or MRI) (ALS 3510)		are comatose after cardiac arrest (weak recommendation, very low–certainty evidence). MRI: We suggest using diffusion-weighted brain MRI for predicting neurological outcome of adults who are comatose after cardiac arrest (weak recommendation, very low–certainty evidence). We suggest using ADC on brain MRI for predicting neurological outcome of adults who are comatose after cardiac arrest (weak recommendation, very low–certainty evidence).				stication is planned

ADC indicates apparent diffusion coefficient; ALS, advanced life support; CT, computed tomography; EEG, electroencephalogram; EvUps, evidence updates; GWR, gray-to-white matter ratio; MRI, magnetic resonance imaging; NfL, neurofilament light; NSE, neuron-specific enolase; PICO, population, intervention, comparator, outcome; RCT, randomized controlled trial; ROSC, return of spontaneous circulation; SSEP, somatosensory evoked potentials; and SysRev, systematic review.

PEDIATRIC LIFE SUPPORT

Defining Chest Compression Components for Children: Rate, Depth, Recoil (BLS 2501: ScopRev)

This topic was reviewed as a nodal ScopRev, led by the BLS Task Force with involvement of the PLS Task Force. Refer to the BLS section of this summary of evidence and treatment recommendations for both adults and children. The full ScopRev report is also available on the ILCOR website.[95]

Ventilation Parameters During Cardiac Arrest in Children (PLS 4120.02, 4080.28: SysRev)

Rationale for Review

The topic of ventilation rates in pediatric CPR with an advanced airway was last examined with a SysRev in 2024[166] and an EvUp in 2025.[252-254] The ALS, BLS, and PLS Task Forces conducted a SysRev (PROSPERO registration CRD420251070065) to incorporate new data and reassess whether specific ventilation parameters influence survival and neurological outcomes. This section summarizes the pediatric results only; refer to the ALS and BLS sections of this ILCOR CoSTR for adult treatment recommendations. The full SysRev report can be found on the ILCOR website.[73]

Population, Intervention, Comparator, Outcome, Study Design, and Time Frame

- Population: Adults and children receiving assisted ventilation during cardiac arrest
- Intervention: Ventilation with a specific tidal volume, respiratory rate, inspiratory time, or PEEP
- Comparator: Any other tidal volume, respiratory rate, inspiratory time, or PEEP or combination of these parameters
- Outcomes: Any clinical outcome, including but not limited to ROSC; survival and survival with favorable neurological outcome at discharge, 30 days, or longer; duration of mechanical ventilation; oxygenation; blood gas parameters; progression to acute respiratory distress syndrome; barotrauma; and ICU and hospital length of stay, with a preference for outcomes listed in the ILCOR COSCA (Core Outcome Set for Cardiac Arrest)[255] or P-COSCA[97]
- Study designs: RCTs and nonrandomized studies (non-RCTs, interrupted time series, controlled before-and-after studies, cohort studies) were eligible for inclusion. Only studies

that included a study comparator were included. Manikin and animal studies were not included. All languages were included provided that there was an English abstract.

- Time frame: All years to November 10, 2025

Consensus on Science

Of 3021 titles and abstracts screened, 13 studies were included: 3 RCTs[74-76] and 10 observational studies.[67,70,77,78,80,83,84,256,257] Only 2 observational studies included children, and results for critical outcomes are summarized in Table 13.[256,257]

Overall certainty for ventilation rate, tidal volume, and adequacy during CPR was very low due to risk of bias, inconsistency, indirectness, and imprecision. Data were mainly from small RCTs and observational studies with heterogeneous populations (adult or pediatric, IHCA or OHCA), airway strategies, and measurement methods. Adult evidence was deemed inappropriate for pediatric recommendations due to substantial heterogeneity and indirectness. Both pediatric studies evaluated ventilation rate; none assessed tidal volume, inspiratory time, or PEEP.

Table 13. Studies Comparing Different Ventilation Rates

Outcome	Population	Comparator	Result	Certainty of evidence
Survival to hospital discharge with favorable neurological outcome	47 children with IHCA[256]	Breaths: >30/min (<1 y) and >25/min (>1 yr) versus lower rates	OR: 4.73 (95% CI, 1.17–19.13)	Very low
Survival to hospital discharge	47 children with IHCA[256]	Breaths: >30/min (<1 y) and >25/min (>1 y) versus lower rates	OR: 4.73 (95% CI, 1.17–19.13)	Very low
ROSC	47 children with IHCA[256]	Breaths: >30/min (<1 y) and >25/min (>1 y) versus lower rates	OR: 4.64 (95% CI, 1.32–16.27)	Very low
ROSC	30 children with OHCA[257] (capnography)	Mean ventilation rate in ROSC versus non-ROSC	Breaths: 9.2/min versus 7.0/min; $P < 0.001$	Very low

IHCA indicates in-hospital cardiac arrest; OHCA, out-of-hospital cardiac arrest; OR, odds ratio; and ROSC, return of spontaneous circulation.

Prior Good Practice Statement (2024)

There is currently no supporting evidence to make a treatment recommendation on a specific ventilatory rate in pediatric CPR with an advanced airway.

For cardiac arrest that occurs with an advanced airway in place, the use of ventilatory rates >10 breaths per minute may be reasonable. The PLS Task Force suggests using ventilatory rates close to age-appropriate respiratory rates with avoidance of hypoventilation and hyperventilation (good practice statement).

2026 Good Practice Statements

For children in cardiac arrest with an advanced airway, it is reasonable to target a ventilation rate consistent with age-related physiological normal values (good practice statement).

It is reasonable to measure ventilation rate and adequacy of tidal volume delivery and avoid hypoventilation (good practice statement).

There is currently no evidence to make a treatment recommendation on the upper limit for ventilation rate, tidal volume delivery, inspiratory time, or PEEP during cardiac arrest in children.

Justification and Evidence-to-Decision Framework Highlights

The complete evidence-to-decision table is provided in Appendix A.

Pediatric data remain extremely limited, and findings are confined to in-hospital cases with advanced airway management (defined in this context as intubated patients with invasive airways [tracheal tube or tracheostomy]). The PLS Task Force considered studies indicating that higher ventilation rates could be associated with improved survival, but optimal targets are undefined and evidence is indirect. In one IHCA study,[256] cubic spline analysis suggested survival stability at 25 to 35 breaths per minute for children older than 1 year and 30 to 50 breaths per minute for those younger than 1 year, though actual rates were often higher. Given these uncertainties, the task force adopted a cautious approach. Adult-based algorithms require validation in children because physiological rationale differs, and current feasibility studies show ventilation rates below those linked to better outcomes.[257] Further research is required before definitive pediatric ventilation targets can be established.

Knowledge Gaps

- Optimal ventilation targets during pediatric cardiac arrest outside hospital, and for children without an advanced airway, including uncertainty around appropriate respiratory rates and oxygenation strategies
- Optimal tidal volume, minute ventilation, PEEP, and ventilation rates (especially in older children and adolescents with advanced airways) and their effects on oxygenation, hemodynamics, and lung injury
- Whether ventilation targets should differ for cardiac arrest of different etiologies, including respiratory, cardiac, or drowning
- Impact of ventilation rate on $Pa\textsc{co}_2$, $Pa\textsc{o}_2$, pH, cerebral perfusion, and blood pressure during CPR
- Whether ventilation parameters should vary by whether a bag-mask device, SGA, or tracheal tube is being used
- The effect of ventilation strategies on neurologically intact survival

IM Epinephrine During Cardiac Arrest in Children (PLS 4090.05: SysRev Adolopment)

Rationale for Review

Delays in epinephrine administration during cardiac arrest, often because of difficulty establishing IV or IO access, may compromise survival and neurological outcomes. IM delivery is simple, rapid, and widely used for anaphylaxis, suggesting potential applicability in cardiac arrest. This new CoSTR was based on adolopment of a published SysRev[180] and evaluates existing evidence on IM epinephrine to determine its effectiveness and safety compared with current recommended routes (PROSPERO registration CRD42021259729). The full online CoSTR can be found on the ILCOR website.[258] Refer to the ALS section of this publication for adult data and recommendations.

Population, Intervention, Comparator, Outcome, Study Design, and Time Frame

- Population: Children in cardiac arrest in any setting
- Intervention: IM route of epinephrine administration
- Comparator: IV or IO administration
- Outcomes
  - Patient outcomes
    - Important: ROSC
    - Critical: Survival and survival with favorable neurological outcome at any time point
  - Process outcomes: Administration of epinephrine, time to epinephrine, and accuracy of dosing
- Study designs: SysRevs, RCTs, and non-RCTs (interrupted time series, controlled before-and-after studies, cohort studies) were included. Because we hypothesized that human data

would be limited, animal studies were also included but analyzed separately. Simulation studies were included for process outcomes. Studies involving neonates and unpublished studies (such as conference abstracts and trial protocols) were excluded. All languages were included provided that there was an English abstract.

- Time frame: All years to June 2, 2025

Consensus on Science

The adoloped review included 8 studies that assessed IM epinephrine for cardiac arrest,[179,182-187] including 1 adult OHCA study[179] and 3 pediatric animal models.[184-186] The other studies—1 with overlapping study populations of adult OHCA,[182] 1 review,[188] and 2 adult animal studies[183,187]—were excluded from informing this CoSTR.

One adult OHCA pre-post study[179] (n = 1405) compared outcomes after the addition of IM epinephrine with IV or IO epinephrine to outcomes with IV or IO epinephrine alone. The group treated with the addition of IM epinephrine (per-protocol analysis) had improved survival to discharge (11.0% versus 7.0%; aOR, 1.73; 95% CI, 1.10–2.71) and survival with favorable neurological outcome (9.8% versus 6.2%; aOR, 1.72; 95% CI, 1.07–2.76). Two sensitivity analyses were performed to address 52 (3.7%) patients who received IV or IO epinephrine only in the “after” period, first by intention-to-treat analysis and then with the exclusion of these patients. Both sensitivity analyses were consistent in favoring the addition of IM epinephrine for survival and survival with favorable neurological outcome (aOR, 2.06 [95% CI, 1.33–3.20] and aOR, 2.16 [95% CI, 1.36–3.43] for intention-to-treat analysis; aOR, 1.91 [95% CI, 1.20–3.03] and aOR, 1.95 [95% CI, 1.19–3.17] with those patients excluded). The certainty of evidence for this study was low.

Animal studies showed similar ROSC rates for IM compared with IV epinephrine.[185] Piglet models reported comparable ROSC and time to ROSC and comparable plasma epinephrine concentrations at 3 minutes (IV 138 nmol/L [25.3 µg/L], IM 134 nmol/L [24.5 µg/L], control [0.9% sodium chloride] 29 nmol/L [5.3 µg/L]).[184] Risk of bias was moderate to high; certainty of animal evidence was very low due to indirectness and risk of bias.

Prior Treatment Recommendations

None

2026 Treatment Recommendations

There is insufficient evidence to recommend adding intra-arrest IM epinephrine to standard resuscitation care for cardiac arrest in children.

Justification and Evidence-to-Decision Framework Highlights

The complete evidence-to-decision table is included in Appendix A.

The task force noted IM epinephrine as a promising research area because earlier epinephrine may improve outcomes[259,260] and obtaining IV or IO access can be challenging.[261] IM administration may be faster but could have suboptimal effects.[262] Adult and animal data were reviewed for completeness but interpreted cautiously because of differences in arrest etiology,[253] lack of standard postarrest care, absence of neurological outcomes,[263] and unrealistically short drug administration times in animal studies.[264]

Knowledge Gaps

- The effect of IM epinephrine on outcomes in pediatric cardiac arrest; the task force considers the biological plausibility and equipoise sufficient to justify pediatric trials comparing initial dosing of IM epinephrine to IV, IO, alternate routes (eg, intranasal), or no epinephrine (eg, in low-resource settings where intravascular access is unavailable)

- Optimal dosing and the pharmacokinetics of IM epinephrine during cardiac arrest; future research should define IM dosing and safety, given potential harm from deviating from standard care and confusion between 2 concentrations (1 mg/mL [1:1000] for IM versus 0.1 mg/mL [1:10 000] for IV or IO)

Vasopressor Use During Cardiac Arrest in Children (PLS 4080.21: SysRev)

Rationale for Review

Epinephrine remains a cornerstone of ALS in pediatric cardiac arrest, despite very low–certainty evidence for improving neurological outcomes and uncertainty about optimal timing or dosing intervals. Given conflicting adult and pediatric data, potential safety risks, and gaps in evidence, the PLS Task Force undertook this updated SysRev to clarify the impact of epinephrine or other vasopressors on survival and neurological outcomes in children. The SysRev was registered on PROSPERO (CRD42024596959) before initiation.[5] The full online CoSTR can be found on the ILCOR website.[265]

Population, Intervention, Comparator, Outcome, Study Design, and Time Frame

- Population: Infants and children (excluding newborns) in cardiac arrest who received chest compressions in any setting
- Intervention: Any use of vasopressors (epinephrine, vasopressin, or combination of vasopressors)
- Comparators: No vasopressor use

- Outcomes: Critical clinical outcomes, including short-term survival and neurological outcomes (eg, hospital discharge, 28 d, 30 d, and 1 mo), and long-term survival and neurological outcomes (eg, 3 mo, 6 mo, and 1 y) per P-COSCA[97]
- Study designs: RCTs and nonrandomized studies (non-RCTs, interrupted time series, controlled before-and-after studies, cohort studies) and case series with a minimum of 5 cases were eligible for inclusion. Unpublished studies (eg, conference abstracts, trial protocols) were excluded. All languages were included provided that there was an English abstract.
- Time frame: All years to April 30, 2025

Consensus on Science

Two propensity score–matched observational studies provided very low– to low-certainty evidence.[266,267] Both studies were in the out-of-hospital setting and compared outcomes of children who received epinephrine with those of children who did not. No studies evaluated vasopressin or a combination of vasopressors. Meta-analysis was possible for the outcome of ROSC only, due to heterogeneity in other outcomes between the 2 studies. No eligible studies included IHCA. Key results are detailed in Table 14. In summary, low- to very low–certainty evidence suggests that epinephrine is not associated with improved neurological or survival outcomes in pediatric OHCA but is associated with a higher rate of ROSC.

Table 14. Studies Evaluating Use of Vasopressor During Cardiac Arrest in Children

Outcome	Study design / n (age)	Adjusted relative risk (95% CI)	Absolute risk difference (per 1000) (95% CI)	Certainty of evidence
Favorable neurological survival at 1 mo (CPC score, ≤2)	Propensity-matched cohort[267] / 608 (8–17 y)	1.56 (0.61–3.96)	15 more (11 fewer to 92 more)	Low
Favorable neurological survival at hospital discharge (mRS score, ≤3)	Propensity-matched cohort[266] / 1426 (<18 y)	1.23 (0.67–2.25)	9 more (13 fewer to 50 more)	Low

Outcome	Study design / n (age)	Adjusted relative risk (95% CI)	Absolute risk difference (per 1000) (95% CI)	Certainty of evidence
Survival at 1 mo	Propensity-matched cohort[267] / 608 (8–17 y)	1.13 (0.67–1.93)	10 more (27 fewer to 78 more)	Low
Survival to hospital discharge	Propensity-matched cohort[266] / 1426 (<18 y)	1.38 (0.87–2.19)	19 more (7 fewer to 64 more)	Low
Prehospital ROSC	2 cohort studies[266,267] / 2034 (<18 y)	1.64 (1.26–2.13)		Very low

CPC indicates Cerebral Performance Category; mRS, modified Rankin Scale; and ROSC, return of spontaneous circulation.

Prior Treatment Recommendations (2025)

We suggest the use of epinephrine in pediatric OHCA (weak recommendation, very low–certainty evidence). There is insufficient evidence to generate a treatment recommendation for the use of epinephrine in pediatric IHCA. However, the task force considers the indirect evidence from OHCA to support the administration of epinephrine in pediatric IHCA (good practice statement).[252-254]

2026 Treatment Recommendations

We suggest the use of epinephrine in pediatric OHCA (weak recommendation, very low–certainty evidence).

We suggest the use of epinephrine in pediatric IHCA (good practice statement).

The preexisting treatment recommendations on timing of epinephrine (PLS 4090.02; EvUp 2025) remain unchanged and are as follows:

We suggest that the initial dose of epinephrine in pediatric patients with nonshockable IHCA and OHCA be administered as early in the resuscitation as possible (weak recommendation, very low–certainty evidence).

We cannot make a recommendation for the timing of the initial epinephrine dose in shockable pediatric cardiac arrest.

The confidence of the effect estimates is so low that we cannot make a recommendation regarding the optimal epinephrine interval for subsequent epinephrine doses in pediatric patients with IHCA or OHCA.[268,269]

Justification and Evidence-to-Decision Framework Highlights

Evidence in pediatric OHCA shows that epinephrine improves ROSC but does not impact neurological or survival outcomes. Because no data are available for IHCA, the PLS Task Force used OHCA data as indirect evidence. The studies were conducted in settings with advanced EMS, and in similar contexts, epinephrine should be included in pediatric ALS, though further research is needed.

Knowledge Gaps

- Whether there are any specific adverse effects of epinephrine use during pediatric cardiac arrest
- Whether certain subpopulations may benefit from prehospital epinephrine administration
- The cost-effectiveness and feasibility of providing pediatric ALS with epinephrine administration for pediatric OHCA while maintaining high-quality BLS in all health care settings, including low- and middle-income countries
- The effect of epinephrine on outcome measures consistent with P-COSCA recommendations
- Safety and efficacy of other vasopressors for cardiac arrest in children

Temperature Control After Cardiac Arrest in Children: Temperature Target and Duration (PLS 4210.03: SysRev)

Rationale for Review

Cardiac arrest in children often leads to death or severe neurological morbidity, primarily due to hypoxic-ischemic brain injury after return of circulation. Active temperature management (ATM), including targeted temperature management protocols, may reduce secondary brain injury by controlling fever and limiting inflammatory and reperfusion processes. This SysRev (PROSPERO registration CRD420251084345) was undertaken to update pediatric evidence on ATM, addressing temperature targets and duration, given prior reliance on adult and neonatal data and the publication of new pediatric studies since the last review.[172,173,268-271] The full online CoSTR can be found on the ILCOR website.[272]

Population, Intervention, Comparator, Outcome, Study Design, and Time Frame

- Population: Children (age, >24 h to 18 y) with sustained return of circulation after IHCA or OHCA and treated with a temperature control protocol* (except where marked)
    - Question 1
        - Intervention 1: A temperature target with active control* (eg, 36.5 °C)
        - Comparator 1: A different temperature target with active control* (eg, 33 °C)
    - Question 2
        - Intervention 2: A temperature target with active control*
        - Comparator 2: No active control* of temperature target
    - Question 3

  - Intervention 3: A temperature target with active control* for a specific duration (eg, 24 h)
  - Comparator 3: A temperature target with active control* for a different duration (eg, 72 h)

*ATM involves intentionally controlling a patient's body temperature to a specific temperature target range using a standardized management protocol. This includes all cooling and warming methods, temperature maintenance duration, pharmacotherapy, and monitoring strategies to achieve and sustain the desired target temperature.

- Outcomes: Any clinical outcome (critical outcomes: survival or survival with favorable neurological outcome; important outcome: HRQOL) as defined by the P-COSCA[97]
- Study designs: RCTs and nonrandomized studies (non-RCTs, interrupted time series, controlled before-and-after studies, cohort studies) were eligible for inclusion. Unpublished studies (eg, conference abstracts, trial protocols) were excluded. All languages were included provided that there was an English abstract.
- Time frame: All years to April 22, 2025

Consensus on Science

This review synthesized evidence from RCTs and observational cohorts to address 3 key questions regarding ATM for children after cardiac arrest. For Question 1 (ATM at 32–34 °C versus 36–37.5 °C), 2 large RCTs (THAPCA [Therapeutic Hypothermia After Pediatric Cardiac Arrest] trials)[273,274] and 1 Bayesian reanalysis[275] provided long-term survival and neurobehavioral outcomes, supplemented by 1 observational study[276] and additional cohort data for intermediate- and short-term outcomes as well as HRQOL[277] (Table 15). Question 2 (ATM at any temperature versus no ATM) included 3 observational cohort studies[278-280] that adjusted for confounding using propensity score methods and evaluated short-term neurological and survival outcomes (Table 16). Question 3 (ATM duration, 24 h versus 72 h) was informed by a single small pilot RCT[281] comparing short-term survival and neurological outcomes (Table 17). Across all questions, certainty of evidence was very low to low, with most data derived from OHCA populations.

Table 15. Question 1: ATM at 32–34 °C Versus 36–37.5 °C

Outcome	Study design / size	Population	Comparator	Effect	Absolute risk difference per 1000 (95% CI)	Certainty of evidence
Favorable neurological outcome (1 y)	2 RCTs[273,274] / n = 517	OHCA and IHCA, comatose (GCS motor score, <5)	32–34 °C versus 36–37.5 °C	RR: 1.05 (95% CI, 0.80–1.39)	13 more (51 fewer to 100 more)	Very low
Favorable neurological outcome (1 y), Bayesian analysis	Bayesian reanalysis of THAPCA-OH[275]	OHCA, comatose (GCS motor score, <5)	32–34 °C versus 36–37.5 °C	Posterior median absolute benefit: 6.8% (CrI, −1.9% to +15.4%); Pr(any benefit) = 94%		Low
Favorable neurological outcome (6 mo)	1 adjusted cohort[276] / n = 79	OHCA and IHCA	<35 °C versus 36–37.5 °C or no ATM	aOR: 0.50 (95% CI, 0.11–2.22)	172 fewer (448 fewer to 174 more)	Very low
Survival (1 y)	2 RCTs [273,274] / n = 614	OHCA and IHCA, comatose (GCS motor score, <5)	32–34 °C versus 36–37.5 °C	RR: 1.14 (95% CI, 0.94–1.37)	53 more (25 fewer to 141 more)	Very low
Survival (1 y), Bayesian analysis	Bayesian reanalysis of THAPCA-OH[275]	OHCA, comatose (GCS motor score, <5)	32–34 °C versus 36–37.5 °C	Posterior median absolute benefit: 6.8% (CrI, −1.9% to +15.4%); Pr(any benefit) = 94%		Low
Survival (6 mo)	1 adjusted cohort[276] / n = 79	OHCA and IHCA	<35 °C versus 36–37.5 °C or no ATM	aOR: 0.50 (95% CI, 0.11–2.22)	171 fewer (468 fewer to 164 more)	Very low

Outcome	Study design / size	Population	Comparator	Effect	Absolute risk difference per 1000 (95% CI)	Certainty of evidence
Survival (30 d or discharge)	3 cohorts[276,277,281] / n = 388	OHCA and IHCA	32–36 °C versus 36–37.5 °C or no ATM	OR: 0.4 (95% CI, 0.09–1.8)[276] OR: 2.13 (95% CI, 0.69–6.62)[281] OR: 0.77 (95% CI, 0.34–1.75)[277]		Very low
HRQOL (physical summary score)	1 adjusted cohort[277] / n = 128	OHCA and IHCA	33 °C versus 36 °C	MD +11.2 (95% CI, +3.1 to +19.3)		Very low

aOR indicates adjusted odds ratio; ATM, active temperature management; CrI, credible interval; GCS, Glasgow Coma Scale; HRQOL, health-related quality of life; IHCA, in-hospital cardiac arrest; MD, mean difference; OHCA, out-of-hospital cardiac arrest; OR, odds ratio; Pr, probability; RCT, randomized controlled trial; RR, risk ratio; and THAPCA-OH, Therapeutic Hypothermia After Pediatric Cardiac Arrest (Out-of-Hospital).

Table 16. Question 2: ATM (Any Temperature) Versus No ATM

Outcome	Study design / size	Population	Comparator	Effect, odds ratio (95% CI)	Absolute risk difference per 1000 (95% CI)	Certainty of evidence
Favorable neurological outcome (discharge)	2 adjusted cohorts [278,280] / n = 877	OHCA	ATM (any target) versus no ATM	1.21 (1.05–1.40)	30 more (7 more to 56 more)	Very low (bias, inconsistency, imprecision)
Survival (30 d / discharge)	2 adjusted cohorts[278,279] / n = 830	OHCA	ATM (any target) versus no ATM	1.06 (0.67–1.68)	14 more (92 fewer to 129 more)	Very low (bias, imprecision)

ATM indicates active temperature management; and OHCA, out-of-hospital cardiac arrest.

Table 17. Question 3: Duration of ATM (24 h Versus 72 h at 33 °C)

Outcome	Study design / size	Population	Comparator	Effect, relative risk (95% CI)	Absolute risk difference per 1000 (95% CI)	Certainty of evidence
Favorable neurological outcome (discharge)	1 RCT[282] / n = 34	Children post-ROSC	24 h versus 72 h at 33 °C	0.86 (0.36–2.02)	58 fewer (264 fewer to 420 more)	Very low (bias, inconsistency, extremely serious imprecision)
Survival (discharge)	1 RCT[282] / n = 34	Children post-ROSC	24 h versus 72 h at 33 °C	0.69 (0.41–1.16)	237 fewer (451 fewer to 122 more)	Very low (bias, inconsistency, extremely serious imprecision)

ATM indicates active temperature management; RCT, randomized controlled trial; ROSC, return of spontaneous circulation.

Prior Treatment Recommendations (2022)[172,173,271]

We suggest that for infants and children who remain comatose following ROSC from OHCA or IHCA, active control of temperature be used to maintain a central temperature ≤37.5 °C (weak recommendation, moderate-certainty evidence).

There is inconclusive evidence to support or refute the use of induced hypothermia (32–34 °C) compared with active control of temperature at normothermia (36–37.5 °C) (or an alternative temperature) for children who achieve ROSC but remain comatose after OHCA or IHCA.

2026 Treatment Recommendations

We recommend using ATM* for comatose infants and children following OHCA or IHCA (strong recommendation, low-certainty evidence).

We recommend using ATM to prevent central temperatures >37.5 °C (strong recommendation, low-certainty evidence).

We suggest that ATM protocols follow one of the published THAPCA trial interventions—(1) ATM at 32 to 34 °C for 48 hours, followed by gradual rewarming and maintenance at 36 to 37.5 °C until a total of 120 hours or (2) ATM at 36 to 37.5 °C for 120 hours total—because current evidence does not show superiority of either temperature target and there is insufficient evidence to recommend alternative durations (weak recommendation, low-certainty evidence).

*ATM involves intentionally controlling a patient's body temperature to a specific temperature target range by using a standardized management protocol. This includes all cooling and warming methods, temperature maintenance duration, pharmacotherapy, and monitoring strategies to achieve and sustain the desired target temperature.

Justification and Evidence-to-Decision Framework Highlights

The complete evidence-to-decision table is provided in Appendix A.

The PLS Task Force prioritized this topic because of ongoing uncertainty about optimal ATM in children after cardiac arrest, including target temperature, duration, and benefit. ATM protocols require ICU-level care and resources, raising feasibility and equity concerns. However, the task force recognized the avoidance of fever as an important intervention, which requires temperature monitoring and an ATM protocol. Given the lack of clear superiority, the task force issued a conditional recommendation for either hypothermia (ATM, 32–34 °C) or normothermia (ATM, 36–37.5 °C) and for ATM over no management, allowing individualized decisions based on patient context, resources, and family values.

Knowledge Gaps

- Need for high-quality randomized trials comparing hypothermia (32–34 °C) and normothermia (36–37.5 °C) in children after cardiac arrest, focusing on long-term neurological outcomes and survival
- The optimal duration of ATM; only a small pilot trial exists, and larger, adequately powered studies are required
- Optimal timing of initiation of ATM, techniques to achieve target temperature, and best rewarming rate
- Effect of ATM on HRQOL and functional outcomes; future studies should use standardized measures like P-COSCA
- Adverse events (fever, arrhythmia, infection, bleeding, accidental overcooling) of ATM; prospective data collection required

- True cost and cost-effectiveness of hypothermia versus normothermia and ATM versus no ATM; resource requirements may affect feasibility and equity
- Barriers and facilitators to implementation of ATM, especially in resource-limited centers
- The effects of implementation of ATM protocols on disparities between high- and low-resource settings
- Effects in subgroups (eg, extracorporeal life support or extracorporeal CPR patients) and differences between OHCA and IHCA
- Tools to guide patient selection for ATM
- Evidence from multicenter registries and collaborative research to improve data quality, generalizability, and benchmarking

Evidence Updates

The PLS EvUps for 2026 are summarized in Table 18. The complete EvUps are provided in Appendix B.

Table 18. Topics Reviewed by PLS EvUps

Topic/PICO	Year of last SysRev	Existing treatment recommendation	RCTs since last review	Observational studies since last review	Key findings	Sufficient data to warrant SysRev?
Treatment of hypotension following cardiac arrest in children (PLS 4190.02)	New	None	0	6	6 observational studies[283-288] were found in infants and children post–cardiac arrest (in-hospital and out-of-hospital), with some studies including arterial line monitoring. Early and sustained hypotension (SBP or MAP below 5th–10th percentile for age) was associated with worse survival and neurological outcomes.	No

Topic/PICO	Year of last SysRev	Existing treatment recommendation	RCTs since last review	Observational studies since last review	Key findings	Sufficient data to warrant SysRev?
					Higher vasoactive inotropic scores and longer duration of vasoactive medication use were linked to increased mortality. Myocardial dysfunction was common post–ROSC and contributed to hypotension. Maintaining SBP or MAP above age-based thresholds (≥10th percentile; some analyses, ≥5th percentile) and minimizing hypotension burden were associated with improved outcomes. No specific vasopressor regimen was shown to be superior; inotrope use was frequent but not protocolized.	

EvUps indicate evidence updates; MAP, mean arterial pressure; PICO, population, intervention, comparator, outcome; PLS, pediatric life support; RCT, randomized controlled trial; ROSC, return of spontaneous circulation; SBP, systolic blood pressure; and SysRev, systematic review.

NEONATAL LIFE SUPPORT

Initial Vascular Access for Neonatal Resuscitation (NLS 5652: SysRev)

Rationale for Review

The need to insert an intravascular device is uncommon during resuscitation of newborn infants but can be critical for those who need medications (most commonly, epinephrine), fluids, or blood products. Umbilical venous catheterization (UVC) to an insertion depth of 4 to 5 cm has been recommended in past ILCOR CoSTR statements.[289-295] However, the umbilical vein may not be an option in the settings of periumbilical congenital anomalies and cord avulsion or in older neonates when the cord has already separated. Some health care professionals, especially those working in prehospital or emergency department settings, are more familiar with insertion of IO devices into the medullary cavity of a long bone.[296,297] Peripheral IV cannulation is an alternative,[298-300] but success rates are highly dependent on patient characteristics and individual health care professional skills. This topic was last addressed in 2020 as part of a nodal SysRev that included adults and children.[301] At the time, no neonatal studies were found. An EvUp conducted for the 2025 CoSTR summary found potentially eligible studies suggesting that an updated review focusing on neonates was justified.[289-291] Full details are available in the published review and on the ILCOR website.[302] The protocol was registered on PROSPERO (CRD420251122463).

Population, Intervention, Comparator, Outcome, Study Design, and Time Frame

- Population: Infants requiring emergency vascular access between birth and 28 days of age or 44 weeks' postmenstrual age
- Intervention: Any type of vascular access (umbilical vein, IO, peripheral vein, or other)
- Comparators: Any other type of vascular access (umbilical vein, IO, peripheral vein, or other)
- Outcomes
    - Important: Time to achieve heart rate >100/min and time required to successfully place the device (important)
    - The following outcomes were also collected, if reported: Successful vascular access at first attempt (important), number of attempts for success (important), complications associated with the procedure (important), and death during the event or death before hospital discharge (critical), although it was considered unlikely that studies would be

able to attribute these to the first-attempted method for vascular access. Outcomes were rated as important or critical according to Strand and colleagues (2020)[303] or task force consensus.

- Study designs: RCTs and nonrandomized studies (non-RCTs, interrupted time series, controlled before-and-after studies, and cohort studies) were eligible for inclusion. Case series of 6 or more cases were included for consideration of success rates and efficacy, but smaller case series and individual case reports were eligible only if they described complications of emergency vascular access methods. Unpublished studies (eg, conference abstracts, trial protocols) and cadaver, manikin, computer model and animal studies were excluded. All languages were included provided that there was an English abstract.
- Time frame: All years to July 30, 2025

Consensus on Science

No trials comparing one method of vascular access to another were found. The included studies comprised 10 case series[298,304-312] and 6 case reports.[313-318] Because of the small number of included infants, the heterogenous settings and indications for vascular access, and the lack of comparisons between types of devices, no pooling of data was feasible and results were described in a narrative. All the evidence was judged to be of very low certainty.[319] Publication bias could not be formally assessed but was considered likely.

For the important outcome of time to achieve heart rate >100/min, one case series examining use of UVCs in the delivery room (DR) for epinephrine administration in 11 infants reported a median time of 17 minutes (range, 12–24 min) from birth to achieve a heart rate >100/min.[312]

For the important outcome of time to successfully place the device, 2 small case series that included a total of 33 infants reported median times to UVC placement from birth of between 9 and 12 minutes, with wide ranges.[308,312] Neither study reported times from birth to decision to insert the device. Indirect evidence is provided from 2 studies that reported times to first dose of epinephrine via UVC (only if the first dose was given first via UVC, not via tracheal tube). Mean (SD) time to first UVC epinephrine was 5.4 (2.2) minutes in 20 infants in a single hospital study[307] and 8 minutes (95% CI, 7–10 min) in 127 infants in a multicenter registry study.[306]

For the important outcome of successful vascular access, one case series described successful UVC insertion in 23/25 (92%) infants in the DR.[308] Five case series described success rates of 60% to 100% for IO device insertion in a total of 412 neonates in in-hospital and out-of-hospital settings.[304,305,309-311] Two case series described success rates of peripheral IV insertion in infants in the DR and in OHCA, but the very few eligible infants (n = 15) preclude any reliable estimates of success.[298,305]

For the important outcome of successful vascular access on first attempt, success rates were 84% for UVC insertion (one study including 27 newborn infants in the DR)[308] and ranged from 50% to 100% for IO device insertion (3 studies including a total of 200 neonates in different settings).[304,310,311]

For the important outcome of number of attempts, no results were available for UVCs. For IO device insertion, between 1 and 4 attempts were required in various settings in 2 case series.[310,311] For peripheral IV insertion, several attempts were required for 1 out of a total of 5 infants in a single very small study.[298]

For the important outcome of complications, no studies reported complications associated with emergency placement of UVCs, although one report described 2 infants who developed gangrene of the buttocks after attempted direct injection of epinephrine into an umbilical vessel with a needle (which may have penetrated an umbilical artery).[314] For IO devices, complications reported in case reports and case series included dislocation and malfunction of the IO needle, tibial fractures, subcutaneous and severe soft tissue necrosis, hematoma, extravasation, osteomyelitis, soft tissue infection, limb amputation, and other unspecified events.[304,309-311,313,315-318] In one of the larger case series, severe complications occurred in 9/161 infants (5.6%)[311] and in another, complications occurred in 11/102 infants (10.8%).[309]

For the critical outcomes of death during the event requiring emergency vascular access and death before hospital discharge, no studies compared methods or devices for vascular access. Risk of confounding by indication was considered too high for any comparison between the various single-arm studies, precluding conclusions about the effect of type of vascular access on the critical (mortality) outcomes of the review.

No data were available for preplanned subgroup analyses by timing of intervention (immediately after birth versus subsequently), setting, health care professional characteristics, or gestational or postnatal age.

Prior Treatment Recommendations (2020)

We suggest UVC as the primary method of vascular access during newborn infant resuscitation in the DR. If umbilical venous access is not feasible, the IO route is a reasonable alternative for vascular access during newborn resuscitation (weak recommendation, very low–certainty evidence).

Outside the DR setting, we suggest that either umbilical venous access or the IO route may be used to administer fluids and medications during newborn resuscitation (weak recommendation, very low–certainty evidence). The actual route used may depend on local availability of equipment, training, and experience.

2026 Treatment Recommendations

During resuscitation of infants immediately after birth, we suggest inserting an UVC as the primary method to obtain emergency vascular access (conditional recommendation, very low–certainty evidence).

During resuscitation of infants immediately after birth, if insertion of an umbilical vein catheter is not successful or not feasible, we suggest that inserting an IO device may be a reasonable alternative to obtain emergency vascular access (conditional recommendation, very low–certainty evidence).

After the immediate newborn period, when the umbilical vein is no longer patent, we suggest that inserting an IO device is a reasonable method to obtain emergency vascular access (conditional recommendation, very low–certainty evidence).

There is insufficient evidence to make a recommendation on the use of a peripheral vein catheter for emergency vascular access in the setting of neonatal cardiac arrest or bradycardia.

Justification and Evidence-to-Decision Framework Highlights

The complete evidence-to-decision table is provided in Appendix A.

The NLS Task Force noted that there were no human infant studies that compared devices, routes or methods for emergency vascular access, so treatment recommendations are based on case series and case reports. This limited evidence increases the subjectivity of the judgements, which were decided by task force consensus.

The included studies indicate that emergency vascular access can be achieved by using a UVC or IO device with the choice depending on indication (DR resuscitation versus other), patency of the umbilical vein, presence of abdominal wall malformations, operator training and experience and available equipment. There may be considerable reporting bias, but a range of serious complications have been described with IO devices, related to insertion and subsequent use. These issues, together with the very low certainty of the direct and indirect evidence, meant that conditional recommendations were considered more suitable than more generally applicable good practice statements.

Knowledge Gaps

- Optimal devices and techniques for each type of vascular access (including insertion, determination of correct placement, and securement)
- Optimal insertion sites for IO and peripheral IV devices
- Accurate estimates of short- and long-term safety of different devices
- Comparison of time to insertion (from the time of decision to insert, taking into account the number of attempts)
- Pharmacokinetics and pharmacodynamics of epinephrine administered via each type of vascular access
- Preferred devices for specific populations of neonates
- Training implications for health care professionals
- How different vascular access devices affect clinical outcomes

Respiratory Function Monitor (RFM) Feedback Devices During Training (NLS 5854: SysRev)

Rationale for Review

PPV is a critical skill for resuscitating newborns. When PPV is delivered via a face mask, both simulation and human infant studies suggest room for improvement in technique to avoid under- or overventilation.[320,321] RFM devices can display variables such as leak around the face mask, tidal volume, ventilation rate, peak inflation pressure (PIP), and PEEP in real time.[322-324] Although the value of RFM devices in clinical practice remains uncertain,[325] when used in simulation-based training with suitable manikins that have no internal air leaks, they may have potential to improve knowledge and skills[326] and, thereby, improve clinical practice and infants' outcomes. The NLS Task Force therefore prioritized a new SysRev on the use of RFM feedback devices for training in face mask PPV.

Full details are available in the published review and on the CoSTR website.[327] The protocol was registered on PROSPERO (CRD42024514139).

Population, Intervention, Comparator, Outcome, Study Design, and Time Frame

- Population: Trainees or health care professionals who receive neonatal resuscitation training
- Intervention: Use of an RFM device during simulation training
- Comparators: No use of an RFM device during simulation training
- Outcomes (rated as important or critical according to Strand and colleagues (2020)[303] or task force consensus)
  - Training performance (measured in simulation setting):
    - Knowledge at training conclusion, up to 1 year and beyond 1 year (important)

        - Skill performance at training conclusion, up to 1 year and beyond 1 year (important)
    - Transfer to clinical performance (measured in DR setting):
        - Quality of performance in actual resuscitations (critical)
    - Clinical outcomes (effectiveness of training in improving clinical outcomes):
        - Patient survival (critical)
        - Respiratory clinical outcomes during PPV in the DR (important)
        - Time to heart rate ≥100/min (important)
    - Financial outcomes:
        - Cost-effectiveness of using RFM in neonatal resuscitation training (important)
- Study designs: RCTs and nonrandomized studies (non-RCTs, interrupted time series, controlled before-and-after studies, cohort studies) were eligible for inclusion. Unpublished studies (eg, conference abstracts, trial protocols) were excluded. Publications in any language were eligible for inclusion provided that there was an English abstract.
- Time frame: All years to May 9, 2025

Consensus on Science

Sixteen studies, including 3 RCTs,[323,328,329] 5 crossover RCTs,[322,330-333] 2 studies with nonrandomized crossover designs,[326,334] and 6 other studies[324,335-339] were included. All studies were conducted in simulation settings, and all examined PPV provided to term or preterm infant manikins using a face mask, except one that assessed PPV via a tracheal tube.[336]

Heterogeneity in the intervention and comparator conditions in the included studies led to a decision to analyze them in 3 groups. Seven RCTs or crossover trials compared participant performance when the RFM device screen was visible to participants in an intervention group and concealed in a control group (comparison 1).[328,329,331-334,337] In 4 single-arm studies, the RFM screen was concealed during a baseline phase, visible to participants during a second (training) phase, and then concealed in a third (outcome measurement) phase (comparison 2).[326,336,338,339] In one RCT, verbal feedback from an instructor[329]—or in a randomized crossover trial, a simulated team leader[322]—was compared with feedback from an RFM (comparison 3).

Other heterogeneity included whether use of the devices was tested in skills stations or during resuscitation scenarios. In one RCT, the training scenario was elective preoperative PPV followed by intubation of a neonate needing surgery and included exposure to both video laryngoscope and RFM displays, to neither, or to instructor feedback from both displays.[329] One study compared RFM signals with and without an indicator light signal augmenting the RFM display.[331] One study had a factorial design and compared both visible versus concealed RFM screen and a T-piece resuscitator versus a self-inflating bag.[334] For each study, only subgroup data that most closely addressed each of comparisons 1, 2, and 3 were included in meta-analysis. Most studies reported measures of face mask leak and tidal volume, but reporting of other outcomes varied, limiting meta-analyses and, hence, certainty of evidence.

Comparison 1: Visible RFM Versus Concealed RFM

Key results are summarized in Table 19. In addition, the proportion of face mask leak better than author-defined thresholds and the proportion of inflations that were within author-defined target limits were probably improved (moderate-certainty evidence).[331,334,337] Effective ventilation (author's definition) was probably achieved earlier and sustained longer, and the time to correct airway assessment was probably reduced in one RCT that included 300 participants (moderate-certainty evidence).[328] In studies that reported PIPs and ventilation rate there, was either little or no difference, and certainty of evidence ranged from very low to moderate. Results for use of an RFM to avoid (author-predefined) overventilation or to promote skill retention at follow-up after a month were also inconclusive or certainty of evidence was very low.

Table 19. Visible RFM Compared With Concealed RFM During Simulation Training

Outcomes (importance)	**Participants (studies*)**	**Certainty of the evidence (GRADE)**	**Anticipated absolute effect (95% CI)**	
			Mean† with RFM concealed	**Mean difference with RFM visible**
Mean face mask leak as percentage of inspired tidal volume (V_{Ti}) (important)	499 participants (2 RCTs)[323,329]	Moderate	Face mask leak was 43.8% of V_{Ti}	Face mask leak was 21% of V_{Ti} lower (32% lower–9% lower)
	108 participants (3 non-RCTs)[326,332,333]	Moderate	Face mask leak was 37.2% of V_{Ti}	Face mask leak was 7% of V_{Ti} lower (14% lower–1% lower)
V_{Te} (important)	388 participants (1 RCT)[323]	Moderate	V_{Te} was 14.2 mL	V_{Te} was 2.4 mL higher (2.4 mL higher–4.6 mL higher)

GRADE indicates Grading of Recommendations Assessment, Development, and Evaluation; RCT, randomized controlled trial; RFM, respiratory function monitoring; V_{Te}, expired tidal volume; and V_{Ti}, inspired tidal volume.

*Because of the relatively few participants for each comparison, for meta-analyses parallel RCTs were analyzed separately, but crossover RCTs and before-after studies were combined, acknowledging that the crossover trials may have had insufficient time between exposures to prevent carryover of effects and hence could have underestimated effect sizes, but might have exaggerated precision.

†Study results reported as medians were converted to means for meta-analysis using the method of Wan et al.[340]

Comparison 2: RFM Visible During Training; Baseline Data Compared With Study Completion Data, Both With Concealed RFM

These studies, in effect, measured the transfer of skills acquired from performing face mask ventilation by using an RFM to performing face mask PPV without an RFM. There were inconclusive effects on face mask leak[326,338,339] but a possible improvement in expired tidal volume (V_{Te})[339] and proportion of inflations delivered within an author-defined safe range.[336,338] Certainty of evidence for each was very low.

Comparison 3: Instructor or Team Leader Verbal Feedback From RFM Compared With RFM Concealed From or Visible to the Participant

There were 2 very different studies examining the role of using RFM to improve instructor or team leader advice. These were not suitable for meta-analysis.[322,329] Effects on respiratory function variables in each were inconclusive, and certainty of evidence was very low.

There were insufficient data for any preplanned subgroup analyses (eg, by trainee experience, type of manikin, type of RFM).

Prior Treatment Recommendations

None

2026 Treatment Recommendations

In training health care professionals to perform neonatal resuscitation during simulation with manikins, where resources permit, RFM may be used as an adjunct to improve face mask ventilation skills (conditional recommendation, very low–certainty evidence).

Justification and Evidence-to-Decision Framework Highlights

The complete evidence-to-decision table is provided in Appendix A.

The moderate-certainty evidence for improvement in trainees' awareness and performance in relation to mask leak and tidal volume suggested that using RFMs during training in face mask ventilation can improve training outcomes. However, the overall evidence for transfer of skills, even immediately after training, to providing PPV to a manikin without a visible RFM display and for retention of skills after training was inconclusive and of very low certainty. No studies addressed the effects of simulation-based training using an RFM on performance (with or without an RFM) in clinical settings after training, or on patient outcomes.

There were also no studies that examined costs, cost benefits, or effects on equity. Hence, resource implications may limit adherence to the treatment recommendation.

Knowledge Gaps

- The best user-interface and screen location for display of RFM information
- Whether follow-up with high frequency, short-duration reinforcement skill stations using an RFM, with or without an instructor, improves transfer (both to skills without an RFM and to clinical settings) and retention
- Whether visual attention to an RFM and added cognitive load of RFM data affect individual or team performance during simulation
- Costs and cost-effectiveness of routine use of RFMs in neonatal resuscitation training
- Whether use of RFMs during training improves performance in clinical settings or clinical outcomes

Strategies for PPV (NLS 5325: ScopRev)

Rationale for Review

For newborn infants without effective spontaneous breathing after birth, PPV is a critical step in resuscitation. In most infants, achieving sufficient lung aeration and minute ventilation will reverse hypoxic bradycardia and, thereby, reduce the need for circulatory support such as chest compressions. ILCOR last reviewed the variables that need to be considered in providing PPV in 2010,[341] and variation in resuscitation council guidelines confirms a lack of consensus about the best strategy. Full details are available in the published review and on the CoSTR website.[342]

Population, Intervention, Comparator, Outcome, Study Design, and Time Frame

- Population: Newborn infants who receive PPV immediately after birth
- Intervention and comparators
  - Higher or lower PIP, ventilation rate, duration of PPV before reassessment of the infant's spontaneous breathing, synchrony with infants' own breaths, or monitoring of V_{Te}.
  - Longer or shorter initial inspiratory time (T_i)
  - Strategy for adjustment of PPV
  - Bundle of the above interventions following any set of guidelines versus those in any other set of guidelines
- Outcomes (rated as important or critical according to Strand and colleagues (2020)[303] or task force consensus)
  - Primary outcome: Success of resuscitation
    - Time until heart rate >100/min after birth (important)
    - Other outcomes:
    - Resuscitation outcomes: Critical—survival in the DR; important—receipt of chest compressions, time to first breath, intubation in the DR, duration of PPV, final oxygen concentration in the DR
    - Neonatal morbidity outcomes (critical): Intraventricular hemorrhage (Papile grade III or IV),[343] bronchopulmonary dysplasia (moderate to severe), neurodevelopmental impairment
    - Physiological outcomes (applicable to animal studies): Measures of lung inflation, pulmonary blood flow, blood gases

- Study designs: Animal studies, human trials (randomized, nonrandomized, historically controlled), and human observational studies (cohort, before-and-after, case-control, case series if ≥6 participants) were included. All languages were included provided that there was an English abstract. Because of insufficient evidence from human infant studies, the literature search was adapted for relevant animal studies.
- Time frame: All years to December 30, 2025.

Summary of Evidence

Of 41 included studies, 12 were in term human infants,[344-355] 19 in preterm infants,[320,356-373] 2 in both preterm and term infants,[374,375] and 9 were in animals.[376-384] One study included both animals and preterm infants.[378] As well as variations in population and design, some studies included providing PPV through a tracheal tube, some via face mask, and some via both. The devices used to deliver PPV included self-inflating bags, flow-inflating bags, T-piece devices and infant ventilators. In this summary, spontaneous respiratory efforts by the infant are referred to as breaths, and the tidal change in lung volume achieved by PPV as inflations. *Peak inflation pressure* is used as a collective term for the highest positive pressure applied during PPV, although some studies referred to this as *peak inspiratory pressure*.

Important themes from this review included that the individual PPV variables, such PIP, T_i, ventilation rate, PEEP and V_{Te}, have interdependent effects on the initial recruitment of the newborn's lung (clearance of lung liquid and establishment of functional residual capacity) and on achieving optimal subsequent minute ventilation.[344,356,382,385] PEEP was not evaluated in detail in this review because it has been the subject of a separate SysRev.[386]

It may be justifiable to use a different strategy for the first few inflations, which are aimed at initial aeration of the lung.[385] Subsequent adjustment will usually be needed due to changing lung mechanics. Different strategies for initial and subsequent phases were examined in some studies,[347,355,358,375,382,387] although the transition between them is gradual and requires sophisticated imaging or measurements to define.

Most studies examined only short-term, physiological outcomes including V_{Te} and exhaled CO_2, but the optimal targets for these variables in the minutes after birth are not yet well defined. While one study usefully describes trajectories of these in healthy infants,[354] optimal targets in vulnerable preterm or asphyxiated infants requiring resuscitation remain uncertain.

Excessive V_{Te} is a determinant of injury to lungs and other organs,[362,377,384] but when comparing between infants there is an unreliable correlation between PIP and $V_{Te.}$ PIP is commonly controlled (eg, using T-piece devices) or measured using manometry. Although adding RFM to monitor V_{Te} is theoretically beneficial, a previous ILCOR SysRev did not demonstrate benefit of RFM in clinical settings.[289-291,325]

PIP was investigated in 9 human term infant studies,[344-351,355] 11 preterm infant studies,[357-360,363,364,368,371,372,374,388] and 1 animal study.[384] In term infants, initial PIPs of up to 40 cm H_2O (for initial inflations)[345,374] or up to 30 cm H_2O for subsequent inflations[344] achieved author-defined target V_{Te} or functional residual capacity in most infants, but the latency in achieving targets depended on initial T_i and PPV rate. For preterm infants, pressures up to 30 cm H_2O generally achieved targets.[356,357,360,362,364,368,369,371,372]

No comparative studies assessed T_i <5 seconds or PPV rate. A previous ILCOR SysRev found that initial sustained inflations >5 seconds were not beneficial and there was possible harm.[289,389] Some observational studies included in the current review supported 1- to 3-second initial sustained inflations for lung recruitment,[358,375,390] although one animal study suggested no overall benefit[391] and human infant studies suggested lack of benefit from longer T_i for subsequent inflations.[356,363,368]

For the duration of PPV before assessing response, one human[361] and one piglet study[376] suggested that, from initial bradycardia, there was a latency of 20 to 30 seconds after commencement of PPV before heart rate rose.

For synchronizing PPV with spontaneous breaths, studies suggested that infants' breaths could be as or more effective than PPV inflations, and they also could augment response to PPV.[320,363,364,368,371,372] The results may depend on airway reflexes.[379] However, no studies examined benefits or harms of an intentional strategy of synchrony.

Strategies for adjustments or optimization of PPV included one study that examined 41 interventions to improve V_{Te} and reported that some were ineffective or potentially harmful.[373]

Bundled interventions, or comparison of the approaches recommended in different guidelines were not addressed in any study.

Task Force Insights

The review identified many gaps in published literature, including a shortage of RCTs or large interventional observational studies. The uncertain reliability of observations of chest expansion,[392,393] the delayed improvement in heart rate after commencing or improving PPV,[361,376] and the poor prediction of V_{Te} from PIP measurements raise concerns that better methods are needed to enable adjustment of PPV strategy to individual infants' needs.

The NLS Task Force will prioritize a SysRev, with questions and search strategies informed by the ScopRev, to update the recommendations by using ILCOR's contemporary evidence appraisal methods.[394]

Treatment Recommendations (2010, Unchanged)

There is no evidence to support the use of inflation pressures higher than those that are necessary to achieve improvement in heart rate or chest expansion. This can usually be achieved in term infants with an inflation pressure of 30 cm H_2O and in preterm infants with pressures of 20 to 25 cm H_2O. Occasionally higher pressures are required. In immature animals, ventilation at birth with high tidal volume associated with the generation of high PIPs for a few minutes causes lung injury, impaired gas exchange, and reduced lung compliance.

EDUCATION, IMPLEMENTATION, AND TEAMS

Targeted BLS Training for Likely Rescuers of High-Risk Populations (EIT 6105: SysRev Adolopment)

Rationale for Review

OHCA is a significant cause of death, and a high proportion of OHCAs occur in the home. This topic was reviewed by ILCOR in 2015, with a published SysRev in 2016 and in 2022.[172,173,395-397] A SysRev published in the 2025 PROSPERO (CRD42021233811) identified 17 new nonrandomized studies in adults and children that targeted training to a variety of high-risk populations (eg, families of cardiac arrest survivors, infants in neonatal ICUs).[398] This review met ILCOR criteria for adolopment and was used for this *ILCOR Consensus on Science and Treatment Recommendations* (CoSTR), with an updated search conducted on November 20, 2025. The complete CoSTR can be found on the ILCOR website.[399]

Population, Intervention, Comparator, Outcome, Study Design, and Time Frame

- Population: Adults and children at high risk of OHCA
- Intervention: Targeted BLS training of likely rescuers (eg, family, caregivers)

- Comparators: No such targeting
- Outcomes
  - Patient outcomes (critical): Survival with favorable neurological outcome at discharge and 30 days, survival to hospital discharge or to 30 days, and ROSC
  - Process outcomes (critical): Rates of bystander CPR (subsequent use of skills), rates of AED use (subsequent use of skills), and bystander CPR quality during OHCA (any available CPR metrics)
  - Education outcomes (important): CPR quality and AED competency after training completion and within 12 months after training, CPR and AED knowledge after training completion and within 12 months after training, confidence to perform CPR after training and within 12 months after training, willingness to perform CPR after training and within 12 months after training, and secondary training of others
- Study designs: RCTs and nonrandomized studies (non-RCTs, interrupted time series, controlled before-and-after studies, cohort studies) were eligible for inclusion. All languages were included provided that there was an English abstract available. Unpublished studies (eg, conference abstracts, trial protocols) were excluded. Review articles were searched for additional citations.
- Time frame: All years to November 20, 2025

Consensus on Science

All the studies used varying methods for BLS training, control groups, and assessment of outcomes and were too heterogeneous to enable meta-analysis for any outcome.

Patient and Process Outcomes

For the critical patient outcomes, 17 adult and pediatric studies (including 3 RCTs) reported at least one critical outcome, and in most studies outcomes were self-reported.[400-416] A large study randomized 7001 adult patients with acute myocardial infarction and those living with them to CPR training with an AED (supplied by the study) or CPR training without provision of a home AED.[402] An AED was applied in 50% of 160 OHCAs over a follow-up of 37 months, with no difference in mortality between the 2 study groups. The largest pediatric RCT randomized parents of 462 neonatal ICU infants to 3 different methods of CPR training or no training.[400] At 1 year, successful resuscitation from 13 OHCA events at home was reported in the CPR training groups, with no OHCA events in the control group.

Educational Outcomes

For the important educational outcome of CPR quality and AED competency, 19 studies (1 RCT,[417] 18 non-RCTs) were found.[409,418-434] Studies that reported an overall quality or competency metric found improvements after training. Beyond training completion, 7 non-RCTs reported on CPR quality and AED competency at some time point after completion of training.[404,421,423,431,435-437] Studies between 2012 and 2020 report improved CPR quality parameters up to guidelines standard immediately after training.[417,418,421-423,433,435,436] Correct use of an AED was assessed in 1 study and showed an improvement from baseline.[423] Another study reported that refresher training resulted in less decay of CPR skills over time.[421]

For the important educational outcomes of CPR and AED knowledge, 13 studies (1 RCT, 12 non-RCTs) were found, reporting an increase in knowledge immediately after training.[401,416,419,426,428,431,432,434,437-441]

For the important outcome of confidence to perform CPR, 5 non-RCTs[418,421-423,432] identified increased confidence following any type of CPR training. However, 2 of those studies reported a decay in confidence over time.[423,432] The updated search identified a non-RCT describing public CPR training for family members of patients with chronic diseases under community care, in which 140 participants were surveyed 6 months after training; 43.6% expressed confidence to perform CPR, 45.7% had moderate confidence, and 10.7% lacked confidence 6 months after training.[442]

Nine non-RCTs reported the important outcome of willingness to provide CPR.[404,406,409,417,418,425,426,439,443,444] Only 3 studies reported a significant increase in willingness to provide CPR after training.[406,418,443]

For the important outcome of secondary training (training others and/or sharing teaching materials with others), 1 RCT[417] and 8 non-RCTs were found.[411,418,422,423,436,443-445] Five reported that 22% to 72% of participants went on to provide secondary training.[417,418,422,423,436] One study reported that 96% of participants intended to teach others, but ultimately only 42% of participants did so.[418]

Prior Treatment Recommendations (2022)

We recommend BLS training for likely rescuers of populations at high risk of OHCA (strong recommendation, low-certainty evidence).

We recommend that health care professionals encourage and direct likely rescuers of populations at high risk of cardiac arrest to attend BLS training (good practice statement).

2026 Treatment Recommendations

We recommend BLS training for likely rescuers of adults and children at high risk of OHCA (strong recommendation, low-certainty evidence).

We recommend health care professionals encourage and direct likely rescuers of adults and children at high risk of cardiac arrest to attend BLS training (good practice statement).

Justification and Evidence-to-Decision Framework Highlights

The complete evidence-to-decision table is available in Appendix A.

In making this recommendation, the EIT task force placed a high value on several factors:

- Training demonstrated measurable improvements in BLS skills and confidence compared with baseline data and guideline standards.
- Improvement in confidence directly influences willingness to act during OHCA.
- The multiplier effect of trained individuals sharing their knowledge and training others may increase the impact of training.
- A high proportion of OHCAs occurs in the home, increasing the likelihood of patients receiving BLS from a family member or caregiver.
- Family members and caregivers are willing to undergo training and apply skills when required.
- No evidence was identified on how training affects anxiety among trainees.
- The task force discussed the opinion that the likelihood of self-initiated training is low, making formal training important.

Knowledge Gaps

- Objective and standardized assessments of skill performance and knowledge, to enable interstudy comparisons

- The long-term impact on patient outcomes, as assessed with new approaches, such as analyzing data collected from cardiac arrest registries
- The best methods for training and retraining to achieve high attendance and long-term skill retention
- Whether health care professionals suggesting the need for BLS training influences likely rescuers to seek training
- How to enhance secondary training, where trained individuals share their knowledge and train others

Terminology for Individuals or Teams Attending Patients in Cardiac Arrest (EIT 6312: ScopRev)

Rationale for Review

Most resuscitation articles studying OHCA and IHCA use inconsistent terminology when describing individuals or teams attending cardiac arrest. This hampers comparability of registries and studies, and poses challenges for implementation, education, and communication. The full report of the ScopRev can be found on the ILCOR website.[446]

Population, Intervention, Comparator, Outcome, Study Design, and Time Frame

- Population: All individuals and teams attending patients with cardiac arrest of any age in any setting (laypersons or health care professionals, witnesses or dispatched responders)
- Intervention: Terms and definitions used to describe such individuals or teams
- Comparators: Not applicable (descriptive ScopRev)
- Outcome: Terms and definitions of individuals and teams

- Study designs: All types of published peer-reviewed literature in English (RCTs, observational studies, reviews, consensus papers, commentaries, editorials) providing definitions or structured terminology for individuals or teams attending a cardiac arrest (any age, setting, role, or affiliation) were included. Articles without explicit definitions, describing emergencies other than resuscitation, or including the simple use of terms without explanation were excluded. Non-English articles were excluded (because translation of terms from other languages into English would not reflect their cultural-linguistic background).
- Time frame: All years to June 5, 2025

Summary of Evidence

The search strategy was developed with input from an ILCOR task force survey including the BLS, ALS, PLS, NLS, FA, and EIT Task Forces, resulting in 21 responses and 48 terms. After screening of 7148 records and removal of duplicates, 23 full-text articles were assessed. The 9 studies included were mainly Utstein updates or consensus documents. Six[5,447-451] provided structured definitions (eg, *bystander*, *first responder*, *volunteer community responder*, *rapid response team*). Definitions varied widely, especially regarding bystanders (including or excluding off-duty professionals). Three studies highlighted inconsistencies without offering formal definitions.[452-454] Terminology for IHCA was very inconsistent.

Task Force Insights

Most reports were publications from large multinational authorship groups, and it is unknown whether these publications reflect the linguistic or cultural background of the entire group of authors. Substantial heterogeneity in terminology of individuals or teams responding to cardiac arrest across all settings was found. No studies address terminology in low-resource settings. Currently, there is no clear set of terminology that is universally accepted covering all aspects of IHCA and OHCA across different contexts.

The most recent Utstein template[5,6] represents ILCOR's iterative consensus with international input defining individuals or teams attending OHCA. This ScopRev opens the question of whether terminology defined for use in registries can be generalized for use in implementation science, resuscitation education, or legal frameworks. For example, in some contexts, it may be important to define the level of training of responders as *untrained*, *BLS trained*, or *ALS trained*. Future work should address the barriers and facilitators that could influence effective implementation of recently formulated definitions from research and registries.

The task force concluded that international consensus that describes the terminology for all persons attending IHCA is lacking. Further consensus statements should follow the current ILCOR standards of Utstein statements and integrate prior Utstein consensus definitions for OHCA, while addressing gaps in terminology related to IHCA and different kinds of first responders for OHCA. Ideally, such input should include key stakeholders such as health care professionals, resuscitation educators, scientists, health policy makers, administrators, patient representatives, and laypersons. Input should come from different resource settings and cultural areas.

There was no previous treatment recommendation, and none has been generated.

Knowledge Gaps

- How terminology varies in low-income countries and other cultural settings, to enable generalizability of findings to global settings

- Standard international terminology for IHCA responders (eg, rapid response teams, resuscitation teams)
- Clarification is needed to determine if registry terminology is generalizable to implementation science, resuscitation education, or legal frameworks

Best Practices for IHCA Team Composition (EIT 6317: ScopRev)

Rationale for Review

Resuscitation teams are generally recommended for the treatment of IHCA,[455-459] and a well-functioning team with optimal teamwork is recognized as an important facilitator for CPR quality.[460] Despite advances in CPR science, significant gaps persist in optimizing team performance, role allocation, and leadership[461-463] Previous ILCOR SysRevs suggest that CPR coaches may optimize resuscitation performance.[457,464] Various team factors might improve teamwork and resuscitation quality (eg, professional background of team members, role allocation, shared leadership, predefined team roles, team size, structured communication).[465-467] Understanding the relationship between team composition, leadership strategies, and performance during IHCA may help to improve patient outcomes and provide important information to hospital administrators and policymakers. This ScopRev was conducted as a nodal review together with the EIT, NLS, and PLS Task Forces. The full ScopRev is available on the ILCOR website.[468]

Population, Intervention, Comparator, Outcome, Study Design, and Time Frame

- Population: In-hospital resuscitation teams performing adult, pediatric, or neonatal ALS in a simulated or clinical setting

- Intervention: Any specific role allocation (eg, shared leadership), team composition (eg, team size), or team member characteristics (eg, clinical or training background, experience, seniority)
- Comparators: Any other role allocation (eg, no shared leadership), team composition, or team member characteristics
- Outcomes
  - Patient outcomes: ROSC, survival to hospital discharge or to 30 days, survival to hospital discharge or to 30 days with favorable neurological outcomes, survival beyond discharge or to 30 days, and survival with favorable neurological outcomes beyond hospital discharge or to 30 days (critical)
  - Real-life clinical performance: CPR skill performance (critical), adherence to guidelines (critical), teamwork (critical), and health care professional workload (critical)
  - Performance in simulated setting: CPR skill performance (important), adherence to guidelines (important), teamwork (important), and health care professional workload (important)
- Study designs: RCTs and nonrandomized studies (non-RCTs, interrupted time series, controlled before-and-after studies, cohort studies, and case series where n > 5) were eligible for inclusion. All languages were included provided that there was an English abstract. Editorials, commentaries, conference abstracts, gray literature, social media, unpublished studies, trial protocols, and non–peer-reviewed studies were not eligible for inclusion. Relevant ScopRevs and SysRevs were screened for relevant original literature.
- Time frame: All years to August 19, 2025

Summary of Evidence

Of 10 872 citations screened, 37 were included (28 from clinical settings,[461,462,467,469-493] 8 from simulation,[463,494-500] and one from both).[501] Simulation studies were all RCTs,[495-500] whereas the clinical studies were observational.[461-463,467,469-486,488-494,501] Twenty-six studies involved adult cardiac arrest teams,[461-463,467,471-474,476-480,482-484,486,487,489-493,496,501] 5 focused on neonatal teams,[469,475,498-500] 3 focused on pediatric IHCA teams,[494,495,497] and 3 were related to mixed IHCA populations.[470,481,485] Studies were grouped into 3 thematic domains (Table 20): team leader characteristics, team size and structure, and role allocation (including telemedicine).

Table 20. Thematic Domains of Cardiac Arrest Team Composition and Outcomes

Thematic domain	Outcomes/influencing factors		Summary
Leadership characteristics (n = 16)[461-465,467,469-503]	**ROSC**	**Experience and training**	No leadership attribute showed a consistent association with patient-centered outcomes.
	• Improved: Specific leader types in defined contexts improved ROSC (eg, ICU physicians outside ICU,[477] cardiologists in the cath lab,[479] resuscitation-trained residents,[475] specialists compared with technicians or ward staff.[470]) • Improved ROSC was setting-specific; however, no improvement in survival was shown in any study. • No differences were shown between residents, hospitalists, internal medicine physicians, or nurse-led teams.[461,469,473,475,481]	• Leadership-focused or combined ALS/BLS training improved early ROSC or early survival in some studies.[471,474,478] • ALS certification alone did not ensure effective leadership behaviors.[472,473] • Simulation training leading to strong leadership behaviors resulted in higher CPR quality performance.[463] • Recent simulation training[480] was associated with improved CPR process measures (shorter pauses, higher compression fraction).	
Team structure and size (n = 11)[467,483-486,493-498]	**ROSC**	**CPR quality and team structure**	Variations in team size and structural configuration showed limited and inconsistent associations with patient-centered outcomes. Any benefits come from effects on teamwork and CPR
	• Dedicated teams achieved higher ROSC.[467,485,493] • Improved ROSC rates did not consistently extend to	• Larger teams and greater number of compressors were associated with lower chest compression fraction, while smaller	

Thematic domain	Outcomes/influencing factors		Summary
	survival to discharge or longer-term outcomes.	teams experienced higher workload.[484,486,498] • Telemedicine-supported leadership was comparable to in-person leadership (teamwork scores, process metrics), without clinically important differences.[495,497]	quality rather than from structural configuration alone.
Role allocation (n = 9)[487-492,499-501]	**ROSC or survival**	**Adherence to algorithms and roles**	Overall, structured role allocation improves CPR organization, medication processes, and adherence to algorithms, with limited and inconsistent impact on patient-centered outcomes.
	• Process outcomes consistently improved with structured role allocation (eg, predefined roles, visible role identifiers, dedicated timekeepers, pharmacist-led medication support). Effect on ROSC or survival remained limited or inconsistent. Timekeeper and role-clarity interventions reduced timing errors without affecting ROSC.[487,499] • Visible role identifiers and structured allocation improved teamwork and role clarity but not ROSC.[488]	• Timekeeper and role-clarity interventions improved algorithm adherence.[487,499] • Involved pharmacists improved medication safety and completion of documentation.[489-492] No improvement in survival to discharge was shown. • It's unclear if pharmacist expertise or the designation of a dedicated team member responsible for medication is responsible for observed effects. • Implementation of clearly assigned roles in clinics was associated with a nonsignificantly shorter time to defibrillation.[501] • Clearly assigned functional roles improved behavior and reduced cognitive load in simulation, but assigning leaders to airway roles increased workload for them.[500]	

ALS indicates advanced life support; BLS, basic life support; CPR, cardiopulmonary resuscitation; ICU, intensive care unit; and ROSC, return of spontaneous circulation.

Task Force Insights

The evidence is heterogeneous and largely observational, which limits the ability to identify a single optimal model for team composition in IHCA. Team leader experience, specific clinical background, and seniority were not consistently associated with CPR quality and patient outcomes, but life support training and recent simulation-based training were generally linked to improved CPR quality and ROSC. There was no clear evidence suggesting that any profession or specialty is superior in function to another as a team leader. Nurse-physician coleadership reduces cognitive load for the primary leader and improves overall CPR quality, which supports the broader view that the leadership role can be shared. The evidence on team size and role allocation remains limited. Although structured role allocation consistently improves adherence to resuscitation processes, only 2 cohort studies compared dedicated versus ad-hoc teams, and their mixed results reflect partial implementation of dedicated team structures.

IHCA team performance benefits from adequate life support training, clear preassigned role allocation, and dedicated, well-structured, and designated team models. Adaptations in team structure, leadership, and/or roles may be required for specific clinical contexts such as pediatric, neonatal, or other unique clinical environments (eg, cardiac catheterization laboratory, emergency room).

There was no treatment recommendation previously, and none has been generated with this ScopRev.

Knowledge Gaps

- The optimal way to structure IHCA response teams
- The ideal team size for different clinical settings and how variations in size influence CPR quality, workload, or team coordination

- How leadership responsibilities are best arranged or shared and the most effective ways to train resuscitation leaders
- The optimal allocation of roles, including responsibilities for medications, documentation, airway management, and timing tasks
- Ideal team composition in pediatric or neonatal environments
- Ideal team composition in low-resource hospitals where staffing, equipment, and professional roles differ substantially
- The relationship between team configuration and health care professional stress or job satisfaction as well as patient-centered outcomes (survival or neurological outcomes)

Evidence Updates

The EIT EvUps for 2026 are summarized in Table 21, with the PICO; existing treatment recommendation; number of studies identified; key findings; and whether a SysRev was deemed worthwhile provided. The complete EvUps are provided in Appendix B.

Table 21. EIT Topics Reviewed by EvUps

Topic/PICO	Year of last SysRev	Existing treatment recommendations	RCTs since last review	Observational studies since last review	Key findings	Sufficient data to warrant SysRev?
CPR self-instruction versus instructor-guided training (EIT 6406)	2020	We suggest the use of either instructor-led training or self-directed digital training for the acquisition of CPR or AED skills in lay adults and high school-aged (>10 y) children (weak recommendation, very low–certainty evidence). We suggest self-directed digital	None	2[504,505]	One of these studies supports the intervention, and the other supports the control.	Yes

Topic/PICO	Year of last SysRev	Existing treatment recommendations	RCTs since last review	Observational studies since last review	Key findings	Sufficient data to warrant SysRev?
		training be used when instructor-led training is not accessible, or when quantity over quality of CPR training is needed in adults and children (weak recommendation, very low–certainty evidence). There was insufficient evidence to make a recommendation on game-in-film, virtual reality, computer programs, online tutorials, or app-based training as a CPR or AED training method.				
Spaced learning (EIT 6408)	2022	For learners undertaking resuscitation courses, we suggest that spaced learning (training or retraining distributed over time) may be used instead of massed learning (training provided at one single time point) (weak recommendation, very low–certainty evidence).	2 new [506,507]	None	• Significantly improved scores with spaced learning immediately after test, after 2 weeks, and after one month • Improved skill retention in the spaced group at 3 months	No
Gamified learning versus other forms of nongamified learning (EIT 6412)	2023	It may be reasonable to consider the use of gamified learning elements as a component of resuscitation training (weak recommendation, very low quality of evidence).	3 new RCTs[508-510] and 1 SysRev on 9 RCTs[511]	3 new[512-514]	SysRev concludes that gamified learning is equally effective as traditional training methods in CPR training. The newly included RCTs and	No

Topic/PICO	Year of last SysRev	Existing treatment recommendations	RCTs since last review	Observational studies since last review	Key findings	Sufficient data to warrant SysRev?
					observational studies exhibit a high degree of heterogeneity in terms of intervention, outcome, and included subjects.	
Deliberate practice design versus non–deliberate practice training (EIT 6414)	2023	We suggest that it may be reasonable to include rapid-cycle deliberate practice as an instructional design feature of BLS and ALS training (weak recommendation, very low–certainty evidence).	None	None	None	No

AED indicates automated external defibrillator; ALS, advanced life support; BLS, basic life support; CPR, cardiopulmonary resuscitation; EIT, education, implementation, and teams; EvUps, evidence updates; PICO, population, intervention, comparator, and outcome; RCT, randomized controlled trial; and SysRev, systematic review.

FIRST AID

Virtual Opioid Poisoning Education and Naloxone Distribution (OPEND) (FA 7443, ScopRev Adolopment)

Rationale for Review

The opioid crisis is a complex and multifaceted public health epidemic. OPEND programs are powerful tools against the opioid poisoning crisis. Due to the COVID-19 pandemic, health services that were previously only provided in person were adapted to be conducted remotely and across long distances, demonstrating the potential of remote OPEND programs. In this review, we aim to support the development of future remote OPEND programs by compiling an overview of existing remote OPEND programs and their advantages and disadvantages. The full ScopRev report can be found online.[515]

Population, Concept, Context, Study Design, and Time Frame

- Population: People at risk of opioid poisoning or likely to witness opioid poisoning or otherwise interested in OPEND program participation
- Concept: Any opioid poisoning education programming with or without naloxone distribution that is conducted entirely at a distance and without in-person interaction between program personnel and participants
- Context: Worldwide
- Study designs: RCTs, non-RCTs and observational studies were included. Conference proceedings, reviews, protocols, case reports, commentaries, and letters to the editor were excluded. All years and all languages were included provided that there was an English abstract.
- Time frame: All years to September 1, 2025

Summary of Evidence

This was an adolopment of a ScopRev,[516] which included 31 studies on OPEND programs.[517-547] The review concluded that most educational interventions lead to increased knowledge, improved attitudes (ie, reduced stigma) toward people who use opioids, and high participant satisfaction. An updated search yielded 11 more articles,[548-558] for a total of 42 studies. The 42 studies were published between 2016 and 2025 and included 20 quasi-experimental pre-post design studies, 13 descriptive studies, 6 RCTs, 2 program evaluations, and

1 non-RCT. Main findings of the additional studies[548-558] identified align with the published ScopRev.

Task Force Insights

The task force discussed the following concepts:

- Both in-person and virtual opioid poisoning education are effective and appropriate for improving knowledge and preparedness.
- In jurisdictions with no existing naloxone distribution program, virtual overdose prevention and response training is still effective in providing education on recognizing and responding to opioid poisoning.
- Virtual OPEND can reach communities that would otherwise be unlikely to receive opioid poisoning education.

Prior Treatment Recommendations

None

2026 Good Practice Statements

Virtual and in-person OPEND programs are effective and appropriate for improving knowledge and preparedness on opioid poisoning response, especially when combined with naloxone distribution (good practice statement).

Virtual programs, in particular, can teach opioid poisoning response anywhere there is a need, such as rural and underserved communities, and can provide lifesaving education on opioid poisoning response with or without naloxone distribution (good practice statement).

Justification and Evidence-to-Decision Framework Highlights

The complete evidence-to-decision framework is included in Appendix A.

The included studies demonstrate that virtual OPEND programs are useful wherever there is a need for opioid poisoning response and that virtual OPEND can reach communities that would otherwise be unlikely to receive opioid poisoning education.

Knowledge Gaps

- The effect of these educational efforts on patient outcomes
- The importance of the order of actions (ie, call for help, administer naloxone, check for breathing)

FA Interventions for a Caustic Agent Attack in Adults and Children (FA 7445: ScopRev)

Rationale for Review

The global incidence of caustic agent attacks has been rising, with an estimated 10 000 cases annually worldwide.[559] These assaults, while not commonly fatal, cause permanent scarring, disfigurement, and long-term disability.[560,561] Despite this, there is little evidence available to guide the optimal FA management for these injuries. The full ScopRev report can be found online.[562]

Population, Intervention, Comparator, Outcome, Study Design, and Time Frame

- Population: Adults or children in the out-of-hospital setting subjected to a caustic agent attack to the skin or eye
- Intervention: Any intervention immediately available to the trained or untrained FA provider (eg, irrigation, cold compression, washing with soap, baking soda) and any duration

- Comparators: Any other treatment immediately available to the trained or untrained FA provider and any other duration, or no treatment
- Outcomes: Any clinical outcomes including pain relief, reduction in pain score, need for analgesia, extent of burn or tissue damage, intervention needed for burn or tissue damage, survival, and adverse reaction from use of treatment (eg, pain, erythema, allergy), including harm to FA providers
- Study designs: All study designs, including animal studies, and all kinds of publications, including conference proceedings, abstracts, case reports, and case series were included. All years and all languages were included provided that there was an English abstract.
- Time frame: All years to September 13, 2025.

Summary of Evidence

This review identified 8 observational studies, including 2 prospective cohorts,[563,564] 2 case series,[565,566] 3 case reports,[567-569] and 1 animal study.[570] One cohort study demonstrated that immediate water irrigation significantly reduced burn depth and hypertrophic scarring in persons assaulted with acid, with water-irrigated patients showing more superficial injuries and requiring fewer surgical procedures.[563] A controlled porcine model supported the benefit of early water irrigation, showing effectiveness only when decontamination occurred within 10 seconds, with diminished benefit after 30 seconds.[570] A second cohort study demonstrated that Diphoterine® shortened healing time compared with saline for mild alkali ocular burns, though there were insufficient data for severe burns to develop an informed conclusion.[564] Diphoterine is an amphoteric, hypertonic rinsing solution designed for the emergency decontamination of chemical splashes on the skin or in the eyes. A case series of severe ammonium hydroxide ocular burns suggested that outcomes were largely determined by initial injury severity, with many progressing to vision loss or eye removal regardless of irrigation.[565] Additional case reports and series described irrigation as part of early care but did not provide data sufficient to form a conclusion.[566-569] Overall, there is consistent observational evidence that immediate and copious water irrigation improves outcomes after chemical burns.

Task Force Insights

While the evidence is primarily observational, it consistently indicates that early, copious irrigation is beneficial in managing caustic skin and eye injuries. The strongest data come from an acid assault cohort demonstrating that prompt water irrigation substantially reduced hypertrophic scarring. An animal study further demonstrated that even short delays greatly diminish the protective effect of irrigation. Although specialized agents such as Diphoterine may offer advantages in select ocular alkali injuries, their limited availability raises concerns about equity, making water the most practical and widely accessible option.

Prior Treatment Recommendations

None

2026 Good Practice Statement

Following a caustic attack, immediately irrigate the injured person's affected area with copious amounts of water or saline (good practice statement).

Justification and Evidence-to-Decision Framework Highlights

The complete evidence-to-decision framework is included in Appendix A. Given the global burden and associated morbidity of caustic agent attacks, the task force concluded that rapid irrigation is a critical early intervention and formulated a good practice statement reflecting this.

Knowledge Gap

- The optimal irrigation agent, timing in relation to the exposure, duration of the irrigation, and the role of clothing removal, in addition to optimal management of children

Simple Single-Stage Concussion Scoring System(s) in the FA Setting (FA 7341: ScopRev)

Rationale for Review

A concussion is commonly caused by motor vehicle collisions, sports injuries, and bicycle accidents. While the sports world has made substantial advances in concussion management, these guidelines do not necessarily translate well to everyday situations for a lay FA responder. This is an update of a prior ScopRev of the management of a suspected concussion by a lay FA provider that was conducted by the ILCOR FA Task Force in 2019.[571,572] The full updated ScopRev can be found online.[573]

Population, Intervention, Comparator, Outcome, Study Design, and Time Frame

- Population: Adults and children with suspected head injury without loss of consciousness
- Intervention: Use of a simple single-stage concussion scoring system
- Excluded: Concussion recognition tool requiring baseline and follow-up testing (2-stage) conducted by trained medical personnel and concussion triage recognition tools, which are not feasible for lay responders in the out-of-hospital setting
- Comparators: Use of a standard FA assessment without a scoring system or triage tool
- Outcomes: Any clinical outcomes (detection or recognition outcomes as proxies).
- Study designs: RCTs and nonrandomized studies (non-RCTs, interrupted time series, controlled before-and-after studies, cohort studies) were included. Unpublished studies (eg, conference abstracts, trial protocols), reviews (all types) not addressing interventions feasible

in the out-of-hospital setting by FA responders, and animal studies were excluded. All languages were included provided that there was an English abstract.

- Time frame: January 2000 to July 24, 2025

Summary of Evidence

This ScopRev included 3 narrative reviews[574-576] and 3 observational studies.[577-579] All narrative reviews focused on sports-related concussions.[574-576] One review[576] found that systematic management of sports-related concussion is critical for minimizing adverse outcomes and ensuring athlete safety. A second review[575] reported on the challenges of diagnosing sports-related concussions, emphasizing the absence of definitive diagnostic tools and the evolving nature of the injury and advocating for a multifaceted diagnostic framework incorporating sideline assessments, extended observation, and exclusion of other conditions. A third review[574] highlighted the lack of a defined, validated biomarker or specific imaging finding to definitively diagnose concussion.

Three observational studies[577-579] were identified during the gray literature search. In summary, the 3 studies[577-579] highlight innovative tools and approaches for recognizing and managing pediatric concussion. One study[577] found that the HeadCheck app effectively increased parental awareness and knowledge of concussion recovery, offering a practical platform for guiding safe return to activities and recognizing severe symptoms. Another study[578] evaluated follow-up adherence and outcomes after using a telephone triage protocol, finding that 84.1% of patients followed urgent care recommendations and 39.5% were diagnosed with a concussion. Together, these studies emphasize the importance of accessible, structured tools to improve recognition, management, and follow-up for pediatric concussions in diverse care settings. One study[579] has demonstrated the feasibility of a triage screening tool for mild pediatric traumatic brain injury implemented by nurses in a clinical setting, showing high concurrence with emergency department diagnoses of concussion by asking 3 simple serial questions.

Task Force Insights

Noting the wide range of concussion symptoms, the FA Task Force found 1 approach, used by emergency department nurses in an observational study, to be useful.[579] Within that study, 3 simple serial questions were used to guide triage: (1) Did an injury occur? (2) Was the mechanism consistent with a head injury? (3) Was there any altered mental status? These questions are similar to the tool used in a retrospective cohort study.[578] The task force noted that the "recognize, remove, and refer" approach underscores the need for immediate removal from activity and referral to appropriate medical care when a concussion is suspected and, therefore, believe lay FA responders can use the 3 simple serial screening questions in the out-of-hospital setting to recognize a potential concussion. Considering these findings, a SysRev is not recommended, but a good practice statement was generated.

Prior Treatment Recommendation

None

2026 Good Practice Statement

When attempting to determine if a concussion has occurred, non–medically trained, non–health care providers (ie, lay FA responders) may consider using a 3-question screening process:

1. Did a potential injury occur?
2. Was the mechanism associated with a potential head injury?
3. Was there any altered mental status?

If the answer to all 3 questions is “yes,” the existing literature suggests that these individuals be removed from the activity and EMS be activated, or the patient be referred to a qualified health care professional (good practice statement).

Because concussion symptoms vary, FA responders who are unsure if a concussion occurred may consider removing the individual from the activity until a qualified health care professional can evaluate them (good practice statement).

Justification and Evidence-to-Decision Framework Highlights

The complete evidence-to-decision table is provided in Appendix A.

This ScopRev identified no direct evidence regarding a concussion triage recognition tool requiring little to no training that can be used as a one-time scoring tool by lay FA responders in the out-of-hospital setting. The FA Task Force agreed that recognition of a concussion is complicated by its variable symptomatology and the lack of a validated concussion triage recognition tool that can be used as a one-time scoring tool by lay FA responders. Symptoms may evolve rapidly (within seconds to minutes) or develop over hours, with acute symptoms such as dizziness and nausea presenting early and irritability and sleep disturbances emerging later. The 3 suggested questions to screen for concussion are similar to those used in a study[578] that estimated the proportion of people who followed up with urgent care recommendations to see a professional and determined the prevalence of concussion diagnoses after being screened with the Barton Schmitt Pediatric Head Injury Telephone Triage Protocol.

Knowledge Gaps

- No validated, single-stage concussion recognition or scoring tool designed for use by lay FA responders in out-of-hospital settings

- The accuracy, safety, and feasibility of simple, question-based screening approaches used by non–medically trained responders, and their impact on timely referral and patient outcomes

Evidence Updates

The FA EvUps for 2026 are summarized in Table 22. The complete EvUps are provided in Appendix B.

Table 22. Topics Reviewed by FA EvUps

Topic/PICO	Year of last SysRev	Existing treatment recommendations or good practice statements	RCTs since last review	Observational studies since last review	Key findings	Sufficient data to warrant SysRev?
Pulse oximetry (FA 7010)	ScopRev 2023	First aid providers who use pulse oximeters for the assessment of acute illness or injuries should be proficient in their use and understand their limitations, including equipment factors, environmental considerations, and patient-specific factors that may produce inaccurate and unreliable readings (good practice statement). The use of a pulse oximeter for first aid assessment should not supersede or replace physical assessment (good practice statement).	0	8 experimental[580-587] on consumer-grade devices, 1 with clinical outcomes	Focus was on accuracy of the device rather than on outcome of the use of it.	No
Recovery position (FA 7040)	SysRev 2022	When providing first aid to a person with a decreased level of responsiveness of	3	2	The RCTs[588,589] investigated all different positions of the body, 2 on arm position and	An updated review should include a parallel review of

Topic/PICO	Year of last SysRev	Existing treatment recommendations or good practice statements	RCTs since last review	Observational studies since last review	Key findings	Sufficient data to warrant SysRev?
		nontraumatic etiology and who does not require immediate resuscitative interventions, we suggest the use of the recovery position (weak recommendation, very low–certainty evidence). When the recovery position is used, monitoring should continue for signs of airway occlusion, inadequate or agonal breathing, and unresponsiveness (good practice statement). If body position, including the recovery position, is a factor impairing the first aid provider's ability to determine the presence or absence of signs of life, the person should be immediately positioned supine and reassessed (good practice statement). People found in positions associated with aspiration and positional asphyxia such as face down, prone, or in neck and torso flexion positions should be repositioned supine			one on lateral versus supine. No significant difference was found for the 2 RCTs on arm position. Patients in the lateral position required fewer airway rescue interventions and were less tachycardiac than those in the supine position.	airway management by first aid providers.

Topic/PICO	Year of last SysRev	Existing treatment recommendations or good practice statements	RCTs since last review	Observational studies since last review	Key findings	Sufficient data to warrant SysRev?
		for reassessment (good practice statement).				
Resuscitation care for suspected opioid-associated emergencies (FA 7442)	2020	We suggest CPR be started without delay in any unconscious person not breathing normally and that naloxone be used by lay rescuers in suspected opioid-related respiratory or circulatory arrest (good practice statement).	0	2	In one study,[590] naloxone was associated with ROSC; in the other,[591] it was not. There might be a role for naloxone in nonshockable cardiac arrest.	No
Types of pediatric tourniquets (FA 7333)	2021	We suggest the use of a manufactured windlass tourniquet for the management of life-threatening extremity bleeding in children (weak recommendation, very low–certainty evidence). We are unable to recommend for or against the use of other tourniquet types in children because of lack of evidence. For infants and children with extremities that are too small to allow the snug application of a tourniquet before activating the circumferential tightening mechanism, we recommend the use of direct manual pressure with or without the	0	2	No mortality reported[592,593]; acceptable safety profile with use of tourniquets, aligning with current recommendations	No

Topic/PICO	Year of last SysRev	Existing treatment recommendations or good practice statements	RCTs since last review	Observational studies since last review	Key findings	Sufficient data to warrant SysRev?
		application of a hemostatic trauma dressing (good practice statement).				
Duration of cooling of burns (FA 7371)	2021	We recommend the immediate active cooling of thermal burns using running water as a first aid intervention for adults and children (strong recommendation, very low–certainty evidence). Because no difference in outcomes could be demonstrated with the different cooling durations studied, a specific duration of cooling cannot be recommended. Young children with thermal burns being actively cooled with running water should be monitored for signs and/or symptoms of excessive body cooling (good practice statement).	0	2	The duration of cooling and impact on outcomes were inconsistent in the studies.[594,595]	No

CPR indicates cardiopulmonary resuscitation; EvUps, evidence updates; FA, First Aid; PICO, population, intervention, comparator, outcome; RCT, randomized controlled trial; ROSC, return of spontaneous circulation; ScopRev, scoping review; and SysRev, systematic review.

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