CoSTR

2025 International Liaison Committee on Resuscitation Consensus on Science With Treatment Recommendations

Advanced Life Support

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ABSTRACT

The International Liaison Committee on Resuscitation conducts continuous reviews of new, peer-reviewed published cardiopulmonary resuscitation science and publishes more comprehensive reviews every 5 years. The Advanced Life Support Task Force chapter of the *2025 International Liaison Committee on Resuscitation Consensus on Science With Treatment Recommendations* addresses all resuscitation evidence reviewed by the task force in the past year, as well as brief summaries of topics reviewed since 2020, to provide a comprehensive update. Newly updated topics this year include defibrillator pad placement, mechanical cardiopulmonary resuscitation devices, mechanical circulatory support after return of spontaneous circulation, intravenous versus intraosseous access, vasopressor choice and hemodynamic targets after return of spontaneous circulation, treatment of cardiac arrest related to hyperkalemia and opioid toxicity, and neuroprotective drugs, among others. Task Force members have assessed, discussed, and debated the certainty of the evidence based on Grading of Recommendations Assessment, Development, and Evaluation criteria, and their statements include consensus treatment recommendations. Insights into the deliberations of the task force are provided in the Justification and Evidence-to-Decision Framework Highlights sections. In addition, the task force lists priority knowledge gaps for further research.

Key words: advanced life support, cardiac arrest, ILCOR, post–arrest care, resuscitation, CPR

INTRODUCTION

This is the *2025 International Liaison Committee on Resuscitation Consensus on Science With Treatment Recommendations* (CoSTR), from the International Liaison Committee on Resuscitation (ILCOR) Advanced Life Support (ALS) Task Force. All reviews conducted by the ALS Task Force in the previous year are included; reviews conducted and published since the 2020 publication are also summarized to provide a single comprehensive reference document for readers. The new ALS Task Force work this year encompasses 12 systematic reviews (SysRevs), 2 scoping reviews (ScopRevs) and multiple evidence updates (EvUps). Numerous topics reviewed from 2021 to 2024 are also included. Draft CoSTRs for all topics evaluated with SysRevs were posted on a rolling basis on the ILCOR website. Each draft CoSTR includes the data reviewed and draft treatment recommendations, with public comments accepted for 2 weeks after posting. The task force considered public feedback and provided responses. All CoSTRs are now available online, adding to the existing CoSTR statements.

Although only SysRevs can generate a full CoSTR and new treatment recommendations, many other topics were evaluated with more streamlined processes, including ScopRevs and EvUps. Good practice statements, which represent the opinion of task force experts in light of very limited or no direct evidence, can be generated after ScopRevs and occasionally after EvUps in cases where the task force thinks providing guidance is especially important. A separate paper in this issue includes the full details of the evidence evaluation process.[1]

This summary statement contains the final wording of the treatment recommendations and good practice statements as approved by the ILCOR ALS Task Force, as well as summaries of the evidence identified. SysRevs include evidence-to-decision highlights and knowledge gaps, and ScopRevs summarize task force insights on specific topics. Links to the published reviews and full online CoSTRs are provided in the corresponding sections. Evidence-to-decision tables

for SysRevs are provided in Appendix A, and the complete EvUp worksheets are provided in Appendix B.

Topics are presented using the Grading of Recommendations Assessment, Development, and Evaluation approach[2] in the population, intervention, comparator, outcome, study design, and time frame format. To minimize redundancy, the study designs have been removed from the text except in cases where the designs differed from the ALS standard criteria. The standard study designs included are randomized controlled trials (RCTs) and nonrandomized studies (non-RCTs, interrupted time series, controlled before-and-after studies, cohort studies), and all languages were included, provided there was an English abstract. Unpublished studies (eg, conference abstracts, trial protocols), letters, editorials, comments, and case reports were excluded.

The following topics are addressed in this ALS Task Force CoSTR summary:

Cardiopulmonary Resuscitation

- Mechanical cardiopulmonary resuscitation (CPR) devices (ALS 3002, SysRev 2025)
- Consciousness during CPR (ALS 3004, ScopRev 2021, EvUp 2024)

Defibrillation Strategies

- Double sequential defibrillation (ALS 3106, SysRev 2023)

Airway, Oxygenation, and Ventilation

- Advanced airway management for cardiac arrest (ALS 3300, 3301, 3302, 3303, 3304, EvUp 2025)
- Emergency front of neck airway access during cardiac arrest (ALS 3606, ScopRev 2024)
- Oxygen and carbon dioxide targets in patients with return of spontaneous circulation (ROSC) after cardiac arrest (ALS 3516, 3517, SysRev 2025)

Circulatory Support During CPR

- Extracorporeal CPR (ECPR) (ALS 3001, SysRev 2024)

Medications During CPR

- Intravenous (IV) versus intraosseous (IO) for initial access during cardiac arrest (ALS 3200, SysRev 2025)
- Administration of vasopressors during cardiac arrest (ALS 3208, SysRev 2025)
- Administration of buffering agents during cardiac arrest (ALS 3205, SysRev 2025)
- Antiarrhythmic medication during cardiac arrest (ALS 3201, EvUp 2025)
- Steroid administration during cardiac arrest (ALS 3202, EvUp 2025)
- Medication for the treatment of torsades de pointes (ALS 3404, EvUp 2025)
- Use of vasopressin and corticosteroids during cardiac arrest (ALS 3202, SysRev 2022)
- Use of calcium during cardiac arrest (ALS 3204, SysRev 2023)

Prognostication and Diagnostics During CPR

- Use of point-of-care ultrasound for prognostication during cardiac arrest (ALS 3608, SysRev 2022, EvUp 2025)
- Use of point-of-care ultrasound to identify cardiac arrest etiology (ALS 3607 EvUp 2025)

Resuscitation of Cardiac Arrest in Special Circumstances

- Pharmacological treatment of hyperkalemia (ALS 3403, SysRev 2025)
- ALS therapies for opioid-related cardiac arrest (ALS 3451, SysRev 2025)
- Cardiac arrest in the catheterization laboratory (ALS 3406, ScopRev 2025)
- CPR in patients who are prone (ALS 3003, EvUp 2025)
- Cardiac arrest during pregnancy (ALS 3401, ScopRev 2024)

- Resuscitation of patients with durable mechanical circulatory support with acutely altered perfusion or cardiac arrest (ALS 3005, ScopRev 2025)
- Cardiac arrest due to confirmed or suspected pulmonary embolism (ALS 3400, EvUp 2025)

Post–Cardiac Arrest Care

- Post–cardiac arrest temperature control (ALS 3523, 3524, 3525, SysRev 2024)
- Mechanical circulatory support after ROSC (ALS 3505, SysRev 2025)
- Post–cardiac arrest hemodynamic targets (ALS 3515, SysRev Adolopment 2024)
- Choice of vasopressor in the post–cardiac arrest period (ALS 3528, SysRev 2025)
- Neuroprotective drugs in patients unresponsive after cardiac arrest (ALS 3507, SysRev Adolopment 2025)
- Post–cardiac arrest percutaneous coronary intervention with and without ST-segment myocardial infarction (ALS 3500, 3501, EvUp 2025)
- Post–cardiac arrest steroids (ALS 3504, EvUp 2025)
- Glucose control after resuscitation (ALS 3519, EvUp 2025)
- Post–cardiac arrest prophylactic antibiotics (ALS 3522, EvUp 2025)

Prognostication

- Neuroprognostication for poor neurological outcome (ALS 3510–3513, EvUp 2025)
- Neuroprognostication for good neurological outcome (ALS 3529–3532, SysRev 2023)
- Organ Donation After Cardiac Arrest (ALS 3600, SysRev 2025)

CARDIOPULMONARY RESUSCITATION

Mechanical CPR Devices (ALS 3002, SysRev 2025)

Rationale for Review

Mechanical CPR device use was last reviewed for the 2015 CoSTR and routine use was not suggested.[3] Mechanical CPR device use increased during the COVID-19 pandemic because it potentially enabled delivery of high-quality CPR while minimizing personnel exposure. This SysRev was undertaken so that new trials could be included. The review was registered before initiation (Prospective Register of Systematic Reviews [PROSPERO] Registration CRD42024537440). The full CoSTR can be found on the ILCOR website.[4]

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

- Population: Adults and children with cardiac arrest in any setting and resuscitation attempted by trained medical personnel
- Intervention: Any type of powered automated mechanical chest compression
- Comparator: Manual chest compressions
- Outcomes:
  - Critical: survival with favorable neurological outcome, survival, quality of life at any time points
  - Important: ROSC, survival to hospital admission, adverse events related to resuscitation
- Study designs: Only RCTs were included.
- Time frame: Because the previous search strategy was amended, we included all years to May 14, 2024.

Consensus on Science

Fourteen studies from 11 trials were included.[5-18] Six of the trials were from the previous 2014 SysRev. Because of heterogeneity across studies a meta-analysis was not performed. Key results are summarized by device type below.

Load-Distributing Band Devices

Three trials[9,10,18] examined the critical outcome of neurological outcome at hospital discharge. Two studies[9,18] enrolling 4364 patients found no difference in favorable neurologic outcome between mechanical CPR and manual CPR. One trial of 767 patients found worse neurologic outcome with mechanical CPR devices.[10]

Three RCTs reported the critical outcome of survival to hospital discharge.[9,10,18] One RCT[18] of 4231 patients found no difference in survival to hospital discharge between mechanical CPR and manual CPR. One RCT[10] of 767 patients found lower odds of survival to hospital discharge with mechanical CPR devices, and 1 RCT with 133 patients found improved survival to hospital discharge with mechanical CPR devices.[9]

Two RCTs reported the important outcome of ROSC.[9,18] One RCT[18] found lower rates of ROSC with mechanical CPR, and the second RCT[9] found higher rates of ROSC with mechanical CPR.

Two studies, one of them of in-hospital arrest, reported rates of postresuscitation injury and found no difference between mechanical CPR and manual CPR.[12,18]

Piston-Based Devices

Two RCTs[15,16] enrolling 4471 and 2549 patients, respectively, found no difference between mechanical CPR and manual CPR for neurological outcome at hospital discharge,[15,16] 3 months,[15,16] or 6 months.[15,16]

Four RCTs[5,15-17] enrolling 8409 patients examined survival at different time points. No difference was found between mechanical and manual CPR for survival at hospital discharge or 30 days,[5,15-17] 90 days,[15] survival at 6 months,[16] or survival at 1 year.[15]

For the important outcome of ROSC, 4 RCTs were identified,[5,15-17] each showing no difference in rates of ROSC between mechanical and manual CPR.

One RCT reported resuscitation-related injuries and found no difference between piston-based mechanical CPR devices and manual CPR.[12]

For in-hospital cardiac arrest, 1 RCT (127 patients) documented no difference in favorable neurological outcome at discharge.[7] For survival to hospital discharge 1 trial (127 patients) found no benefit of mechanical CPR compared with manual CPR.[7] A second trial (150 patients) found increased survival to hospital discharge with mechanical CPR compared with manual CPR.[13]

Three trials in in-hospital cardiac arrest reported ROSC. Two trials (75 and 127 patients) found no difference in ROSC,[6,7] and 1 trial (150 patients) found increased rates of ROSC[13] with mechanical CPR compared with manual CPR.

A single trial found no difference in the rates of resuscitation-related injuries.[12]

Prior Treatment Recommendations (2015)

We suggest against the routine use of automated mechanical chest compression devices to replace manual chest compressions (weak recommendation, moderate-quality evidence)

We suggest that automated mechanical chest compression devices are a reasonable alternative to high-quality manual chest compressions in situations where sustained high-quality manual chest compressions are impractical or compromise provider safety (weak recommendation, low-quality evidence).

Treatment Recommendations (2025)

We suggest against the routine use of automated mechanical chest compression devices to replace manual chest compressions for out-of-hospital cardiac arrest (weak recommendation, low-certainty evidence).

We suggest against the routine use of automated mechanical chest compression devices to replace manual chest compressions for in-hospital cardiac arrest (weak recommendation, very low–certainty evidence).

Automated mechanical chest compression devices may be a reasonable alternative to manual chest compressions in situations where sustained high-quality manual chest compressions are impractical or compromise provider safety (good practice statement).

Justification and Evidence-to-Decision Framework Highlights

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

The task force discussed concerns about the potential for delays to initial defibrillation with mechanical CPR devices in cardiac arrest with shockable rhythms. This concern could be alleviated by not deploying a mechanical device until after the first shock has been delivered (if indicated).

The task force discussed the lack of justification for the cost associated with mechanical CPR devices and the training required for their use given that the evidence suggests no benefit. However, there is insufficient evidence to suggest that health care systems currently using mechanical CPR devices routinely need to change practice.

The task force agreed that mechanical CPR is useful in settings where manual CPR either risks provider safety (eg, during transport) or interferes with other potentially life-saving

procedures (eg, in the cardiac catheterization lab or during extracorporeal membrane oxygenation cannulation).

There are several mechanical CPR devices available currently, and there is no evidence to favor one over another.

The task force discussed the importance of training when mechanical CPR devices are used to minimize pauses in compressions during placement and to ensure proper placement so that visceral injuries are minimized.

One of the included trials[15] reported decreased adjusted odds of survival with favorable neurologic outcome at 3 months with mechanical CPR (adjusted odds ratio [OR], 0.72; 0.52–0.99)]. The task force decided to report the findings of each study as relative risk (RR) for consistency across studies. Conversion from adjusted OR to RR resulted in a similar point estimate but a broader confidence interval (CI), making the result nonsignificant. The unadjusted OR reported in the original paper was similarly nonsignificant. The task force discussed the slight differences in these ways of reporting the outcomes, but it did not impact the final treatment recommendation.

Knowledge Gaps

- Whether mechanical CPR improves outcome from in-hospital cardiac arrest
- Whether the possible benefit of mechanical CPR depends on timing of use, cardiac arrest rhythm, or setting
- Whether one mechanical CPR device is superior to another
- Whether rates of CPR-related injuries from mechanical CPR vary by patient size and age

- The optimal approach to defibrillation when mechanical CPR devices are used (ie, whether to pause the device for defibrillation versus other approaches such as timing defibrillation with compression phase)

Consciousness During CPR (ALS 3004, ScopRev 2021, EvUp 2024)

CPR-induced consciousness was addressed by a 2021 ScopRev,[19] and details can be found in the 2021 CoSTR summary.[20] An EvUp in 2024 did not identify sufficient new evidence to warrant an updated ScopRev or SysRev.

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

- Population: Adults in any setting with consciousness during CPR
- Interventions: Sedation, analgesia, or other interventions to prevent consciousness
- Comparator: No specific intervention for consciousness
- Outcomes: Any clinical outcome including cardiac arrest outcomes and psychological well-being after arrest; rescuer outcomes were also considered
- Study designs: In addition to the standard study designs, we included case reports, case series, gray literature, and unpublished studies (eg, conference abstracts, trial protocols). Articles based on the Lazarus phenomenon and cough CPR and narrative articles referring to near-death experiences and consciousness were excluded.
- Time frame: All years to November 24, 2020; EvUp updated to September 21, 2023

Treatment Recommendations (2021)

In settings in which it is feasible, rescuers may consider using sedative or analgesic drugs (or both) in very small doses to prevent pain and distress to patients who are conscious during CPR (good practice statement).

Neuromuscular-blocking drugs alone should not be given to conscious patients (good practice statement).

The optimal drug regimen for sedation and analgesia during CPR is uncertain. Regimens can be based on those used in critically ill patients and according to local protocols (good practice statement).

DEFIBRILLATION STRATEGIES

Double Sequential Defibrillation for Cardiac Arrest With Refractory Shockable Rhythm (ALS 3106, SysRev 2023)

The use of double sequential external defibrillation for cardiac arrest with refractory shockable rhythm was initially addressed by a 2020 SysRev[21] and the SysRev was updated for the 2023 CoSTR summary.[22]

Population, Intervention, Comparator, Outcome, and Time Frame

- Population: Adults in any setting (in-hospital or out-of-hospital) with cardiac arrest and a shockable ventricular fibrillation (VF)/pulseless ventricular tachycardia (pVT) cardiac arrest rhythm
- Intervention: double sequential external defibrillation
- Comparator: Standard defibrillation strategy
- Outcomes:
  - Critical: Survival with favorable neurological outcome at discharge, 30 days, 60 days, 90 days, 180 days, and/or 1 year; survival at discharge, 30 days, 60 days, 90 days, 180 days, and/or 1 year
  - Important: ROSC or survival to hospital admission
  - Other: Termination of VF/pVT
- Time frame: February 28, 2020, to November 7, 2022

Treatment Recommendations (2023)

We suggest that a double sequential defibrillation strategy (weak recommendation, low-certainty evidence) or a vector change defibrillation strategy (weak recommendation, very low–certainty evidence) may be considered for adults with cardiac arrest who remain in VF or pVT after 3 or more consecutive shocks.

If a double sequential defibrillation strategy is used, we suggest an approach similar to that in the available trial, with a single operator activating the defibrillators in sequence (good practice statement).

AIRWAY, OXYGENATION, AND VENTILATION

Advanced Airway Management for Cardiac Arrest (ALS 3300, 3301, 3302, 3303, 3304, EvUp 2025)

Advanced airway management for cardiac arrest was last addressed by a SysRev in 2019.[23,24] An EvUp was done for 2024 and again for 2025.

Population, Intervention, Comparator, Outcome, and Time Frame

- Population: Adults with cardiac arrest from any cause and in any setting (in-hospital or out-of-hospital)
- Intervention: A specific airway management method during cardiac arrest
- Comparators: A different advanced airway management method or no advanced airway management method during cardiac arrest
- Outcomes: Resuscitation process metrics, airway process metrics, ROSC, survival or survival with favorable neurological outcome at discharge/30 days or longer
- Time frame: August 17, 2023, to October 12, 2024

Summary of Evidence

The complete EvUp is provided in Appendix B.

Overall, there was insufficient new evidence to warrant an updated SysRev. The task force agreed that a SysRev was indicated for the use of video laryngoscopy compared with direct laryngoscopy, as this has not been reviewed previously.

Treatment Recommendations (2019)

We suggest using bag-mask ventilation or an advanced airway strategy during CPR for adult cardiac arrest in any setting (weak recommendation, low to moderate–certainty evidence).

If an advanced airway is used, we suggest a supraglottic airway for adults with out-of-hospital cardiac arrest in settings with a low tracheal intubation success rate (weak recommendation, low-certainty evidence).

If an advanced airway is used, we suggest a supraglottic airway or tracheal intubation for adults with out-of-hospital cardiac arrest in settings with a high tracheal intubation success rate (weak recommendation, very low–certainty evidence).

If an advanced airway is used, we suggest a supraglottic airway or tracheal intubation for adults with in-hospital cardiac arrest (weak recommendation, very low–certainty evidence).

Emergency Front of Neck Airway Access During Cardiac Arrest (ALS 3606, ScopRev 2024)

Emergency front of neck airway access during cardiac arrest was addressed by a 2024 ScopRev[25] and can be found in the 2024 CoSTR summary.[26]

Population, Intervention, Comparator, Outcome, and Time Frame

- Population: Adult patients in cardiac arrest in any setting (in-hospital or out-of-hospital) in which adequate ventilation cannot be rapidly achieved by using basic or advanced airway management strategies

- Intervention: Front-of-neck airway access attempt
- Comparator: Ongoing attempts at basic or advanced airway management strategies
- Outcomes: Any clinical outcomes
- Time frame: All years to November 2, 2023

Treatment Recommendations (2024)

In adults in cardiac arrest, when standard airway management strategies (eg, oropharyngeal airway and bag-mask, supraglottic airway, or tracheal tube) have failed, it is reasonable for appropriately trained rescuers to attempt front-of-neck airway access using a cricothyroidotomy technique (good practice statement).

Oxygen and Carbon Dioxide Targets in Patients With ROSC After Cardiac Arrest (ALS 3516, 3517, SysRev 2025)

Rationale for Review

Oxygen and ventilation (carbon dioxide) targets are important components of post–cardiac arrest management. This topic was previously addressed by a SysRev for the 2024 CoSTR summary and was updated for this year so that a new secondary analysis of a previous RCT examining long-term patient outcomes could be included.[26] The SysRev was registered before initiation (PROSPERO Registration CRD42022371007). The full CoSTR can be found on the ILCOR website.[27]

Population, Intervention, Comparator, Outcome, and Time Frame

- Population: Unresponsive adults with sustained ROSC after cardiac arrest in any setting
- Intervention: A ventilation strategy targeting specific Sp_{O_2}, Pa_{O_2}, and/or Pa_{CO_2} targets
- Comparators: Treatment without specific targets or with an alternate target to the intervention

- Outcomes: Clinical outcomes including survival or survival with a favorable neurologic outcome after hospital discharge, 30 days, 90 days, 180 days, 1 year, etc
- Time frame: June 1, 2023, to May 14, 2024

Consensus on Science

Only the updated results are summarized here. All other results are in the 2024 ILCOR CoSTR document.[26] One additional secondary analysis of a previously reported RCT[28] of oxygen strategies in the intensive care unit setting was identified in our updated search, adding to evidence on long-term outcomes included in the prior review.

For the critical outcome of favorable neurologic outcome at 1 year, no difference was found between higher and lower oxygen targets from a secondary analysis of 1 RCT including 771 patients, (RR, 1.06; 95% CI, 0.94–1.18). For survival at 1 year, 2 RCTs including 1120 patients also found no difference (RR, 1.03; 95% CI, 0.93–1.14).[28-30]

Treatment Recommendations (2025, Unchanged From 2024)

We recommend the use of 100% inspired oxygen until the arterial oxygen saturation or the partial pressure of arterial oxygen can be measured reliably in adults with ROSC after cardiac arrest in the prehospital setting (strong recommendation, moderate-certainty evidence) and in-hospital setting (strong recommendation, low-certainty evidence).

We recommend avoiding hypoxemia in adults with ROSC after cardiac arrest in any setting (strong recommendation, very low–certainty evidence).

We suggest avoiding hyperoxemia in adults with ROSC after cardiac arrest in any setting (weak recommendation, low-certainty evidence).

Following reliable measurement of arterial oxygen levels, we suggest targeting an oxygen saturation of 94% to 98% or a partial pressure of arterial oxygen of 75 to 100 mm Hg

(approximately 10–13 kPa) in adults with ROSC after cardiac arrest in any setting (good practice statement).

When relying on pulse oximetry, health care professionals should be aware of the increased risk of inaccuracy that may conceal hypoxemia in patients with darker skin pigmentation (good practice statement).

Carbon Dioxide Targets

We suggest targeting normocapnia (a partial pressure of carbon dioxide of 35–45 mm Hg or approximately 4.7–6.0 kPa) in adults with ROSC after cardiac arrest (weak recommendation, moderate-certainty evidence).

Justification and Evidence-to-Decision Framework Highlights

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

No changes were made to the treatment recommendations as only a single secondary analysis of a previously reported RCT was identified from the literature search. The results of this study were consistent with previous research examining shorter-term outcomes included in the prior CoSTR.

Knowledge Gaps

- Whether there is a threshold at which hyperoxemia becomes harmful
- Optimal duration for specific oxygen strategies
- Whether there is a threshold at which hypocapnia and hypercapnia become harmful and if these thresholds are patient- and condition-specific

CIRCULATORY SUPPORT DURING CPR

Extracorporeal CPR (ALS 3001, SysRev 2024)

The use of ECPR during cardiac arrest was addressed by a 2022 SysRev, which was updated again for the 2024 CoSTR summary.[26,31]

Population, Intervention, Comparator, Outcome, and Time Frame

- Population: Adults (≥18 years) with cardiac arrest in any setting
- Intervention: ECPR, including extracorporeal membrane oxygenation or cardiopulmonary bypass during cardiac arrest
- Comparators: Manual or mechanical CPR
- Outcomes: Any clinical outcome
- Time frame: June 21, 2022, to May 10, 2023

Treatment Recommendations (2024)

We suggest that ECPR may be considered as a rescue therapy for selected adults with out-of-hospital cardiac arrest when conventional CPR is failing to restore spontaneous circulation in settings where this can be implemented (weak recommendation, low-certainty evidence).

We suggest ECPR may be considered as a rescue therapy for selected adults with in-hospital cardiac arrest when conventional CPR is failing to restore spontaneous circulation in settings where this can be implemented (weak recommendation, very low–certainty evidence).

MEDICATIONS DURING CPR

IV Versus IO Approach for Initial Vascular Access During Cardiac Arrest (ALS 3200, SysRev 2025)

Rationale for Review

Timely vascular access is essential for medication administration during cardiac arrest. Previous guidelines recommended an IV approach, moving to IO after failed IV attempts. The ALS Task Force last conducted a SysRev of this topic for the 2020 CoSTR,[32] and prioritized this updated SysRev based on the recent publication of 3 RCTs comparing initial IV with initial IO strategies. The SysRev was registered before initiation (PROSPERO Registration CRD42024577647) and has been published.[33] The full CoSTR can be found on the ILCOR website.[34]

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

- Population: Adults (≥18 years) with cardiac arrest in any setting with an indication for vascular access
- Interventions: Initial attempt(s) at vascular access in cardiac arrest made via the IO route
- Comparators: Initial attempts(s) at vascular access in cardiac arrest made via the IV route
- Outcomes: ROSC, survival (30 days/discharge, 3 months, 6 months), survival with favorable neurological outcome (30 days/discharge, 3 months, 6 months), health-related quality of life (3 months, 6 months)
- Study designs: RCTs only
- Time frame: All years to September 4, 2024

Consensus on Science

Three RCTs were identified that included 9272 adult patients with out-of-hospital cardiac arrest.[35-37] There was no benefit for the IO route compared with the IV route for survival at 30

days, (OR, 0.99; 95% CI, 0.84–1.17) or survival with favorable neurological outcome at 30 days/hospital discharge (OR, 1.07; 95% CI, 0.88–1.30).

Similarly, there was no difference in the outcomes of health-related quality of life at 3 months or 6 months, ROSC at any time, survival to hospital discharge, survival at 3 months or 6 months, or favorable neurological outcome at 3 months.

For the outcome of sustained ROSC, evidence from 2 RCTs (7518 adults with out-of-hospital cardiac arrest) showed a lower OR with an initial IO strategy compared with an initial IV strategy (OR, 0.89; 95% CI, 0.80–0.99).[35,37]

Prior Treatment Recommendations (2020)

We suggest IV access as compared to IO access as the first attempt for drug administration during adult cardiac arrest (weak recommendation, very low–certainty evidence).

If attempts at IV access are unsuccessful or IV access is not feasible, we suggest IO access as a route for drug administration during adult cardiac arrest (weak recommendation, very low–certainty evidence).

Treatment Recommendations (2025)

We suggest IV access, as compared to IO access, as the first attempt for vascular access during adult cardiac arrest (weak recommendation, low-certainty evidence)

If IV access cannot be rapidly achieved within 2 attempts, it is reasonable to consider IO access as an alternative route for vascular access during adult cardiac arrest (good practice statement).

Justification and Evidence-to-Decision Framework Highlights

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

In considering the importance of this topic the task force noted several observational studies have reported a marked increase in the use of the IO route in adult out-of-hospital cardiac arrest in recent years,[38,39] despite council guidelines continuing to recommend that peripheral IVs should be the primary route for drug administration for adult cardiac arrest.

The expected mechanism by which IO drug administration might improve clinical outcomes is by facilitating faster administration of time-critical cardiac arrest drugs. While this effect was observed in an early RCT, time to initial drug administration was similar between IO and IV groups in all 3 recent RCTs.

All 3 trials were superiority trials, and the absence of an observed effect cannot be interpreted as indication that an IO access strategy is equivalent to an IV access strategy.

There was moderate-certainty evidence that the use of IO access reduced the odds of achieving sustained ROSC.

Knowledge Gaps

- The optimum anatomical site for IO insertion.
- There are few data on patient outcomes beyond hospital discharge/30 days.

Administration of Vasopressors During Cardiac Arrest (ALS 3208, SysRev 2025)

Rationale for Review

This topic was last reviewed with a SysRev for the 2020 CoSTR.[32,40] The ALS Task Force was aware of a secondary analysis of a previously reported RCT[41] that examined long-term outcomes associated with the use of epinephrine that was the impetus for this update to the SysRev, which was registered before initiation (PROSPERO Registration CRD42024534331). The full CoSTR can be found on the ILCOR website.[42]

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

- Population: Adults with cardiac arrest in any setting (in-hospital or out-of-hospital)
- Intervention: The use of vasopressor or a combination of vasopressors provided intravenously or intraosseously during cardiac arrest
- Comparators: No vasopressor, a different vasopressor, a different combination of vasopressors, a different vasopressor dose, or a different timing of vasopressors provided intravenously or intraosseously during cardiac arrest
- Outcomes:
  - Critical: Survival at 30 days, hospital discharge, or any subsequent time point; survival with favorable neurological outcome at 30 days, hospital discharge, or any subsequent time point
  - Important: ROSC, survival to hospital admission
- Study designs: Only RCTs were considered.
- Time frame: November 18, 2018, to May 9, 2024

Consensus on Science

Only RCTs were considered for this SysRev update. Four additional studies were identified in adult patients since the last review: 1 RCT comparing epinephrine plus vasopressin with epinephrine alone,[43] 2 secondary analyses from a prior RCT of epinephrine and placebo reporting long-term outcomes[41] and time to epinephrine administration,[44] and 1 cost-effectiveness study.[45] Only results of the newly included studies are presented here. For details of studies included in the prior review, see the online CoSTR,[42] published SysRev,[46] and 2020 CoSTR.[32]

Epinephrine

In one substudy of a prior RCT[41,47] (n=7997 patients), the use of epinephrine was associated with improved survival at 6 months (RR, 1.37; 95% CI, 1.04–1.81) and 12 months (RR, 1.33; 95% CI, 1.00–1.77) compared with placebo. There was no improvement in favorable neurological outcome at 6 months with epinephrine RR 1.34 (95% CI, 0.96–1.88).

Epinephrine Plus Vasopressin

After adding the new study identified,[43] there remained no benefit with the use of epinephrine plus vasopressin compared with epinephrine alone for any of the outcomes.

Treatment Recommendations (2025, Unchanged From 2020)

We recommend administration of epinephrine during CPR (strong recommendation, low-certainty evidence).

For patients with nonshockable rhythms (pulseless electrical activity/asystole), we recommend administration of epinephrine as soon as feasible during CPR (strong recommendation, very low–certainty evidence).

For patients with shockable rhythms (VF or pVT), we suggest administration of epinephrine after initial defibrillation attempts are unsuccessful during CPR (weak recommendation, very low–certainty evidence).

We suggest against the administration of vasopressin in place of epinephrine during CPR (weak recommendation, very low–certainty evidence).

We suggest against the addition of vasopressin to epinephrine 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.

The ALS Task Force concluded that the additional evidence identified from the SysRev did not warrant changes to the current treatment recommendations.

Epinephrine plus vasopressin or vasopressin alone has shown no statistical advantage over epinephrine. The task force continues to recommend epinephrine only, instead of vasopressin only or a combination of these vasopressors, to minimize the complexity of the treatment algorithms. A recent network meta-analysis conducted on this topic,[48] considering both direct comparisons between interventions within trials and indirect comparisons across trials, supports these recommendations.

Knowledge Gaps

- The optimal timing of epinephrine administration in relation to defibrillations
- The optimal dose of epinephrine
- The optimal dosing interval for epinephrine
- There are no RCTs evaluating epinephrine for in-hospital cardiac arrest

Administration of Buffering Agents During Cardiac Arrest (ALS 3205, SysRev Adolopment 2025)

Rationale for Review

This topic has not been evaluated with a SysRev since 2010.[49,50] Despite a lack of evidence and the absence of a current guideline recommendation, buffering agents (eg, sodium bicarbonate) continue to be administered commonly during resuscitation. A recently published SysRev examining this topic was felt to be of sufficient quality to be utilized for adolopment.[51]

The SysRev was registered before initiation (PROSPERO Registration CRD42024577647). The full CoSTR can be found on the ILCOR website.[52]

Population, Intervention, Comparator, Outcome, and Time Frame

- Population: Adults with cardiac arrest in any setting (in-hospital or out-of-hospital)
- Interventions: The use of buffering agents alone or in combination with other drugs
- Comparator: Standard resuscitation
- Outcomes:
  - Critical: Survival at 30 days, hospital discharge, or any subsequent time point; survival with favorable neurological outcome at 30 days, hospital discharge, or any subsequent time point
  - Important: ROSC, survival to hospital admission
- Time frame: Original search all years to July 15, 2023; updated September 27, 2024

Consensus on Science

This was an adolopment of a previously published SysRev.[51] A total of 3 RCTs[53-55] and 3 propensity score matched cohort studies[56-58] were included. No additional studies were identified in the updated literature search.

None of the studies identified found any difference between administration of buffering agents and standard care for any clinical outcome.

Prior Treatment Recommendations (2010)

Routine administration of sodium bicarbonate for treatment of in-hospital cardiac arrest and out-of-hospital cardiac arrest is not recommended.

Treatment Recommendations (2025)

We suggest against the administration of buffering agents such as sodium bicarbonate in the treatment of out-of-hospital cardiac arrest, unless a special circumstance for its use is present (weak recommendation, low-certainty evidence).

We suggest against the administration of buffering agents such as sodium bicarbonate in the treatment of in-hospital cardiac arrest, unless a special circumstance for its use is present (weak recommendation, very low–certainty of evidence).

Justification and Evidence-to-Decision Framework Highlights

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

These recommendations do not address the use of buffering agents in special circumstances, such as for the treatment of hyperkalemia or sodium channel blocker or tricyclic antidepressant poisoning.

The task force placed a high value on not allocating resources to an unproven intervention, which may divert rescuer time from more beneficial interventions.

The task force cautions against drawing conclusions from observational studies on this topic, even with rigorous propensity-score matching, if the study does not account for resuscitation time bias given the tendency for providers to give sodium bicarbonate late in resuscitation as a last-resort medication. Any study that does not account for resuscitation time bias should be considered to have critical risk of bias. A clinical trial examining buffering agents for in-hospital cardiac arrest (NCT05564130) is currently enrolling patients.[59]

Knowledge Gaps

- RCT data do not exist for buffering agents for in-hospital cardiac arrest or for pediatric arrest in any setting.

- Whether subpopulations, such as people with prolonged cardiac arrest, might have different outcomes from buffering agent administration than cardiac arrest patients in general.

Antiarrhythmic Medication During or After Cardiac Arrest (ALS 3201, 3514, EvUp 2025)

Population, Intervention, Comparator, Outcome and Time Frame

- Population: Adults in any setting with cardiac arrest and a shockable rhythm at any time during CPR or immediately after ROSC
- Intervention: Administration of antiarrhythmic drugs (eg, amiodarone, lidocaine)
- Comparator: No administration of antiarrhythmic drugs or administration of another antiarrhythmic drug
- Outcomes: Recurrence of VF/pVT, ROSC, survival to hospital discharge (or later time point), neurological outcome at hospital discharge (or later time point)
- Time frame: July 1, 2023, to October 7, 2024

Summary of Evidence

The complete EvUp is provided in Appendix B. This review was an update of a previous SysRev,[60,61] and an EvUp in the 2024 CoSTR summary.[26] Seven studies were identified that met inclusion criteria: 6 observational studies[62-67] and 1 RCT.[68] Given a new RCT of landiolol, the task force decided to include beta blockers along with other antiarrhythmics. This clarification of the treatment recommendation was based on 2 EvUps (2023 and 2024) that occurred since the original SysRev in 2018.[61,69] There was insufficient evidence to warrant a SysRev for any antiarrhythmic.

Treatment Recommendations (2018)

We suggest the use of amiodarone or lidocaine in adults with shock refractory VF/pVT (weak recommendation, low-certainty evidence).

We suggest against the routine use of magnesium in adults with shock-refractory VF/pVT (weak recommendation, very low–certainty evidence).

The confidence in effect estimates is currently too low to support an ALS Task Force recommendation about the use of beta blockers,* bretylium, nifekalant, or sotalol in the treatment of adults in cardiac arrest with shock refractory VF/pVT.

The confidence in effect estimates is currently too low to support an ALS Task Force recommendation about the use of prophylactic antiarrhythmic drugs immediately after ROSC in adults with VF/pVT cardiac arrest.

*Beta blockers included for clarification based on identification of studies during 2023 and 2024 EvUps.

Medication for the Treatment of Torsades de Pointes (ALS 3404, EvUp 2025)

Population, Intervention, Comparator, Outcome, and Time Frame

- Population: Adult (>18 years) patients with torsades de pointes
- Intervention: Any drug or combination of drugs
- Comparator: Not using drugs or alternative drugs
- Outcomes: Any clinical outcome
- Time frame: May 2, 2021, to February 10, 2024

Summary of Evidence

This topic was reviewed in 2010,[49,50] and an EvUp was done in 2020[40] and again for 2025. The complete EvUp is provided in Appendix B. No new studies were identified, and the task force concluded that a full SysRev was not warranted. The 2010 treatment recommendations have been downgraded to good practice statements to acknowledge that they have not been reviewed using the Grading of Recommendations Assessment, Development, and Evaluation process.

Treatment Recommendations (2010)

Polymorphic wide-complex tachycardia associated with familial long QT may be treated with IV magnesium, pacing, and/or beta blockers; however, isoprenaline should be avoided (good practice statement).

Polymorphic wide-complex tachycardia associated with acquired long QT may be treated with magnesium (good practice statement).

Addition of pacing or IV isoprenaline may be considered when acquired polymorphic wide-complex tachycardia is accompanied by bradycardia or appears to be precipitated by pauses in rhythm (good practice statement).

Use of Steroids During Cardiac Arrest (ALS 3202, SysRev, 2022, EvUp 2025)

Any use of steroids during cardiac arrest was previously reviewed with an EvUp in 2020.[32,40] The use of vasopressin and corticosteroids during cardiac arrest, a secondary question addressed by this population, intervention, comparator, and outcome question, was reviewed with a SysRev adolopment [70] for the 2022 CoSTR summary.[71] An EvUp for this secondary question was done for 2025 and is included in Appendix B. Treatment recommendations for both vasopressin and steroids and for steroids alone are included.

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

- Population: Adults with cardiac arrest in any setting (in-hospital or out-of-hospital)
- Intervention: Administration of the combination of vasopressin and corticosteroids during CPR
- Comparator: Not using vasopressin and corticosteroids during CPR
- Outcomes:

- Critical: Health-related quality of life; survival with favorable functional outcome at discharge, 30 days, 60 days, 90 days, 180 days, and/or 1 year; survival at discharge, 30 days, 60 days, 90 days, 180 days, and/or 1 year
- Important: ROSC, survival to admission

- Study design: Only RCTs were eligible for inclusion.
- Time frame: September 1, 2022, to April 30, 2024

Summary of Evidence

The search identified 2 new studies; 1 post hoc analysis of a previous RCT and 1 long-term outcome study of the same RCT.[72,73] The studies found no difference in hemodynamics or long-term outcomes when vasopressin and methylprednisolone were added to standard care. Two ongoing RCTs were identified. The task force did not consider the identified evidence sufficient to warrant a full SysRev.

Treatment Recommendations (2022)

We suggest against the use of the combination of vasopressin and corticosteroids in addition to usual care for adult in-hospital cardiac arrest, due to low confidence in effect estimates for critical outcomes (weak recommendation, low- to moderate–certainty evidence).

We suggest against the use of the combination of vasopressin and corticosteroids in addition to usual care for adult out-of-hospital cardiac arrest (weak recommendation, very low– to low-certainty evidence).

Treatment Recommendations (2015)

For in-hospital cardiac arrest, the task force was unable to reach a consensus recommendation for or against the use of steroids during cardiac arrest.

We suggest against the routine use of steroids during CPR for out-of-hospital cardiac arrest (weak recommendation, very low–certainty evidence).

Use of Calcium During Cardiac Arrest (ALS 3204, SysRev 2023)

The use of calcium during cardiac arrest management was addressed by a 2023 SysRev[74] and can be found in the 2023 CoSTR summary.[22]

Population, Intervention, Comparator, Outcome, and Time Frame

- Population: Adults with cardiac arrest in any setting
- Intervention: Administration of calcium during cardiac arrest
- Comparator: No administration of calcium during cardiac arrest
- Outcomes:
  - Critical: Health-related quality of life; survival with favorable functional outcome at discharge, 30 days, 60 days, 90 days, 180 days, and/or 1 year; survival at discharge, 30 days, 60 days, 90 days, 180 days, and/or 1 year
  - Important: ROSC or survival to hospital admission
- Time frame: All years to September 31, 2022

Treatment Recommendations (2023)

We recommend against routine administration of calcium for the treatment of out-of-hospital cardiac arrest in adults (strong recommendation, moderate-certainty evidence).

We suggest against routine administration of calcium for the treatment of in-hospital cardiac arrest in adults (weak recommendation, low-certainty evidence).

PROGNOSTICATION AND DIAGNOSTICS DURING CPR

Use of Point-of-Care Ultrasound for Prognostication During Cardiac Arrest (ALS 3608 EvUp 2025)

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

- Population: Adults (>18 years) with nontraumatic cardiac arrest in any setting

- Intervention: A particular finding on point-of-care echocardiography during CPR
- Comparators: The absence of that finding or a different finding on point-of-care echocardiography during CPR
- Outcomes: ROSC, survival to hospital admission, survival/survival with a favorable neurological outcome at hospital discharge, and survival/survival with a favorable neurological outcome beyond hospital discharge
- Study designs: In addition to standard criteria, randomized and nonrandomized cohort studies (prospective and retrospective) and case-control studies with data on both point-of-care ultrasound findings and an external reference standard to contribute to a contingency table (ie, true-positive, false-positive, false-negative, true-negative) were included.
- Time frame: October 2019 to April 2024

Summary of Evidence

This topic was previously reviewed with a SysRev for the 2020 CoSTR.[40] The complete EvUp is provided in Appendix B. Five observational studies (prospective and retrospective) were identified.[75-78] Studies documented a mixture of neutral and positive findings for the use of ultrasound; however, significant bias, heterogeneity, and lack of clinician blinding make interpretation of findings difficult. The task force did not consider the identified evidence sufficient to warrant a full SysRev.

Treatment Recommendations (2020)

We suggest against using point-of-care echocardiography for prognostication during CPR (weak recommendation, very low–certainty evidence).

Use of Point-of-Care Ultrasound to Identify Cardiac Arrest Etiology (ALS 3607, SysRev 2022, EvUp 2025)

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

The use of point-of-care ultrasound during cardiac arrest resuscitation to diagnose the etiology of cardiac arrest was addressed by a SysRev[79] for 2022, and details can be found in the 2022 CoSTR summary.[71] An EvUp was done for 2025. The complete EvUp is provided in Appendix B.

- Population: Adults with cardiac arrest in any setting
- Intervention: A particular finding on point-of-care ultrasound during CPR
- Comparator: An external confirmatory test or process including some component other than point-of-care ultrasound
- Outcome: A specific etiology of pathophysiologic state that led to cardiac arrest
- Study design: In addition to standard criteria, randomized and nonrandomized cohort studies (prospective and retrospective) and case-control studies with data on both point-of-care ultrasound findings and an external reference standard to contribute to a contingency table (ie, true-positive, false-positive, false-negative, true-negative)
- Time frame: October 6, 2021, to April 2024

Summary of Evidence

No new studies were identified on this topic, thus a SysRev is not indicated.

Treatment Recommendations (2022)

We suggest against routine use of point-of-care ultrasound during CPR to diagnose reversible causes of cardiac arrest (weak recommendation, very low–certainty evidence).

We suggest that if point-of-care ultrasound can be performed by experienced personnel without interrupting CPR, it may be considered as an additional diagnostic tool when clinical

suspicion for a specific reversible cause is present (weak recommendation, very low–certainty evidence).

Any deployment of diagnostic point-of-care ultrasound during CPR should be carefully considered and weighed against the risk of interrupting chest compressions and misinterpreting the sonographic findings (good practice statement).

RESUSCITATION OF CARDIAC ARREST IN SPECIAL CIRCUMSTANCES

Pharmacological Interventions for the Treatment of Hyperkalemia (ALS 3403, SysRev 2025)

Rationale for Review

Hyperkalemia is a potentially life-threatening condition leading to cardiac instability, arrhythmia, and cardiac arrest. Standard treatment of life-threatening arrhythmias in the setting of hyperkalemia often involves administration of calcium, beta-agonists, and high-dose insulin therapy. However, the utility of these interventions once a person has a cardiac arrest is not known and was the basis for this SysRev,[80] which was registered on PROSPERO (CRD42023440553). The full CoSTR for this nodal topic, including ALS and Pediatric Life Support, can be found on the ILCOR website.[81]

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

- Population: Adults and children with hyperkalemia in any setting (both with and without cardiac arrest)
- Intervention: Any acute pharmacological intervention with the aim of mitigating the harmful effect of hyperkalemia or with the aim of lowering potassium levels
- Comparators: No intervention, a different intervention (including a different dose), or placebo

- Outcomes: Any clinical outcome, including change in potassium; use of dialysis; electrocardiogram changes/arrhythmias; survival at hospital discharge, 28 days, 30 days, and 1 month; favorable neurological outcome at hospital discharge, 28 days, 30 days, and 1 month; survival at later time frames (eg, 90 days, 180 days, 1 year); favorable neurological outcome at later time frames (eg, 90 days, 180 days, 1 year); health-related quality of life; and cost-effectiveness
- Study designs: In addition to standard criteria, we included original studies and trials without a control group such as single-arm interventional trials, observational studies, and experimental animal studies. Non-English articles were translated using online translation tools such as Google Translate.
- Time frame: All years to September 9, 2024

Consensus on Science

Few studies reported patient-centered outcomes; therefore, no formal synthesis of the results for these outcomes could be performed. Meta-analyses were performed where possible for the outcome of potassium values. Results and certainty of evidence are summarized in Table 1. Inhaled salbutamol, IV salbutamol, insulin, and glucose all appeared to reduce serum potassium values in patients without cardiac arrest, while studies of bicarbonate and calcium did not find an effect. The only study in patients with cardiac arrest found higher absolute mortality with administration of calcium in patients with cardiac arrest.[82]

Table 1. Evidence Summary for the Pharmacological Treatment of Hyperkalemia in Patients With and Without Cardiac Arrest

Pharmacological treatment	Studies (participants), n	Certainty of evidence, GRADE	Outcome	Absolute effect	95% CI
Non–cardiac arrest					
Insulin (8–12 U) + glucose	8 (112)[83-90]	Low	Change in serum potassium	–0.7 mmol/L	–0.9 to –0.6

Salbutamol 10–20 mg inhaled	7 (87)[83,91-96]	Very low	Change in serum potassium	–0.9 mmol/L	–1.2 to –0.7
Salbutamol 0.5 mg intravenous + glucose	6 (100)[85,87,94-97]	Very low	Change in serum potassium	–1.0 mmol/L	–1.4 to –0.6
Salbutamol (0.5 mg) compared to insulin (10 U)	3 (64)[85,87,90]	Very low	Change in serum potassium	–0.3 mmol/L	–0.5 to 0.0
Salbutamol (0.5 mg) *plus* insulin (10 U) and glucose	3 (25)[85,87,90]	Very low	Change in serum potassium	–1.2 mmol/L	–1.5 to –0.8
Salbutamol (0.5 mg) *plus* insulin (10 U) compared to insulin (10 U) alone	3 (50)[85,87,90]	Very low	Change in serum potassium	–0.5 mmol/L	–0.7 to –0.2
Salbutamol (0.5 mg) *plus* insulin (10 U) compared to salbutamol (0.5 mg) alone	3 (64)[85,87,90]	Very low	Change in serum potassium	–0.22 mmol/L	–0.5 to 0.1
Sodium bicarbonate 50–390 mmol intravenous	5 (44)[87,98-100]	Very low	Change in serum potassium	–0.1 mmol/L	–0.3 to 0.1
Calcium	1 (111)[101]	Very low	Change in ECG rhythm	No changes	
Cardiac arrest					
Calcium	1 (109)[82]	Very low	Change in ECG rhythm	No changes	

CI indicates confidence interval; ECG, electrocardiogram; and GRADE, Grading of Recommendations Assessment, Development and Evaluation.

Treatment Recommendations (2025)

Patients Without Cardiac Arrest

For the treatment of acute hyperkalemia, we suggest IV insulin in combination with glucose, and/or inhaled or IV beta2-agonists (weak recommendation, low-certainty evidence).

For the treatment of acute hyperkalemia, we suggest against the routine use of IV sodium bicarbonate (weak recommendation, low-certainty evidence).

For the treatment of acute hyperkalemia, there is insufficient evidence to recommend for or against the use of calcium for the treatment of hyperkalemia (weak recommendation, very low–certainty evidence).

Patients With Cardiac Arrest

For the treatment of cardiac arrest suspected to be caused by acute hyperkalemia, we suggest IV insulin in combination with glucose (weak recommendation, very low–certainty evidence).

For the treatment of cardiac arrest suspected to be caused by acute hyperkalemia, there is insufficient evidence to make a recommendation for or against the use of IV sodium bicarbonate (weak recommendation, very low–certainty evidence).

For the treatment of cardiac arrest suspected to be caused by acute hyperkalemia, there is insufficient evidence to recommend for or against the use of calcium (weak recommendation, very low–certainty evidence).

Justification and Evidence-to-Decision Framework Highlights

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

Treatment recommendations were divided into noncardiac arrest and cardiac arrest because the pathophysiology of the 2 conditions differs making the treatment effect likely different in each group. Additionally, almost all the evidence identified was in noncardiac arrest patients.

Patients Without Cardiac Arrest

Despite limited evidence, a treatment strategy aimed at acutely lowering extracellular potassium values, in combination with more permanent potassium-lowering strategies seems logical. The rationale for combining insulin (and glucose) with inhaled or IV beta2-agonists is based on a meta-analysis of 50 patients that demonstrated a greater reduction of potassium values with a combination of therapies compared with insulin alone. Only a few studies compared

different treatment strategies and doses. Specific recommendations on dosing and a ranking of specific interventions are not included.

Patients With Cardiac Arrest

The recommendation for insulin in combination with glucose is based on indirect evidence from noncardiac arrest patients.

Beta2-agonists were not recommended based on the following considerations:

- Beta-adrenergic activation is already provided by the administration of epinephrine
- The theoretical potential for harmful effects from excessive beta stimulation during cardiac arrest
- The difficulty of dose titration of IV beta2-agonists during a cardiac arrest
- The general recommendation against tracheal administration of drugs during cardiac arrest due to unpredictable drug delivery

The recommendation regarding sodium bicarbonate is based on the lack of identified studies addressing this question and the general lack of effect of bicarbonate in cardiac arrest. The decision not to recommend against was based on the lack of evidence of harm in the general cardiac arrest population.

The recommendation regarding calcium was based on several considerations:

- Only anecdotal evidence of a protective effect of calcium during hyperkalemia
- Current guidelines recommend the use of calcium for the treatment of hyperkalemia
- One observational study demonstrating a higher mortality in patients with cardiac arrest receiving calcium[82]; the study was assessed as having critical risk of bias
- The potential harm of routine calcium administration during out-of-hospital cardiac arrest
- The general recommendation against routine use of calcium during cardiac arrest

The ALS Task Force acknowledges that not recommending calcium administration in cardiac arrest that is suspected to be caused by acute hyperkalemia challenges current guidelines. The task force recognizes that distinguishing between noncardiac arrest and cardiac arrest can be clinically challenging, especially for patients in the peri-arrest phase. The evidence for harm of calcium is based on out-of-hospital cardiac arrest, whereas the recommendation for in-hospital cardiac arrest patients is based on indirect evidence.

Knowledge Gaps

- The effect of treatments for hyperkalemia on patient-centered outcomes such as mortality
- The optimal doses or combinations of drugs (eg, insulin, glucose, and salbutamol) used for the treatment of hyperkalemia
- The optimal treatment of hyperkalemia during cardiac arrest
- The optimal ratio between insulin and glucose for treatment of suspected hyperkalemia during cardiac arrest

ALS Therapies for Opioid-Related Cardiac Arrest (ALS 3451, SysRev 2025)

Rationale for Review

Opioid-related emergencies, including cardiac arrest, continue to be a major public health crisis in some countries. Opioid antagonists (eg, naloxone) are effective in reversing respiratory depression from opioid overdose, potentially preventing cardiac arrest. When a patient goes into cardiac arrest from opioid overdose, however, it is not known whether specific treatments such as naloxone should be administered in addition to standard resuscitation. This topic was reviewed in 2015.[3,102] and the treatment recommendations remained unchanged after an EvUp in 2020.[40] The ALS Task Force, therefore, prioritized this for review (PROSPERO Registration CRD42024596637).[103] The full CoSTR can be found on the ILCOR website.[104]

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 secondary to suspected opioid poisoning
- Intervention: Any opioid-specific ALS-level therapy (eg, intra-arrest naloxone or other drugs, or other intra-arrest ALS-level interventions) for cardiac arrest resuscitation
- Comparators: Standard basic life support and/or advanced cardiac life support
- Outcomes:
  - Critical: Favorable neurological outcome at hospital discharge, 30 days, or longer; survival at hospital discharge, 30 days, or longer
  - Important: ROSC or survival to hospital admission
- Study designs: In addition to standard criteria, we included experimental animal studies and conference abstracts.
- Time frame: All years to September 14, 2024

Consensus on Science

Five observational studies (including 2 conference abstracts) were identified, providing very low–certainty evidence across all outcomes (downgraded for risk of bias and indirectness, as well as inconsistency).

Naloxone

Three observational studies reported the outcome of favorable neurological outcome at hospital discharge.[105-107] One conference abstract[106] including 218 adults with out-of-hospital cardiac arrest caused by presumed overdose (not specific to opioids) reported that naloxone administration was not associated with favorable neurological outcome (adjusted OR, 1.99; 95% CI, 0.34–11.55). A subsequent analysis of the same overall dataset included 1807 cardiac arrests with initial nonshockable rhythms not witnessed by emergency medical services, and reported

that naloxone (given prior to vascular access) was associated with increased odds of favorable neurological outcomes (adjusted OR, 4.61; 95% CI, 1.74–12.19).[107] A third study, also in abstract form only, including 164 adults with out-of-hospital cardiac arrests with a history of substance use (not specific to opioids) reported no difference in favorable neurological outcomes in patients treated with or without naloxone (26% versus 27%; *P*=0.915).[105]

Four observational studies reported survival to hospital discharge.[105-108] One study of 8195 adults with undifferentiated out-of-hospital cardiac arrests found naloxone was associated with increased survival to hospital discharge (risk difference, 6.2%; 95% CI, 2.3%–10.0%).[108] Another study of undifferentiated out-of-hospital cardiac arrest reported that naloxone was not associated with survival to hospital discharge (adjusted OR, 1.01; 95% CI, 0.46–2.21).[109] An observational study of 1807 patients with out-of-hospital cardiac arrest unwitnessed by emergency medical services and with an initial nonshockable rhythm found that naloxone was associated with improved survival (adjusted OR, 4.41; 95% CI, 1.78–10.97),[107] whereas a smaller study (conference abstract) based on the same dataset did not detect an association (adjusted OR, 1.99; 95% CI, 0.39–10.30) among out-of-hospital cardiac arrests due to presumed overdose.[106]

Three observational studies[107-109] reported ROSC and results were similarly mixed, with 2 studies finding higher rates of ROSC[107,108] with naloxone and 1 study finding no difference.[109]

Sodium Bicarbonate

One observational study[110] of 1545 out-of-hospital cardiac arrest with suspected drug overdose found that administration of sodium bicarbonate was associated with a decreased odds of survival (adjusted OR, 0.16; 95% CI, 0.08–0.31).

Prior Treatment Recommendations (2015)

We recommend the use of naloxone by IV, intramuscular, IO, or intranasal routes in respiratory arrest associated with opioid toxicity (strong recommendation, very low–quality evidence). The dose of naloxone required will depend on the route.

We can make no recommendation about the modification of standard ALS in opioid-induced cardiac arrest.

Treatment Recommendations (2025)

During ALS for cardiac arrest due to opioid poisoning, there is insufficient evidence to recommend any additional opioid-specific therapies (eg, naloxone) beyond standard resuscitation care.

If rescuers are uncertain whether a patient with suspected opioid poisoning is actually in cardiac arrest, administration of an opioid antagonist (eg, naloxone) is warranted (good practice statement).

Justification and Evidence-to-Decision Framework Highlights

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

This recommendation is directed at ALS providers (ie, clinicians who are able to distinguish respiratory depression/apnea from cardiac arrest). It is not intended to inform care by individuals without training to ascertain pulselessness.

The ALS Task Force acknowledges that cardiac arrest resuscitations are time-sensitive, task-saturated endeavors with multiple competing priorities. The task force felt that the very low–certainty evidence for any benefit of opioid-specific ALS interventions did not outweigh the risk of interfering with other evidence-based interventions. We placed a higher value on not

adding yet-unproven therapies. Given the uncertain state of the evidence there is also a possibility of harm.

The identified studies were limited by serious risk of bias and indirectness. There were no studies that examined patients with opioid-associated cardiac arrest, specifically.

Previous studies have shown drug-related cardiac arrest is associated with improved outcomes compared with undifferentiated cardiac arrest, and opioid-related cardiac arrest is associated with improved outcomes compared with other drug-related out-of-hospital cardiac arrest. Drug-related cases are more likely to be treated with naloxone, and therefore, the treatment with naloxone may simply be a marker of opioid toxicity and improved prognosis rather than providing any benefit.

Knowledge Gaps

- There were no RCTs that evaluated standard care with and without naloxone or other opioid-antagonists in suspected opioid-associated cardiac arrest.
- There was no evidence available for in-hospital or pediatric cardiac arrest.

Cardiac Arrest in the Catheterization Laboratory (ALS 406, ScopRev 2025)

Rationale for Review

Cardiac arrest in the catheterization laboratory is unique from other in-hospital cardiac arrest. Patients undergoing invasive procedures are extensively monitored and the circumstances of cardiac arrest differ. It is not known if management beyond standard basic life support and ALS is warranted. The ALS Task Force, therefore, prioritized this for review. The full CoSTR can be found on the ILCOR website.[111]

Population, Intervention, Comparator, Outcome, and Time Frame

- Population: Adults (>18 years) who experience a cardiac arrest in the cardiac intervention laboratory

- Intervention: Patient management other than national/international resuscitation guidelines
- Comparator: Patient management using national/international resuscitation guidelines
- Outcomes: ROSC; survival to hospital discharge, 30 days, and longer-term; functional outcome (modified Rankin Scale or Cerebral Performance Category) at hospital discharge, 30 days, and longer-term
- Time frame: All years; the literature search was conducted on March 12, 2024.

Summary of Evidence

The search identified 35 studies meeting our inclusion criteria.[112-146] Studies were categorized into 6 domains:

1. Incidence and outcome of cardiac arrest in the cardiac intervention laboratory
2. Incidence and outcome from cardiac arrest during percutaneous coronary intervention in the cardiac intervention laboratory among patients with and without acute ST-elevation myocardial infarction
3. Mechanical CPR in the cardiac intervention laboratory
4. ECPR in the cardiac intervention laboratory
5. Mechanical circulatory support in the cardiac intervention laboratory
6. Intracoronary epinephrine in the cardiac intervention laboratory

A brief narrative summary is provided here. See Tables 1 through 7 in Appendix C for additional details of included studies for each category.

Three observational studies (2 retrospective cohort studies[137,140] and 1 prospective cohort study[118]) described the incidence and outcome from cardiac arrest in the cardiac intervention laboratory among patients undergoing a variety of interventions. The incidence rate was 0.2%

and 0.5%, and 77% and 67%, respectively, survived the event.[137,140] Two studies[118,140] reported survival to discharge (56.1% and 38.1%).

Three observational studies (1 prospective[125] and 2 retrospective[112,146] described the incidence and outcome from cardiac arrest in the cardiac intervention laboratory among patients (elective and nonelective) undergoing percutaneous coronary intervention. The incidence of VF cardiac arrest was 0.84% to 2%, and the one study reporting outcomes documented successful defibrillation within 1 minute and survival to hospital discharge in all 164 (100%) VF cardiac arrest.[112]

Seven observational studies described outcomes following use of a mechanical chest compression to manage cardiac arrest in the cardiac intervention laboratory.[116,126,143,144]

Nine observational studies described the use of ECPR to treat patients in the cardiac intervention laboratory.[121,122,124,132,133,135,136,138] The heterogeneity of patient samples, settings, and procedures across the studies makes it very challenging to draw definitive conclusions from the data.

Five retrospective observational studies[114,119,127,134,142] and a case series[115] described the use of mechanical circulatory support (mainly microaxial flow pump, or Impella) in the cardiac intervention laboratory. Whether cardiac arrest occurred in the cardiac intervention laboratory or before transfer to the laboratory was not clear in most of these studies.

Two prospective cohort studies compared intracoronary epinephrine with either peripheral IV or central venous epinephrine in a total of 320 patients developing cardiac arrest.[113,141] ROSC, survival to discharge, and survival with favorable functional outcome were all significantly higher in the intracoronary groups compared with the peripheral IV groups.

Task Force Insights

Interpretation of the included studies is difficult because it is often unclear whether the cardiac arrest occurred in the cardiac intervention laboratory or beforehand.

Many studies included patients in cardiogenic shock as well as cardiac arrest, and in most cases, it was not possible to extract outcome data from the cardiac arrest cases alone.

The performance and quality of standard resuscitative measures (eg, CPR) were not characterized in the studies.

Knowledge Gaps

- There are no RCTs of interventions.
- The outcomes for patients developing cardiac arrest in the catheterization laboratory and then treated with mechanical chest compression devices, or mechanical circulatory support, or centrally administered drugs are unclear.
- Further study of the use of intracoronary epinephrine should be considered.

CPR in Patients Who Are Prone (ALS 3003, SysRev 2021, EvUp 2025)

CPR and defibrillation for patients in the prone position was addressed by a 2021 SysRev[147] and can be found in the 2021 CoSTR summary.[20] An EvUp was conducted for 2025. The complete EvUp is provided in Appendix C.

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

- Population: Adults and children with cardiac arrest in any setting, occurring while in the prone position
- Intervention: Performing CPR and/or defibrillation while the patient remains in the prone position
- Comparators: Turning the patient supine prior to initiation of CPR and/or defibrillation

- Outcomes:
  - Critical: Survival and survival with favorable neurologic outcome to discharge, 30 days, or longer
  - Important: Arterial blood pressure during CPR, time to initiation of CPR, time to defibrillation for shockable rhythms during CPR, end-tidal capnography during CPR, ROSC
- Study designs: In addition to standard criteria, case series and reports were included as the writing group was aware that the human data on prone CPR are extremely limited.
- Time frame: December 9, 2020, to July 15, 2024

Summary of Evidence

One SysRev[148] and 1 report of 2 cases in adults were identified.[149] The task force did not consider the identified evidence sufficient to warrant a full SysRev.

Treatment Recommendations (2021)

For patients with cardiac arrest occurring while in the prone position with an advanced airway already in place and for whom immediate supination is not feasible or poses significant risk to the patient, initiating CPR while the patient is still prone may be a reasonable approach (good practice statement).

Invasive blood pressure monitoring and continuous $ETCO_2$ monitoring may be useful to ascertain whether prone compressions are generating adequate perfusion, and this information could inform the optimal time to turn the patient supine (good practice statement).

For patients with cardiac arrest occurring while in the prone position without an advanced airway already in place, we recommend turning the patient supine as quickly as possible and beginning CPR (strong recommendation, very low–certainty evidence).

For patients with cardiac arrest with a shockable rhythm who are in the prone position and cannot be supinated immediately, attempting defibrillation in the prone position is a reasonable approach (good practice statement).

Cardiac Arrest During Pregnancy (ALS 3401, ScopRev 2024)

Cardiac arrest during pregnancy was addressed by a 2023 ScopRev and can be found in the 2024 CoSTR summary.[26] The ScopRev led to 2 new good practice statements in 2024, adding to the existing treatment recommendations.

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

- Population: Pregnant or up to 1 year postpartum patients in cardiac arrest in any setting
- Intervention: Any specific intervention(s)
- Comparators: Standard care or usual resuscitation practice
- Outcomes:
  - Maternal
    - Critical: Survival with favorable functional outcome at discharge, 30 days, 60 days, 90 days, 180 days, and/or 1 year; survival at discharge, 30 days, 60 days, 90 days, 180 days, and/or 1 year
    - Important: ROSC or survival to hospital admission
  - Neonatal
    - Critical: Survival with favorable functional outcome at discharge, 30 days, 60 days, 90 days, 180 days, and/or 1 year; survival at discharge, 30 days, 60 days, 90 days, 180 days, and/or 1 year
    - Important: ROSC or survival to hospital admission
- Study designs: In addition to standard criteria, case series with ≥20 patients, and descriptive studies without a comparator group were eligible for inclusion. Gray

literature, social media, and non–peer-reviewed studies, unpublished studies, conference abstracts, and trial protocols were eligible for inclusion.

- Time frame: August 2014 to September 2023

Treatment Recommendations (2015, With Addition of Good Practice Statements in 2024)

We suggest delivery of the fetus by perimortem cesarean delivery for women in cardiac arrest in the second half of pregnancy (weak recommendation, very low–certainty evidence).

There is insufficient evidence to define a specific time interval by which delivery should begin.

High-quality usual resuscitation care and therapeutic interventions that target the most likely cause(s) of cardiac arrest remain important in this population.

There is insufficient evidence to make a recommendation about the use of left-lateral tilt or uterine displacement during CPR in the pregnant patient.

ECPR may be considered as a rescue therapy for selected cardiac arrest patients during pregnancy or in the postpartum period when conventional CPR fails and in settings in which it can be implemented (good practice statement).

Institution readiness and resuscitation education are required to accommodate the unique physiologic challenges of cardiac arrest during pregnancy (good practice statement).

Resuscitation of Patients With Durable Mechanical Circulatory Support With Acutely Altered Perfusion or Cardiac Arrest (ALS 3005, ScopRev 2025)

Rationale for Review

This topic was prioritized by the ALS Task Force for review due to the increasing prevalence of durable mechanical circulatory support devices, left ventricular assist devices (LVADs) in particular, both in-hospital and in the community. The optimal approach to the

identification and resuscitation of patients with acutely impaired perfusion supported by mechanical circulatory support devices is controversial. This topic has not been previously reviewed by ILCOR.

Population, Concept, Context, and Time Frame

This SysRev followed the population, concept, context framework and not the traditional population, intervention, comparator, outcome, study design, and time frame that is more suitable for SysRevs.

- Population: Patients of any age who were receiving durable mechanical support of any kind
- Concept: Acute impaired perfusion resulting in the need for acute resuscitation
- Context: In-hospital and out-of-hospital settings
- Time frame: All years to September 2024

Summary of Evidence

Of the 3557 studies identified, 32 (0.9%) met inclusion criteria.[150-181] Of the included studies, 25 were case reports (2 or fewer patients),[150,153-157,159,162-174,177-181] 4 were case series (3–10 patients),[151,158,161,176] and 3 were retrospective cohort studies (10+ patients).[152,160,175] Eleven studies described a patient who had a cardiac arrest and received chest compressions.[152,155,156,158,160,164,167,172,175,176,180] Durable mechanical circulatory support devices were LVADs or biventricular assist devices in all studies.

Several studies highlighted challenges of identifying patients with acutely altered perfusion and cardiac arrest.[150,158,167,174,176,182,183] These challenges included complexity resulting from expected pulselessness in continuous-flow LVAD–supported patients who do not have

native heart rates. Other challenges described included difficulty of measuring blood pressure and challenges determining adequate perfusion.

Delays in chest compressions were documented in several reports.[158,160,164,172] In one study of hospitalized patients, 4 of 9 (44.4%) patients with LVADs who had a cardiac arrest had delays of over 2 minutes before starting chest compressions.[160] The most common reason clinicians provided for not performing chest compressions was the belief that chest compressions were contraindicated in patients with LVADs. Because of the difficulty in assessments and the uncertainty of providers, the authors of several studies proposed algorithms for resuscitation of patients with durable mechanical circulatory support.

Three studies compared chest compressions with no chest compressions with respect to patient outcomes. The largest study (n=578) found higher in-hospital mortality (74% versus 55%) in patients who received chest compressions.[152] The second study of 16 patients found 22% (2 of 9) of patients with chest compressions survived to discharge and 43% (3 of 7) who did not receive chest compressions survived to hospital discharge.[160] The study did not make any direct comparisons between these groups. The third study of 58 patients with LVAD who had a cardiac arrest in a single center found no difference between those who received chest compressions compared to those who did not.[175]

Of all patients with an LVAD who received chest compressions across 11 studies (n=226), 71 (31%) were reported as having a favorable outcome.[152,155,156,158,160,164,167,172,175,176,180]

No study reported dislodgement or other complications related to device function after chest compressions.

Additional study details are provided in supplementary Tables 8 and 9 in Appendix C.

Task Force Insights

The task force highlighted the overall lack of evidence to support recommendations on the optimal approach to resuscitation. Most publications identified were case reports or case series. The few observational cohort studies all had significant limitations, including confounding by indication, lack of generalizability, and high risk of misclassification wherein patients with acutely impaired perfusion are designated as having a cardiac arrest but may not have had an acute cardiac arrest.

The task force found the evidence compelling that there is low risk of device dislodgement from chest compressions.

The task force also reviewed a Scientific Statement from the American Heart Association[183] and guidance from the British Societies LVAD Emergency Algorithm Working Group.[182] One recommendation from the British Society Working Group was to delay chest compressions for up to 2 minutes while efforts to restart the device are made. The task force considered that these 2 minutes may be unnecessary, and efforts to restart the LVAD device could occur in parallel with chest compressions as long as multiple rescuers are available.

Treatment Recommendations (2025)

In patients receiving durable mechanical circulatory support who develop acutely impaired perfusion because of cardiac arrest and who are not in the immediate peri-device implantation period, we suggest performing, rather than withholding, chest compressions (good practice statement).

When caring for patients with durable mechanical circulatory support who have acutely impaired perfusion as a result of cardiac arrest, we suggest minimizing delays in initiating chest

compressions while simultaneously assessing for device-related reversible causes of acutely impaired perfusion (good practice statement).

We suggest rescuers follow an algorithmic approach to concurrently assess and respond to acutely impaired perfusion in patients receiving durable mechanical circulatory support (good practice statement).

Cardiac Arrest Due to Confirmed or Suspected Pulmonary Embolism (ALS 3400, EvUp 2025)

The treatment of cardiac arrest for confirmed or suspected pulmonary embolism was addressed by an EvUp for 2022, and details can be found in the 2022 CoSTR summary.[71] An EvUp was completed for 2025. The complete EvUp is provided in Appendix B.

Population, Intervention, Comparator, Outcome, and Time Frame

- Population: Among adults who are in cardiac arrest due to pulmonary embolism or suspected pulmonary embolism in any setting
- Intervention: Any specific alteration in treatment algorithm (eg, fibrinolytics)
- Comparators: Standard basic life support and ALS care
- Outcomes: Survival with favorable neurologic/functional outcome at discharge, 30 days, or longer; survival at discharge, 30 days, or longer
- Time frame: November 29, 2021, to December 20, 2023

Summary of Evidence

One retrospective cohort study of 64 patients was identified.[184] The study found that use of thrombolysis (alteplase) was associated with improved survival compared with no thrombolysis. The task force did not consider the identified evidence sufficient to warrant a full SysRev.

Treatment Recommendations (2020)

We suggest administering fibrinolytic drugs for cardiac arrest when pulmonary embolism is the suspected cause of cardiac arrest (weak recommendation, very low–certainty of evidence).

We suggest the use of fibrinolytic drugs or surgical embolectomy or percutaneous mechanical thrombectomy for cardiac arrest when pulmonary embolism is the known cause of cardiac arrest (weak recommendation, very low–certainty evidence).

POST–CARDIAC ARREST CARE

Post–Cardiac Arrest Temperature Control (ALS 3523, 3524, 3525, SysRev 2024)

The SysRev for post–cardiac arrest temperature management was last updated for the 2024 CoSTR summary. This population, intervention, comparator, outcome, study design, and time frame includes 6 different comparisons:

1. The use of temperature control
2. Timing of temperature control
3. Optimal temperature
4. Duration of temperature control
5. Method of temperature control
6. Rewarming rates

The population, outcome, study design, and time frame were the same for all comparisons. Details of the SysRev and the specific interventions and comparators can be found in the 2024 CoSTR summary.[26,185]

Population, Outcome, Study Design, and Time Frame

- Population: Adults with cardiac arrest in any setting
- Outcome: Critical—survival and favorable neurologic/functional outcome at discharge,30 days, or longer

- Study designs: Only controlled trials in humans, including RCTs and nonrandomized trials (eg, pseudo-randomized trials), were included. Studies assessing cost effectiveness were included for a descriptive summary.
- Time frame: June 17, 2021, to May 31, 2023

Treatment Recommendations (2024)

We suggest actively preventing fever by targeting a temperature ≤37.5°C for patients who remain comatose after ROSC from cardiac arrest (weak recommendation, low-certainty evidence).

Whether subpopulations of cardiac arrest patients may benefit from targeting hypothermia at 32°C to 34°C remains uncertain.

Comatose patients with mild hypothermia after ROSC should not be actively warmed to achieve normothermia (good practice statement).

We recommend against the routine use of prehospital cooling with rapid infusions of large volumes of cold IV fluid immediately after ROSC (strong recommendation, moderate-certainty evidence).

We suggest surface or endovascular temperature control techniques when temperature control is used in comatose patients after ROSC (weak recommendation, low-certainty evidence).

When a cooling device is used, we suggest using a temperature control device that includes a feedback system based on continuous temperature monitoring to maintain the target temperature (good practice statement).

We suggest active prevention of fever for 36 to 72 hours in post–cardiac arrest patients who remain comatose (good practice statement).

Post–Cardiac Arrest Seizure Prophylaxis and Treatment (ALS 3502 and 3503, SysRev, 2024)

Post–cardiac arrest seizure prophylaxis and treatment was addressed by an updated SysRev for 2024 and details can be found in the 2024 CoSTR summary.[26] This was a nodal review between the ALS and Pediatric Life Support Task Forces. For pediatric recommendations see the Pediatric Life Support section of the 2024 CoSTR summary.

Population, Intervention, Comparator, Outcome, and Time Frame

- Population: Adults or children with ROSC after cardiac arrest in any setting
- Intervention: One strategy for prophylactic antiseizure medication or seizure treatment
- Comparators: Another strategy, or no prophylactic antiseizure medication or seizure treatment
- Outcomes: Critical—survival with favorable functional outcome at discharge, 30 days, 60 days, 90 days, 180 days, and/or 1 year; survival at discharge, 30 days, 60 days, 90 days, 180 days, and/or 1 year
- Time frame: September 26, 2019, to September 11, 2023

Treatment Recommendations (2024)

We suggest against the use of prophylactic antiseizure medication in post–cardiac arrest adults (weak recommendation, very low–certainty evidence).

We suggest treatment of clinically apparent and electrographic seizures in post–cardiac arrest adults (good practice statement).

We suggest treatment of rhythmic and periodic electroencephalogram (EEG) patterns that are on the ictal-interictal continuum in comatose post–cardiac arrest adults (weak recommendation, low-certainty evidence).

Mechanical Circulatory Support After ROSC Following Cardiac Arrest (ALS 3505, SysRev 2025)

Rationale for Review

Temporary mechanical circulatory support refers to devices (eg, microaxial flow pump, or Impella; intra-aortic balloon pump) that can be used in patients with cardiogenic shock to support circulation, improve cardiac output, and restore end-organ perfusion. This SysRev was undertaken to incorporate new data on the use of mechanical circulatory support devices in acute myocardial infarction complicated by cardiogenic shock, including a large proportion of post–cardiac arrest patients.[186] It was registered before initiation (PROSPERO Registration CRD42024566810). The full CoSTR can be found on the ILCOR website.[187]

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

- Population: Adults with cardiogenic shock after ROSC following cardiac arrest in any setting
- Intervention: Management with a mechanical circulatory support device
- Comparators: Management without a mechanical circulatory support device or usual post–cardiac arrest care
- Outcomes:
  - Critical: Favorable neurological outcome; quality of life; survival at hospital discharge, 30 days, or longer
  - Important: Length of hospital and intensive care unit stay, adverse events or complications (eg, bleeding, limb ischemia, arrhythmias, recurrent cardiac arrest, acute kidney injury ± renal replacement therapy, stroke, hemolysis), as defined by study authors

- Study designs: We included only RCTs. Studies where a mechanical circulatory support device was initiated during ongoing CPR (ie, ECPR) were not considered.
- Time frame: All years to July 3, 2024

Consensus on Science

For the critical outcome of survival to hospital discharge or 30-day survival, there were 13 RCTs[188-200] examining patients in cardiogenic shock that found no difference with the use of mechanical circulatory support devices. A subgroup of post–cardiac arrest patients from 6 of the included trials[190,192,193,196,199,200] similarly found no difference with the use of mechanical circulatory support devices compared with standard care. One RCT examining in-hospital cardiac arrest again found no difference in survival with the use of mechanical circulatory support.[193]

For longer-term survival (6 months, 12 months, and longest follow-up time), 14 RCTs[188-201] of patients with cardiogenic shock found no difference with the use of mechanical circulatory support, including in the post–cardiac arrest subgroup. A single RCT comparing the use of a microaxial flow pump with standard care in conscious post–cardiac arrest patients with infarct-related cardiogenic shock found improved survival at 6 months.[193]

Three RCTs[195,197,199] found no difference in favorable neurologic outcome with mechanical circulatory support for cardiogenic shock. No specific data on cardiac arrest patients was identified for this outcome.

More detailed numeric results are provided in Table 10 in Appendix C.

Treatment Recommendations (2025)

We suggest against the routine use of mechanical circulatory support devices in patients with cardiogenic shock after cardiac arrest and ROSC (weak recommendation, low-certainty evidence).

We suggest considering mechanical circulatory support devices in highly selected patients with cardiogenic shock after cardiac arrest and ROSC, in settings where this can be implemented (weak recommendation, low-certainty evidence).

When a mechanical circulatory support device is used, we suggest monitoring for adverse events and complications to allow their rapid identification and treatment (good practice statement).

Justification and Evidence-to-Decision Framework Highlights

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

No benefits were found in any outcome between treatment with mechanical circulatory support and standard care in patients with cardiogenic shock, with or without prior cardiac arrest. Only a single RCT comparing the use of a microaxial flow pump with standard care found improved survival at 6 months.

All evidence was indirect, coming from studies in patients with cardiogenic shock (64% of patients resuscitated from cardiac arrest), except a small (n=60) RCT enrolling patients resuscitated from in-hospital cardiac arrest caused by acute coronary syndrome.

The task force considered that there may be groups of patients who benefit from mechanical circulatory support. There was a lack of evidence on how to select patients with cardiogenic shock after cardiac arrest for mechanical circulatory support. The patient subgroups who may benefit include those with a Glasgow Coma Scale score >8 at hospital arrival with

infarct-related cardiogenic shock,[193] patients with ST-segment myocardial infarction without prior resuscitation before arrival of emergency medical services, or with a short duration of cardiac arrest (<10 minutes).[202]

The task force considered that hypoxic brain injury is the leading cause of death post–cardiac arrest, while persistent cardiac failure is the primary cause in those with cardiogenic shock without preceding cardiac arrest. Therefore, in patients at high risk of brain injury the benefit of mechanical circulatory support devices may be less apparent.

The task force also considered that implementation of mechanical circulatory support may incur significant costs and require specialized resources and skills, which may not be feasible in all settings.

Knowledge Gaps

- The effect of mechanical circulatory support devices on neurologically intact survival in patients with ROSC after cardiac arrest
- The value of mechanical circulatory support devices following cardiac arrest of noncardiac origin
- Whether there are differences between different types of mechanical circulatory support devices or combinations of devices
- The optimal timing for initiating mechanical circulatory support after ROSC
- The ideal settings for implementing mechanical circulatory support in post–cardiac arrest patients

Post–Cardiac Arrest Hemodynamics (ALS 3515, 2024 SysRev Adolopment)

Rationale for Review

Postarrest hemodynamics was reviewed with adolopment of a SysRev[203] in 2024, and details can be found in the 2024 CoSTR summary.[26,185] It was registered before initiation (PROSPERO Registration CRD42024566810). The full CoSTR can be found online.[204]

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

- Population: Adults with sustained ROSC after cardiac arrest
- Intervention: Targeting a mean arterial pressure of 71 mm Hg or higher
- Comparator: Targeting a mean arterial pressure of 70 mm Hg or lower
- Outcomes:
  - Critical: Survival or good functional outcome defined as a modified Rankin Scale score of 1 to 3 or a Cerebral Performance Category score of 1 or 2 at 90 to 180 days
  - Important: Intensive care unit mortality, new arrhythmia resulting in hemodynamic compromise or cardiac arrest while in the intensive care unit
- Study design: Only RCTs were eligible for inclusion.
- Time frame: Original search all years to October 2022; updated for adolopment in August 2023

Treatment Recommendations (2024)

There is insufficient scientific evidence to recommend a specific blood pressure goal after cardiac arrest. Therefore, we suggest a mean arterial blood pressure of at least 60 to 65 mm Hg in patients after out-of-hospital (moderate-certainty to low-certainty evidence) and in-hospital cardiac arrest (low-certainty to very low–certainty evidence).

Choice of Vasopressor in the Post–Cardiac Arrest Period (ALS 3528, SysRev 2025)

Rationale for Review

There are very few data to guide vasopressor choice for post–cardiac arrest shock; therefore, a SysRev was undertaken. It was registered on PROSPERO (CRD42024549394) prior to undertaking the search. The full CoSTR can be found on the ILCOR website.[205]

Population, Intervention, Comparator, Outcome and Time Frame

- Population: Adults with sustained ROSC after cardiac arrest and a need for a vasopressor infusion to manage low blood pressure
- Interventions: Vasopressor or a combination of vasopressors provided intravenously as an infusion after ROSC
- Comparators: No vasopressor, a different vasopressor, or a different combination of vasopressors provided intravenously as an infusion after ROSC
- Outcomes:
  - Critical: Survival or good functional outcome defined as a modified Rankin Scale score of 1 to 3 or Cerebral Performance Category scale score of 1 or 2 at the longest time point (author defined)
  - Important: Intensive care unit or emergency department mortality, new arrhythmia resulting in hemodynamic compromise or cardiac arrest while in the emergency department or intensive care unit
- Time frame: All years to August 2024

Consensus on Science

Of 7048 screened, 8 studies were included.[206-213] The evidence across all outcomes was of very low certainty. Three comparisons were performed within the included studies: norepinephrine compared with epinephrine,[206,208-212] norepinephrine compared with dopamine,[207]

and dopamine compared with dopamine combined with a different vasopressor (norepinephrine or epinephrine).[207,213]

Norepinephrine Compared With Epinephrine

For the critical outcome of survival at 30 days, 1 RCT[209] of 40 out-of-hospital cardiac arrest patients with ROSC in the emergency department showed no difference with norepinephrine compared with epinephrine (10% versus 10%; *P*=1.0). Two retrospective studies[206,208] including 766 and 221 patients with ROSC in-hospital after out-of-hospital cardiac arrest showed that epinephrine was associated with higher in-hospital mortality (adjusted OR, 2.6; 95% CI, 1.4–4.7 and adjusted OR, 6.2; 95% CI, 2.4–16.3), and 1 study[206] reported higher likelihood of unfavorable neurologic outcome (adjusted OR, 3.4; 95% CI, 2.4–5.0) at discharge. Two studies,[210,212] including 451 patients and 1893 patients, respectively, found no difference in survival to hospital discharge in those who received epinephrine compared with norepinephrine (adjusted OR, 1.08; 95% CI, 0.60–1.93 and adjusted OR, 1.0; 95% CI, 0.6–1.7, respectively). One of these studies also found no difference in good neurologic function at hospital discharge (adjusted OR, 0.89; 95% CI, 0.45–1.77).[212]

Five studies reported the important outcome of rearrest, with 4 of the 5 favoring norepinephrine[206,208,211,212] and 1 finding no difference.[210]

Norepinephrine Compared With Dopamine

One retrospective study[207] including 1011 patients found no difference in 30-day survival (adjusted OR, 1.0; 95% CI, 0.48–2.06) or favorable functional outcome (adjusted OR, 0.8; 95% CI, 0.28–2.53) in patients treated with norepinephrine compared with dopamine.

Norepinephrine Combined With Dopamine Compared With Dopamine Alone

Two studies examined the use of norepinephrine together with dopamine compared with dopamine alone for patients with hypotension in hospital after out-of-hospital cardiac arrest. One retrospective cohort study found that norepinephrine and dopamine compared with dopamine alone was not associated with any difference in survival to 30 days (adjusted OR, 0.6; 95% CI, 0.3–1.1) but was associated with lower odds of favorable neurologic outcome at 30 days (adjusted OR, 0.20; 95% CI, 0.04–0.78).[207] A second retrospective study including 310 patients found that dopamine together with norepinephrine or epinephrine was associated with higher 30-day mortality compared with dopamine alone (adjusted OR, 2.0; 95% CI, 1.3–3.0).[213]

Treatment Recommendation (2025)

There is insufficient evidence to recommend a specific vasopressor to treat low blood pressure in patients after cardiac arrest.

Justification and Evidence-to-Decision Framework Highlights

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

The evidence for the choice of different vasopressors is of very low certainty. There is only 1 small feasibility RCT, and all observational studies are prone to confounding by indication (ie, epinephrine is often used in the most critical and unstable patients).

There was a lack of consensus about the treatment recommendation, with some members suggesting a recommendation for norepinephrine as the first line vasopressor (7 members) and some suggesting that there is insufficient evidence to make any recommendation (9 members).

The feasibility of giving different vasopressors likely varies between settings. The task force discussed the possibility that vasopressor choice would vary based on clinical situation and timing. Peri-arrest stabilization and more longitudinal postarrest intensive care unit care may

require different approaches to vasopressor choice, but there is little evidence to guide these choices.

Vasopressors are commonly used to manage blood pressure in other critically ill patients. The latest Surviving Sepsis Campaign Guidelines recommend norepinephrine as the first line vasopressor.[214]

Vasopressors are commonly used for the management of low blood pressure and low cardiac output in patients with cardiogenic shock. The recommendations for the first line vasopressor for the management of low blood pressure is norepinephrine in some international guidelines.[215,216]

Knowledge Gaps

- The effects of norepinephrine and epinephrine on brain circulation and cerebral blood flow
- Studies enrolling patients with in-hospital cardiac arrest (all studies were conducted in patients with out-of-hospital cardiac arrest)
- The effect of intermittent bolus administration of vasopressors to treat low blood pressure after ROSC
- Whether specific vasopressors are better or worse in specific clinical scenarios (eg, during patient transport, or when central access is or is not available)
- Whether the use of inotropes such as dobutamine, levosimendan, or milrinone together with vasopressors to increase blood pressure is more effective than vasopressors alone for postarrest shock

Administration of Neuroprotective Drugs in Patients with ROSC after Cardiac Arrest (ALS 3507, SysRev Adolopment 2025)

Rationale for Review

A recent ILCOR scientific statement on why therapeutic interventions have failed to translate to improved neurological outcomes in clinical trials identified the effect of any specific drug therapies for neuroprotection in comatose survivors of cardiac arrest as a significant knowledge gap.[217] The ALS Task Force was aware of a SysRev addressing this question, which was deemed suitable for adolopment.[218] The SysRev was registered on PROSPERO (CRD42023488043). The full CoSTR can be found on the ILCOR website.[219]

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

- Population: Adults aged ≥16 years who are comatose after cardiac arrest
- Intervention: Neuroprotective drug administration irrespective of route of administration; the intervention may have commenced during the cardiac arrest but must have continued after ROSC
- Comparators: Placebo or usual care
- Outcomes:
  - Critical: Mortality and functional outcome at 30 days or hospital discharge, health-related quality of life
  - Important: Serious adverse events
- Study designs: Only RCTs were eligible for inclusion. Studies with results published on trial registries (but were not published in peer-reviewed journals) were included.
- Time frame: All years to April 12, 2024

Consensus on Science

Forty-two studies[220-262] (5502 patients) were included in the adoloped SysRev.[218] Studies are grouped thematically as supportive drug therapy (7 studies), neuroprotective agent (19 studies), and anti-inflammatory/antioxidant (16 studies) to facilitate narrative reporting of results.

Supportive Drug Therapies

In 5 RCTs[222,238,239,246,254] investigating antiplatelet agents, sedation, and neuromuscular blockade, there was no difference in the critical outcome of mortality at 30 days or hospital discharge. One study found no difference in 12-month survival in out-of-hospital cardiac arrest patients treated with neuromuscular blockade administered as a continuous infusion or placebo.[255] There was no difference in serious adverse events between intervention and control arms in the supportive drug therapies category.

Neuroprotective Agents

Fourteen studies investigated 13 therapies, including thiopental,[224] the dopamine agonist amantadine,[226] calcium channel blockers nimodipine[234,252] and lidoflazine,[223] inhaled xenon,[237] nitric oxide,[262] hydrogen,[256] the glucagon-like peptide-1 agonist exenatide,[259] epoetin alfa,[225] sodium nitrite,[228] magnesium,[257] MLC901 (a combination of 9 herbal components),[249] and the anticholinergic penehyclidine hydrochloride.[258] Thirteen studies reported no effect on mortality at 30 days or hospital discharge. One small single-center study of 80 patients reported reduced 30-day or hospital mortality with penehyclidine hydrochloride compared with hyoscine hydrobromide (RR, 0.17; 95% CI, 0.04–0.70) (high risk of bias in 2 domains).[258] One multicenter study from Japan comparing inhaled hydrogen with nitrogen placebo reported reduced mortality between 30 days or hospital discharge and 180 days (RR, 0.39; 95% CI, 0.17–0.91), but this study was terminated early (less than 20% included).[256] For the critical outcome of good functional outcome, no significant effects were seen in any study. Significantly increased

rates of serious adverse events were seen in the studies of thiopental (hypotension), lidoflazine (hypotension), and epoetin alfa (thrombosis) within the intervention arms.[223-225]

Anti-inflammatory and Antioxidant Agents

In the anti-inflammatory and antioxidant category, 16 studies of 9 therapies were included. Therapies investigated included steroids,[229,242,248] vasopressin in conjunction with steroids,[241] thiamine,[221,230,250] coenzyme Q10,[227,235,261] vitamin C,[251] the interleukin-6 inhibitor tocilizumab,[245] the prostacyclin analogue iloprost,[244] the neutrophil elastase inhibitor urinastatin,[233] and the traditional Chinese medicine Shenfu.[260] Individual study results were variable and are included in the online CoSTR. Meta-analysis results for mortality at 30 days are presented in Table 2.

Table 2. Meta-Analysis Results for the Effect of Anti-Inflammatory and Antioxidant Agents on Mortality at 30 Days or Hospital Discharge

Studies (participants), n	Intervention	Comparator	RR (95% CI) ARD (95% CI)	Certainty of evidence
5 (739)[229,241-243,248]	Steroids	Placebo	RR, 0.93 (0.83–1.04) ARD, 56 fewer deaths/1000 (136 fewer to 32 more deaths/1000)	Low
3 (107)[227,235,261]	Coenzyme Q10/ubiquinol	Placebo	RR, 0.91(0.61–1.37) ARD 40 fewer deaths/1000 (173 fewer to 248 more deaths/1000)	Low
3[221,230,250]	Thiamine	Placebo	RR, 1.11 (0.88–1.40) ARD, 67 more deaths/1000 (73 fewer to 242 more deaths/1000)	Low

ARD indicates absolute risk difference; CI, confidence interval; and RR, relative risk.

Treatment Recommendation (2025)

There is insufficient evidence to recommend the use of any specific drug therapy for comatose survivors of cardiac arrest (weak recommendation, low- to very low–certainty evidence).

Justification and Evidence-to-Decision Framework Highlights

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

The task force recognized that most of the evidence was derived from single center trials with few participants in each trial.

Trials of the anticholinergic penehyclidine,[258] the traditional Chinese medicine Shenfu,[260] and inhaled hydrogen[256] reported reduced mortality. However, a high risk of bias, small sample size and lack of supporting evidence does not support a recommendation of these agents without further studies.

Two trials of intra-arrest vasopressin and methylprednisolone plus hydrocortisone for postresuscitation shock reported a reduction in mortality,[241] but it was impossible to separate the treatment effect of postarrest steroids from co-interventions commenced during cardiac arrest, which included vasopressin. A CoSTR review that specifically examined the effect of vasopressin and corticosteroids during cardiac arrest does not recommend the use of intra-arrest vasopressin and corticosteroids.[71,263]

The task force recognized the very low certainty of evidence for thiamine. The task force also noted that 2 studies were stopped early because of concerns about harm in a subgroup of patients with lactate >5 mmol/L at study inclusion.[221,230]

Post–Cardiac Arrest Percutaneous Coronary Intervention With and Without ST-Segment Myocardial Infarction (ALS 3500 and 3501 SysRev 2022, EvUp 2025)

The use of coronary angiography for patients with ROSC after cardiac arrest was addressed by a SysRev for 2022, and details can be found in the 2022 CoSTR summary.[71] An EvUp was completed for 2025.

Population, Intervention, Comparator, Outcome, and Time Frame

- Population: Unresponsive adults (>18 years old) with ROSC after cardiac arrest
- Intervention: Emergent or early coronary angiography with percutaneous coronary intervention if indicated
- Comparators: Delayed coronary angiography or no coronary angiography
- Outcome: Any clinical outcome
- Time frame: January 8, 2022, to April 5, 2024

Summary of Evidence

The complete EvUp is provided in Appendix B. Three additional relevant studies were identified in the updated search. All studies investigated early versus delayed coronary angiography in patients without ST-segment elevation myocardial infarction. Two RCTs, both stopped early, found no evidence of a difference in outcomes. A secondary analysis of a previous RCT examining 1-year mortality found higher mortality in the immediate angiography group (hazard ratio, 1.25; 95% CI, 0.99–1.57). The task force did not consider the identified evidence sufficient to warrant a full SysRev.

Treatment Recommendations (2020)

When coronary angiography is considered for comatose postarrest patients without ST elevation, we suggest that either an early or delayed approach for angiography is reasonable. (weak recommendation, low-certainty evidence).

We suggest performing early coronary angiography in comatose post–cardiac arrest patients with ST-segment elevation (good practice statement).

Post–Cardiac Arrest Steroid Administration (ALS 3504, EvUp 2025)

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

- Population: Adult patients with ROSC after cardiac arrest in any setting
- Intervention: Treatment with corticosteroids
- Comparator: Standard care without use of corticosteroids
- Outcome: Any clinical outcome
- Time frame: September 1, 2022, to May 7, 2024

Summary of Evidence

One new RCT and 1 substudy of an RCT were identified. The RCT (n=137) found reduced interleukin-6 values but no differences in clinical outcomes.[248] The secondary analysis found reduced need for vasopressors with glucocorticoid administration.[264] No survival outcomes were analyzed. The task force did not consider the identified evidence sufficient to warrant a full SysRev.

Treatment Recommendation (2010)

There is insufficient evidence to support or refute the use of corticosteroids alone or in combination with other drugs after cardiac arrest.

Glucose Control After Resuscitation (ALS 3519, EvUp 2025)

Population, Intervention, Comparator, Outcome, and Time Frame

- Population: Adults (≥18 years) with ROSC after cardiac arrest in any setting
- Intervention: Specific target range for blood glucose management (eg, strict 4–6 mmol/L, 72–108 mg/dL)
- Comparator: Any other target glucose range

- Outcomes: Critical—survival with favorable neurological/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival to hospital discharge, 30 days, 60 days, 90 days, 180 days, and/or 1 year
- Time frame: April 6, 2014, to March 4, 2024

Summary of Evidence

The complete EvUp is provided in Appendix B. No new studies were identified that examined active glucose management during post–cardiac arrest care, so a SysRev is not warranted.

Treatment Recommendations (2014)

We suggest no modification of standard glucose management protocols for adults with ROSC after cardiac arrest (weak recommendation, moderate-quality evidence).

Post–Cardiac Arrest Prophylactic Antibiotic Administration (ALS 3522, EvUp 2025)

Population, Intervention, Comparator, Outcome, and Time Frame

- Population: Adult patients with ROSC after cardiac arrest in any setting
- Intervention: Early/prophylactic antibiotic administration
- Comparator: Delayed/clinically driven antibiotic administration
- Outcome: Any clinical outcomes
- Time frame: June 1, 2016, to January 27, 2024

Summary of Evidence

The complete EvUp is provided in Appendix B. The updated literature search identified 1 previously included RCT[232] (n=194) and 1 new post hoc analysis[265] of patients enrolled in a previous RCT (n=696).[266] The new study supported previous findings of reduced rates of ventilator-associated pneumonia and undifferentiated pneumonia but no differences in survival

outcomes with prophylactic antibiotics. The task force did not consider the identified evidence sufficient to warrant a full SysRev.

Treatment Recommendations (2020)

We suggest against the use of prophylactic antibiotics in patients following ROSC. (weak recommendation, low-certainty evidence).

POST–CARDIAC ARREST PROGNOSTICATION

Neuroprognostication of Poor Neurological Outcome (ALS 3510–3513, EvUp 2025)

For prognostication of poor neurological outcome, the population, comparator, outcomes, study designs, and time frames were as listed below. The evidence identified is presented by intervention, and treatment recommendations are all listed together at the end of this section.

- Population: Adult (≥16 years) who are comatose after ROSC from cardiac arrest in any setting
- Comparator: Accuracy of the index test was assessed by comparing the predicted outcome with the final outcome.
- Outcomes: Poor neurological outcome (defined as Cerebral Performance Category score of 3 to 5, Glasgow Outcome Scale score 1 to 3, or modified Rankin Scale score of 4 to 6, at hospital discharge, 1 month, or later
- Study designs: Any study design where the sensitivity and false positive rate could be calculated (ie, where the 2×2 contingency table of true/false negatives and positives for prediction of poor neurologic outcome was reported or could be calculated); all studies were eligible for inclusion provided there was an English abstract.
- Time frame: This was an updated search from a previous review. The search included studies from April 2020 to June 30, 2024.

Imaging for Post–Cardiac Arrest Neuroprognostication (ALS 3510)

- Intervention: Index test based on any imaging modality (eg, computed tomography [CT], magnetic resonance imaging [MRI])

Summary of Evidence

Nine new studies were identified examining CT imaging[267-275] and 10 studies for MRI.[269,275-283] All studies of CT were observational ranging from 78 to 354 patients and measured different aspects of grey-white ratio on brain CT. Studies of MRI included 1 secondary analysis of a previous RCT and 9 observational cohort studies (prospective and retrospective) ranging from 50 to 428 patients and reporting a variety of different findings on MRI imaging within 7 days of ROSC. The task force did not consider the identified evidence sufficient to warrant a full SysRev.

Neurophysiological Tests for Post–Cardiac Arrest Neuroprognostication (ALS 3511)

Intervention: Index test based on electrophysiology: EEG and short-latency somatosensory evoked potentials

Summary of Evidence

Nine studies evaluated the presence of highly malignant patterns on EEG (suppression or burst suppression defined according to the American Clinical Neurophysiology Society terminology) in a total of 1794 patients[277,280,284-290] between 12 hours and 7 days after ROSC. In all but one study, the presence of these patterns at ≥24 hours from arrest predicted poor outcome with 100% specificity. One study[290] in 801 patients evaluated the additional value of the absence of reactivity on EEG at 24 hours to 14 days after ROSC, showing that it predicted poor neurological outcome at 6 months with 60% (57%–64%) specificity and 79% (76%–82%) sensitivity. The false-positive rate was about 40%.

A total of 6 observational studies[280,285,291-296] were identified ranging from 29 to 260 patients and measured different aspects of short-latency somatosensory evoked potentials. The task force did not consider the identified evidence sufficient to warrant a full SysRev.

Biomarkers for Post–Cardiac Arrest Neuroprognostication (ALS 3512)

- Intervention: Index test based on biomarkers (glial fibrillary acidic protein, tau protein, neurofilament light chain, and neuron-specific enolase)

Summary of Evidence

Glial Fibrillary Acidic Protein and Tau Protein

Five observational studies[284,297-300] were identified in the search examining glial fibrillary acidic protein. Studies ranged from 77 to 717 patients measuring glial fibrillary acidic protein at a variety of timepoints after ROSC. Three observational studies[284,298,300] measured tau protein at different timepoints after ROSC.

Neurofilament Light Chain

4 secondary analyses of previous RCTs[289,299,301,302] and 3 observational studies[300,303,304] (retrospective and prospective) were included as relevant ranging from 48 to 428 patients.

Studies measured neurofilament light chain at different timepoints from 12 to 72 hours after ROSC.

Neuron-Specific Enolase

One secondary analysis of a previous RCT,[289] 2 post hoc analyses of prospective studies,[302,305] and 12 observational cohort studies[269,284,285,306-314] (retrospective and prospective) were included ranging from 66 to 623 patients. Neuron-specific enolase values were measured between admission and 96 hours after ROSC using a variety of biomarker thresholds for prognostication.

The task force did not consider the identified evidence sufficient to warrant a full SysRev.

Clinical Examination for Post–Cardiac Arrest Neuroprognostication (ALS 3513)

- Intervention: Index test based on clinical examination
- Comparator: The accuracy of the index test was assessed by comparing the predicted outcome with the final patient outcome.

Summary of Evidence

One substudy of a previous RCT[315] and 7 observational cohort studies[280,285,286,292,295,316,317] (prospective and retrospective) were identified in the search. Four studies examined pupillary light reflexes,[280,286,292,295] 3 examined automated pupillometry,[315-317] 3 studies examined corneal reflexes,[280,286,292] and 2 studies examined the presence of myoclonus or status myoclonus.[285,292] The task force did not consider the identified evidence sufficient to warrant a full SysRev.

Treatment Recommendations (2020)

General

We recommend that neuroprognostication always be undertaken by using a multimodal approach because no single test has sufficient specificity to eliminate false positives (strong recommendation, very low–certainty evidence).

Imaging

We suggest using gray-white matter ratio on brain CT for predicting neurological outcome of adults who are comatose after cardiac arrest (weak recommendation, very low–certainty evidence). However, no gray-white matter ratio threshold for 100% specificity can be recommended.

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 apparent diffusion coefficient on brain MRI for predicting neurological outcome of adults who are comatose after cardiac arrest (weak recommendation, very low–certainty evidence).

Neurophysiological Tests

We suggest using a bilaterally absent N20 wave of short-latency somatosensory evoked potential in combination with other indices to predict poor outcome in adult patients who are comatose after cardiac arrest (weak recommendation, very low–certainty evidence).

We suggest against using the absence of EEG background reactivity alone to predict poor outcome in adult patients who are comatose after cardiac arrest (weak recommendation, very low–certainty evidence).

We suggest using the presence of seizure activity on EEG in combination with other indices to predict poor outcome in adult patients who are comatose after cardiac arrest (weak recommendation, very low–certainty evidence).

We suggest using burst suppression on EEG in combination with other indices to predict poor outcome in adult patients who are comatose and effects of sedation after cardiac arrest have cleared (weak recommendation, very low–certainty evidence).

Biomarkers

We suggest using neuron-specific enolase within 72 hours 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.

We suggest against using S-100B protein for predicting neurological outcome of adults who are comatose after cardiac arrest (weak recommendation, low-certainty evidence).

We suggest against using serum values of glial fibrillary acidic protein, serum tau protein, or neurofilament light chain for predicting poor neurological outcome of adults who are comatose after cardiac arrest (weak recommendation, very low–certainty evidence).

Clinical Examination

We suggest using pupillary light reflex at 72 hours or more 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 hours or more 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 hours or more 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 days after ROSC, in combination with other tests, for predicting poor 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 Favorable Neurological Outcome in Patients With ROSC After Cardiac Arrest (ALS 3529–3532 SysRev Adolopment 2023)

Prognostication of favorable neurological outcome in patients with ROSC after cardiac arrest was addressed by a 2021 SysRev and can be found in the 2023 CoSTR summary.[22,318] This review was based on adolopment of a previously published SysRev.[319]

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

- Population: Adults (≥16 years) who are comatose after resuscitation from cardiac arrest in any setting (in-hospital or out-of-hospital) regardless of target temperature
- Intervention: Any prognostication marker such as Glasgow Coma Scale motor score, imaging studies, biomarkers, EEG, somatosensory evoked potentials
- Comparator: None
- Outcome: Critical—Good neurological outcome defined as Cerebral Performance Category score of 1 or 2 or modified Rankin Scale score of 1 to 3 at hospital discharge, 1 month, or later
- Study designs: Prognostic accuracy studies for which the 2×2 contingency table (ie, number of true/false negatives and true/false positives for prediction of poor outcome)

was reported or for which those variables could be calculated from reported data were eligible for inclusion; unpublished studies, reviews, case reports, case series, studies including <10 patients, letters, editorials, and conference abstracts and studies published in abstract form were excluded.

- Time frame: The original SysRev was conducted on October 31, 2021, and the search was updated on May 20, 2022.

Treatment Recommendations (2023)

Glasgow Coma Scale Motor Score

We suggest assessing the Glasgow Coma Scale motor score in the first 4 days after cardiac arrest to identify patients with a score >3, which may indicate an increased likelihood of favorable outcome (weak recommendation, very low–certainty evidence).

Imaging Studies

We suggest using the absence of diffusion restriction on MRI between 72 hours and 7 days after ROSC, in combination with other tests, for predicting good neurological outcome of adults who are comatose after cardiac arrest (weak recommendation, very low–certainty evidence).

We suggest against using gray-white matter ratio, quantitative regional abnormality, and Alberta Stroke Program Early CT Score on brain CT to predict good neurological outcome in patients who are comatose after cardiac arrest (weak recommendation, very low–certainty evidence).

We suggest against using apparent diffusion coefficient on brain MRI to predict good neurological outcome in patients who are comatose after cardiac arrest (weak recommendation, very low–certainty evidence).

We suggest against using gradient-recalled echo on brain MRI to predict good neurological outcome in patients who are comatose after cardiac arrest (weak recommendation, very low–certainty evidence).

Brain Biomarkers

We suggest using normal neuron-specific enolase (<17 ug/L) within 72 hours after ROSC, in combination with other tests, for predicting favorable neurological outcome in adults who are comatose after cardiac arrest (weak recommendation, very low–certainty evidence).

We suggest against using serum levels of glial fibrillary acidic protein, serum tau protein, or neurofilament light chain in clinical practice for predicting favorable neurological outcome in adults who are comatose after cardiac arrest (weak recommendation, very low–certainty evidence).

Electroencephalogram

We suggest using a continuous or nearly continuous normal-voltage EEG background without periodic discharges or seizures within 72 hours from ROSC in combination with other indices to predict good outcome in patients who are comatose after cardiac arrest (weak recommendation, very low–certainty evidence).

There is insufficient evidence to recommend for or against using a low-voltage or a discontinuous EEG background on days 0 to 5 from ROSC to predict good neurological outcome after cardiac arrest (weak recommendation, very low–certainty evidence).

We suggest using American Clinical Neurophysiology Society definitions for favorable EEG patterns when using these to predict good neurological outcome after cardiac arrest (weak recommendation, very low–certainty evidence).

We suggest against the use of other EEG metrics, including reduced montage or amplitude-integrated EEG, bispectral index, or EEG-derived indices, to predict good outcome in patients who are comatose after cardiac arrest (weak recommendation, very low–certainty evidence).

We suggest that the American Clinical Neurophysiology Society terminology be used to classify the EEG patterns used for prognostication (good practice statement).

Somatosensory Evoked Potentials

We suggest against using the amplitude of the N20 short-latency somatosensory evoked potential wave to predict good neurological outcome of adults who are comatose after cardiac arrest (weak recommendation, very low–certainty evidence).

Organ Donation After Cardiac Arrest (ALS 3600, SysRev 2025)

Rationale for Review

The effect of preceding cardiac arrest and CPR in the donor on graft function of the donated organs is not well understood. This topic was previously reviewed for the 2015 CoSTR and an ILCOR scientific statement was made in 2023.[3,32,320-322] A SysRev was undertaken for 2025, and it was registered at PROSPERO (CRD42024599459) prior to undertaking the search. The full CoSTR can be found on the ILCOR website.[323]

Population, Intervention, Comparator, Outcome, and Time Frame

- Population: Adults and children receiving solid organ transplantation in any setting
- Intervention: Transplantation of an organ retrieved from a donor who, following cardiac arrest, received CPR (eg, donation after initial successful CPR or after unsuccessful CPR)
- Comparator: Transplantation of an organ retrieved from a donor who did not receive CPR

- Outcome: Graft function or recipient survival at 30 days, 1 year, or the longest available follow-up
- Time frame: All years to November 1, 2024

Consensus on Science

Thirty-four observational studies were identified, grouped by the donated organ (Table 3). Twenty-three studies included adults only, 6 included children only, and 6 included adults and children. The outcomes among recipients receiving organs from brain-dead donors with prior CPR were compared with those receiving organs from dead donors who had not had prior CPR in 28 studies. Recipient outcomes following uncontrolled donation after circulatory death were compared with donation from brain-dead donors without prior CPR in 6 studies. One study compared outcomes among recipients receiving organs from uncontrolled donation after circulatory death with those receiving organs from controlled donation after circulatory death without prior CPR.

Complete results are included in the online CoSTR. Overall, for all organ grafts studied there was no significant difference in graft function or recipient survival with organs from donors who had received CPR before donation, compared with donors who had not received CPR. Evidence for the critical outcome of graft function or recipient survival at the longest available follow-up is presented in Table 3. The longest available follow-up varied considerably across studies, from days to years. Results for other outcomes, including subgroup analyses, can be found in the online CoSTR.

Table 3. Effect of Receiving a Donated Organ From a Donor Who Received CPR Compared With a Donor Not Receiving CPR on Graft Function or Recipient Survival at the Longest Available Follow-Up*

Donated organ	Studies (participants), n	Odds ratio (95% CI)	Certainty of evidence
Heart	12[324-335] (48 371)	1.07 (0.86–1.33)	Very low
Lung	2[336,337] (1194)	1.82 (0.37–9.11)	Very low
Kidney	10[330,338-346] (16 405)	0.98 (0.73–1.30)	Very low
Pancreas	4[330,344,347,348] (14 559)	1.04 (0.87–1.25)	Very low
Liver	9[338,349-356] (6714)	0.90 (0.70–1.16)	Very low

Intestine	1[357] (67)	1.11 (0.21–5.88)	Very low

*Longest available follow-up ranged from 7 days to 15 years. In most cases, some studies included adults and some included children, while others included both.
CI indicates confidence interval.

Treatment Recommendation (2025, Unchanged From 2015)

We recommend that all patients who have restoration of circulation after CPR and who subsequently progress to death be evaluated for organ donation (strong recommendation, low-certainty evidence).

Justification and Evidence-to-Decision Framework Highlights

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

The suitability of organs for donation is based on criteria established by the transplantation team. This review suggests that, once these criteria are met, transplant organ outcomes are similar regardless of whether the donors have had CPR or not before donation.

Despite the low-certainty evidence, the task force has made a strong recommendation, valuing ensuring that those waiting for a donated organ can benefit from organs donated by those who die after CPR, given that many studies show organ function and recipient outcomes are similar when comparing donors who received CPR and donors who did not.

Seven of the 35 studies in this review compared the outcomes of kidneys and livers transplanted from patients who died after unsuccessful resuscitation (uncontrolled donors after cardiac death; Maastricht category II) with those of organs transplanted from donors after death by neurological criteria (donors after brain death; 6 studies)[339,340,342,346,350,351] or from donors who die by cardiac criteria after life-sustaining treatment is suspended because of futility (controlled donors after cardiac death: Maastricht category III; 1 study).[345] In these studies, the outcomes of organs transplanted from uncontrolled donors after cardiac deaths at 1 month and 1 year were significantly worse than in the comparator group.

In uncontrolled donors after cardiac death studies, the donors' witnessed status was not always explicitly reported. Consequently, there was a chance that some donors were unrecoverable at the arrival of the treating team (found dead) and that resuscitation was started only with the aim of potential donation (Maastricht category I). Because of this inconsistency, the task force decided not to make any recommendation regarding uncontrolled organ donors.

Knowledge Gaps

- Future controlled studies that more clearly distinguish between donors who received CPR and then progressed to brain death after ROSC and those who were brain dead and then received CPR before organ retrieval
- Reliable data on donation from controlled donation after circulatory death because this is probably underreported
- Data on rate of donation after cardiac arrest
- There are no established criteria to identify the potential for donation in patients who die after CPR.

Topics Updated by EvUp Only From 2021 to 2025

- Administration of fibrinolytics post–cardiac arrest (ALS 3520)
- Administration of fibrinolytics during cardiac arrest (ALS 3203)
- Administration of atropine during cardiac arrest (ALS 3206)
- Cardiac arrest associated with asthma (ALS 3408, EvUp 2024)

Topics Not Updated in 2021 to 2025

- Administration of IV fluids post–cardiac arrest (ALS 3518)
- Use of standardized treatment protocols post–cardiac arrest (ALS 3521)
- Administration of IV fluids during cardiac arrest (ALS 3207)
- Oxygen concentration during CPR (ALS 3305)

- Use of automatic ventilators during cardiac arrest (ALS 3306)
- Ventilation rate during continuous chest compressions (ALS 3307)
- Defibrillation strategies for VF/pVT (ALS 3100)
- Cardioversion strategies with an implantable cardioverter defibrillator or pacemaker (ALS 3101)
- Automated external defibrillator versus manual defibrillation (ALS 3102)
- Use of adhesive pads versus paddles for defibrillation (ALS 3103)
- Waveform analysis for predicting successful defibrillation (ALS 3104)
- Use of anticipatory charging during defibrillation (ALS 3105)
- Use of impedance threshold device curing CPR (ALS 3000)
- Cardiac arrest associated with electrolyte disturbances (except for hyperkalemia) (ALS 3402)
- Cardiac arrest associated with cardiac tamponade (ALS 3405)
- Cardiac arrest in avalanche victims (ALS 3407)
- Cardiac arrest associated with anaphylaxis (ALS 3409)
- Toxicological causes of cardiac arrest (ALS 3450, 3452, 3453, 3454, 3455, 3456, 3457, 3458, 3459)
- Use of end-tidal carbon dioxide to predict outcome of cardiac arrest (ALS 3601)
- Monitoring physiologic parameters during CPR (ALS 3602)
- Prediction rule for in-hospital cardiac arrest outcomes (ALS 3605)

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