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Part 1: Executive summary 2015 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations☆,☆☆

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Toward international consensus on science

The International Liaison Committee on Resuscitation (ILCOR) was formed in 1993 and currently includes representatives from the American Heart Association (AHA), the European Resuscitation Council, the Heart and Stroke Foundation of Canada, the Australian and New Zealand Committee on Resuscitation, the Resuscitation Council of Southern Africa, the InterAmerican Heart Foundation, and the Resuscitation Council of Asia. The ILCOR mission is to identify and review international science and information relevant to cardiopulmonary resuscitation (CPR) and emergency cardiovascular care (ECC) and to offer consensus on treatment recommendations. ECC includes all responses necessary to treat sudden life-threatening events affecting the cardiovascular and respiratory systems, with a particular focus on sudden cardiac arrest. For this 2015 consensus publication, ILCOR also included first aid topics in its international review and consensus recommendations.

In 1999, the AHA hosted the first ILCOR conference to evaluate resuscitation science and develop common resuscitation guidelines. The conference recommendations were published in the *Guidelines 2000 for CPR and ECC.*[1] Since 2000, researchers from the ILCOR member councils have evaluated and reported their International Consensus on CPR and ECC Science With Treatment Recommendations (CoSTR) in 5-year cycles. The conclusions and recommendations of the 2010 CoSTR were published at the end of 2010.[2,3] Since that time, ILCOR meetings and webinars have continued to identify and evaluate resuscitation science. The most recent ILCOR 2015 International Consensus Conference on CPR and ECC Science With Treatment Recommendations was held in Dallas in February 2015, and this publication contains the consensus science statements and treatment recommendations developed with input

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from the ILCOR task forces, the invited participants, and public comment.

The Parts of this CoSTR publication include a summary of the ILCOR processes of evidence evaluation and management of potential or perceived conflicts of interest, and then reports of the consensus of the task forces on adult basic life support (BLS; including CPR quality and use of an automated external defibrillator [AED]); advanced life support (ALS; including post-cardiac arrest care); acute coronary syndromes (ACS); pediatric BLS and ALS; neonatal resuscitation; education, implementation, and teams (EIT); and first aid.

The 2015 CoSTR publication is not a comprehensive review of every aspect of resuscitation medicine; not all topics reviewed in 2010 were rereviewed in 2015. This Executive Summary highlights the evidence evaluation and treatment recommendations of this 2015 evidence evaluation process. Not all relevant references are cited here, because the detailed systematic reviews are included in the individual Parts of the 2015 CoSTR publication.

A list of all topics reviewed can be found in Appendix A.

Evidence evaluation process

The 2015 evidence evaluation process started in 2012 when ILCOR representatives formed 7 task forces: BLS, ALS, ACS, pediatric BLS and ALS, neonatal resuscitation, EIT, and, for the first time, first aid. Each task force performed detailed systematic reviews based on the recommendations of the Institute of Medicine of the National Academies,[4] and the criteria of a measurement tool to assess systematic reviews (AMSTAR).[5] The task forces used the methodologic approach for evidence evaluation and development of recommendations proposed by the Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) Working Group.[6] Each task force identified and prioritized the questions to be addressed (using the PICO [population, intervention, comparator, outcome] format)[7] and identified and prioritized the outcomes to be reported. Then, with the assistance of information scientists, a detailed search for relevant articles was performed in each of 3 online databases (PubMed, Embase, and the Cochrane Library).

By using detailed inclusion and exclusion criteria, articles were screened for further evaluation. The reviewers for each question created a reconciled risk of bias assessment for each of the included studies, using state-of-the-art tools: Cochrane for randomized controlled trials (RCTs),[8] Quality Assessment of Diagnostic Accuracy Studies (QUADAS)-2 for studies of diagnostic accuracy,[9] and GRADE for observational studies that inform both therapy and prognosis questions.[10]

Using the online GRADE Guideline Development Tool, the evidence reviewers created evidence profile tables[11] to facilitate evaluation of the evidence in support of each of the critical and important outcomes. The quality of the evidence (or confidence in the estimate of the effect) was categorized as high, moderate, low, or very low,[12] based on the study methodologies and the 5 core GRADE domains of risk of bias, inconsistency, indirectness, imprecision, and publication bias (and occasionally other considerations).[6]

These evidence profile tables were then used to create a written summary of evidence for each outcome (the Consensus on Science statements). These statements were drafted by the evidence reviewers and then discussed and debated by the task forces until consensus was reached. Whenever possible, consensus-based treatment recommendations were created. These recommendations (designated as strong or weak and either for or against a therapy or diagnostic test) were accompanied by an overall assessment of the evidence, and a statement from the task force about the values and preferences that underlie the recommendations. Further details of the methodology of the evidence evaluation process are found in "Part 2: Evidence Evaluation and Management of Conflicts of Interest."

This summary uses wording consistent with the wording recommended by GRADE and used throughout this publication. Weak recommendations use the word *suggest*, as in, "We suggest. . .." Strong recommendations are indicated by the use of the word *recommend*, as in, "We recommend. . .."

In the years 2012–2015, 250 evidence reviewers from 39 countries completed 169 systematic reviews addressing resuscitation or first aid questions. The ILCOR 2015 Consensus Conference was attended by 232 participants representing 39 countries; 64% of the attendees came from outside the United States. This participation ensured that this final publication represents a truly international consensus process.

Many of the systematic reviews included in this 2015 CoSTR publication were presented and discussed at monthly or semimonthly task force webinars as well as at the ILCOR 2015 Consensus Conference. Public comment was sought at 2 stages in the process. Initial feedback was sought about the specific wording of the PICO questions and the initial search strategies, and subsequent feedback was sought after creation of the initial draft consensus on science statements and treatment recommendations.[13] A total of 492 comments were received. At each of these points in the process, the public comments were made available to the evidence reviewers and task forces for their consideration.

With the support of science and technology specialists at the AHA, a Web-based information system was built to support the creation of scientific statements and recommendations. An online platform known as the Scientific Evaluation and Evidence Review System (SEERS) was developed to guide the task forces and their individual evidence reviewers. The SEERS system was also used to capture public comments and suggestions.

To provide the widest possible dissemination of the science reviews performed for the 2015 consensus, as noted above, the list of completed systematic reviews is included in Appendix A. In addition, in each Part of the 2015 CoSTR document, each summary of the consensus on science and the treatment recommendations contains a live link to the relevant systematic review on the SEERS site. This link is identified by 3 or 4 letters followed by 3 numbers. These systematic reviews will be updated as additional science is published.

This publication was ultimately approved by all ILCOR member organizations and by an international editorial board (listed on the title page of this supplement). The AHA Science Advisory and Coordinating Committee and the Editor-in-Chief of *Circulation* obtained peer reviews of each Part of this supplement before it was accepted for publication. The supplement is being published online simultaneously by *Circulation* and *Resuscitation*.

Management of potential conflicts of interest

A rigorous conflict of interest (COI) management policy was followed at all times and is described in more detail in "Part 2: Evidence Evaluation and Management of Conflicts of Interest" of this 2015 CoSTR. A full description of these policies and their implementation can be found in "Part 4: Conflict of Interest Management Before, During, and After the 2010 International Consensus Conference on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations" in the 2010 CoSTR.[14] As in 2010, anyone involved in any part of the 2015 process disclosed all commercial relationships and other potential conflicts; in total, the AHA processed more than 1000 COI declarations. These disclosures were taken into account in assignment of task force co-chairs and members, writing group co-chairs, and other leadership roles. In keeping with the

AHA COI policy, a majority of the members of each task force writing group had to be free of relevant conflicts. Relationships were also screened for conflicts in assigning evidence reviewers for each systematic review.

As in 2010, dual-screen projection was used for all sessions of the ILCOR 2015 Consensus Conference. One screen displayed the presenter's COI disclosures continuously throughout his or her presentation. Whenever participants or task force members spoke, their relationships were displayed on one screen, so all participants could see potential conflicts in real time, even while slides were projected on the second screen. During all other ILCOR meetings and during all conference calls and webinars, relevant conflicts were declared at the beginning of each meeting and preceded any comments made by participants with relevant conflicts.

Applying science to improve survival

From consensus on science to guidelines

This publication presents international consensus statements that summarize the science of resuscitation and first aid and, wherever possible, treatment recommendations. ILCOR member organizations will subsequently publish resuscitation guidelines that are consistent with the science in this consensus publication, but they will also take into account geographic, economic, and system differences in practice and the availability of medical devices and drugs and the ease or difficulty of training. All ILCOR member organizations are committed to minimizing international differences in resuscitation practice and to optimizing the effectiveness of resuscitation practice, instructional methods, teaching aids, and training networks.

The recommendations of the ILCOR 2015 Consensus Conference confirm the safety and effectiveness of various current approaches, acknowledge other approaches as ineffective, and introduce new treatments resulting from evidence-based evaluation. *New and revised treatment recommendations do not imply that clinical care that involves the use of previously published guidelines is either unsafe or ineffective.* Implications for education and retention were also considered when developing the final treatment recommendations.

Ischemic heart disease is the leading cause of death in the world,[15] and in the United States cardiovascular disease is responsible for 1 in 3 deaths, approximately 786 641 deaths every year.[16] Annually in the United States, there are approximately 326 200 out-of-hospital cardiac arrests (OHCAs) assessed by emergency medical services (EMS) providers, and there are an additional estimated 209 000 treated in-hospital cardiac arrests (IHCAs).[16] There are no significant differences between Europe, North America, Asia, and Australia in the incidence of OHCA. The incidence of patients with OHCA considered for resuscitation is lower in Asia (55 per year per 100 000 population) than in Europe (86), North America (103), and Australia (113).[17] The incidence of patients in OHCA with presumed cardiac cause in whom resuscitation was attempted is higher in North America (58 per 100 000 population) than in the other 3 continents (35 in Europe, 32 in Asia, and 44 in Australia).[17] However, most victims die out of hospital without receiving the interventions described in this publication.

The actions linking the adult victim of sudden cardiac arrest with survival are characterized as the adult Chain of Survival. The links in this Chain of Survival are early recognition of the emergency and activation of the EMS system, early CPR, early defibrillation, early ALS, and skilled post–cardiac arrest/postresuscitation care. The links in the infant and child Chain of Survival are prevention of conditions leading to cardiopulmonary arrest, early CPR, early activation of the EMS system, early ALS, and skilled post–cardiac arrest/postresuscitation care.

Newest developments in resuscitation: 2010–2015

There is good evidence that survival rates after OHCA are improving.[18–22] This is particularly true for those cases of witnessed arrest when the first monitored rhythm is shockable (i.e., associated with ventricular fibrillation [VF] or pulseless ventricular tachycardia [pVT]), but increases in survival from nonshockable rhythms are also well documented.[23] These improvements in survival have been associated with the increased emphasis on CPR quality as well as improved consistency in the quality of post-cardiac arrest/post resuscitation care.

Each task force identified important developments in resuscitation science since the publication of the 2010 CoSTR. These developments are noted in brief below. After the brief list of developments, summaries of the evidence reviews are organized by task force.

Adult basic life support

The following is a summary of the most important evidence-based recommendations for performance of adult BLS:

- The EMS dispatcher plays a critical role in identifying cardiac arrest, providing CPR instructions to the caller, and activating the emergency response.[24–28]
- The duration of submersion is a key prognostic factor when predicting outcome from drowning.[29–40]
- The fundamental performance metrics of high-quality CPR remain the same, with an emphasis on compressions of adequate rate and depth, allowing full chest recoil after each compression, minimizing pauses in compressions, and avoiding excessive ventilation. Some additional registry data suggest an optimal range for compression rate and depth.[41,42]
- Public access defibrillation programs providing early defibrillation have the potential to save many lives if the programs are carefully planned and coordinated.[43–55]

Advanced life support

The most important developments in ALS included the publication of additional studies of the effects of mechanical CPR devices, drug therapy, and insertion of advanced airway devices on survival from cardiac arrest. In addition, the task force evaluated several studies regarding post-cardiac arrest care and the use of targeted temperature management (TTM).

- The evidence in support of mechanical CPR devices was again reviewed. Three large trials of mechanical chest compression devices[56–58] enrolling 7582 patients showed outcomes are similar to those resulting from manual chest compressions. While these devices should not routinely replace manual chest compressions, they may have a role in circumstances where high-quality manual compressions are not feasible.
- The Executive Summary for the 2010 CoSTR[2,3] noted the insufficient evidence that drug administration improved survival from cardiac arrest. The 2015 systematic review identified large observational studies that challenged the routine use of advanced airways[59–65] and the use of epinephrine[66–68] as part of ALS. Because of the inherent risk of bias in observational studies, these data did not prompt a recommendation to change practice but do provide sufficient equipoise for large RCTs to test whether advanced airways and epinephrine are helpful during CPR.
- Post-cardiac arrest care is probably the area of resuscitation that has undergone the greatest evolution since 2010, with substantial potential to improve survival from cardiac arrest. Recent improvements include further delineation of the effects, timing, and components of TTM, and awareness of the need to control

oxygenation and ventilation and optimize cardiovascular function.

- The effect and timing of TTM continues to be defined by many studies published after 2010. One high-quality trial could not demonstrate an advantage to a temperature goal of either 33 °C or 36 °C for TTM,[69] and 5 trials could not identify any benefit from prehospital initiation of hypothermia with the use of cold intravenous fluids.[70–74] The excellent outcomes for all patients in these trials reinforced the opinion that post-cardiac arrest patients should be treated with a care plan that includes TTM, but there is uncertainty about the optimal target temperature, how it is achieved, and for how long temperature should be controlled.

Acute coronary syndromes

The following are the most important evidenced-based recommendations for diagnosis and treatment of ACS since the 2010 ILCOR review:

- Prehospital ST-segment elevation myocardial infarction (STEMI) activation of the catheterization laboratory reduces treatment delays and also improves patient mortality.
- Adenosine diphosphate receptor antagonists and unfractionated heparin (UFH) can be given either prehospital or in-hospital for suspected STEMI patients with a planned primary percutaneous coronary intervention (PCI) approach.
- Prehospital enoxaparin may be used as an alternative to prehospital UFH as an adjunct for primary PCI for STEMI. There is insufficient evidence to recommend prehospital bivalirudin as an alternative.
- The use of troponins at 0 and 2 h as a stand-alone measure for excluding the diagnosis of ACS is strongly discouraged.
- We recommend against using troponins alone to exclude the diagnosis of ACS. We suggest that negative high-sensitivity troponin I (hs-cTnI) measured at 0 and 2 hours may be used together with low-risk stratification or negative cardiac troponin I (cTnI) or cardiac troponin T (cTnT) measured at 0 and 3 to 6 hours with very-low risk stratification to identify those patients who have a less than 1% 30-day risk of a major adverse high-sensitivity cardiac troponin I (hs-cTnI) cardiac event (MACE).
- We suggest withholding oxygen in normoxic patients with ACS.
- Primary PCI is generally preferred to fibrinolysis for STEMI reperfusion, but that decision should be individualized based on time from symptom onset (early presenters), anticipated time (delay) to PCI, relative contraindications to fibrinolysis, and other patient factors.
- For adult patients presenting with STEMI in the emergency department (ED) of a non-PCI-capable hospital, either transport expeditiously for primary PCI (without fibrinolysis) or administer fibrinolysis and transport early for routine angiography in the first 3 to 6 h (or up to 24 h).
- For select adult patients with return of spontaneous circulation (ROSC) after OHCA of suspected cardiac origin with ST-elevation on electrocardiogram (ECG), we recommend emergency cardiac catheterization laboratory evaluation (in comparison with delayed or no catheterization). In select comatose adult patients with ROSC after OHCA of suspected cardiac origin but without ST-elevation on ECG, we suggest emergency cardiac catheterization evaluation.

Pediatric basic and advanced life support

The most important new developments in pediatric resuscitation since 2010 include the publication of the results of a study of TTM in children following ROSC after OHCA. Additional new developments include refinement of long-standing recommendations regarding fluid therapy and antiarrhythmics. These new developments are summarized here:

- When caring for children remaining unconscious after OHCA, outcomes are improved when fever is prevented, and a period of moderate therapeutic hypothermia or strict maintenance of normothermia is provided.[75]
- The use of restricted volumes of isotonic crystalloid may lead to improved outcomes from pediatric septic shock in specific settings. When caring for children with febrile illnesses (especially in the absence of signs of overt septic shock), a cautious approach to fluid therapy should be used, punctuated with frequent patient reassessment.[76]
- The use of lidocaine or amiodarone for treatment of shock-resistant pediatric VF/pVT improves short-term outcomes, but there remains a paucity of information about their effects on long-term outcomes.[77]

Neonatal resuscitation

The Neonatal Task Force identified new information about the association between admission temperature in newly born infants and morbidity and mortality, evaluated new evidence regarding the role of routine intubation of nonvigorous infants born through meconium-stained amniotic fluid, and new evaluated evidence regarding the use of the ECG to assess heart rate. The systematic reviews of these topics will result in new recommendations.

- The admission temperature of newly born nonasphyxiated infants is a strong predictor of mortality and morbidity at all gestations. For this reason, it should be recorded as a predictor of outcomes as well as a quality indicator.[78–82]
- There is insufficient published human evidence to suggest routine tracheal intubation for suctioning of meconium in nonvigorous infants born through meconium-stained amniotic fluid as opposed to no tracheal intubation for suctioning.[83]
- It is suggested in babies requiring resuscitation that the ECG can be used to provide a rapid and accurate estimation of heart rate.[84–86]

Education, Implementation, and Teams

The most noteworthy reviews or changes in recommendations for EIT since the last ILCOR review in 2010 pertain to training and the importance of systems of care focused on continuous quality improvement.

Training

It is now recognized that training should be more frequent and less time consuming (high frequency, low dose) to prevent skill degradation; however, the evidence for this is weak.

- High-fidelity manikins may be preferred to standard manikins at training centers/organizations that have the infrastructure, trained personnel, and resources to maintain the program.
- The importance of performance measurement and feedback in cardiac arrest response systems (in-hospital and out-of-hospital) is well recognized but remains supported by data of low quality. CPR feedback devices (providing directive feedback) are useful to learn psychomotor CPR skills.
- Retraining cycles of 1 to 2 years are not adequate to maintain competence in resuscitation skills. The optimal retraining intervals are yet to be defined, but more frequent training may be helpful for providers likely to encounter a cardiac arrest.

Systems

- You can't improve what you don't measure, so systems that facilitate performance measurement and quality improvement initiatives are to be used where possible.
- Data-driven, performance-focused debriefing can help improve performance of resuscitation teams.
- There is increasing evidence (albeit of low quality) that treatment of post-cardiac arrest patients in regionalized cardiac arrest centers is associated with increased survival.[87,88] OHCA victims should be considered for transport to a specialist cardiac arrest center as part of a wider regional system of care.
- Advances in the use of technology and social media for notification of the occurrence of suspected OHCA and sourcing of bystanders willing to provide CPR. The role of technology/social media in the bystander CPR response for OHCA is evolving rapidly.

First aid

The First Aid Task Force reviewed evidence on the medical topics of stroke assessment, treatment of hypoglycemia in patients with diabetes, and on the injury topics of first aid treatment of open chest wounds and severe bleeding and on identification of concussion.

- The single most important new treatment recommendation of the 2015 International Consensus on First Aid Science With Treatment Recommendations is the recommendation in favor of the use of stroke assessment systems by first aid providers to improve early identification of possible stroke and enable subsequent referral for definitive treatment. The FAST (Face, Arm, Speech, Time)[89,90] tool and the Cincinnati Prehospital Stroke Scale[91] are recommended, with the important caveat that recognition specificity can be improved by including blood glucose measurement.
- First aid providers are often faced with the signs and symptoms of hypoglycemia. Failure to treat this effectively can lead to serious consequences such as loss of consciousness and seizures. The 2015 CoSTR recommends the administration of glucose tablets for conscious individuals who can swallow. If glucose tablets are not immediately available, then recommendations for various substitute forms of dietary sugars have been made.[92–94]
- The recommendation for the management of open chest wounds by not using an occlusive dressing or device, or any dressing or device that may become occlusive, emphasizes the inherent serious life-threatening risk of creating a tension pneumothorax.[95]
- Recommendations for the management of severe bleeding include the use of direct pressure, hemostatic dressings,[96–99] and tourniquets.[100–106] However, formal training in the use of hemostatic dressings and tourniquets will be required to ensure their effective application and use.
- The 2015 First Aid Task Force recommends the development of a simple validated concussion scoring system for use by first aid providers in the accurate identification and management of concussion (minor traumatic brain injury), a condition commonly encountered by first aid providers in the prehospital environment.

Summary of the 2015 ILCOR consensus on science with treatment recommendations

The following sections contain summaries of the key systematic reviews of the 2015 CoSTR. These summaries are organized by task force. Note that there are few references cited in the summaries; we refer the reader to the detailed information prepared by each task force in other Parts of the 2015 CoSTR.

Adult basic life support

The ILCOR 2015 Consensus Conference addressed intervention, diagnostic, and prognostic questions related to the performance of BLS. The body of knowledge encompassed in this Part comprises 23 systematic reviews, with 32 treatment recommendations, derived from a GRADE evaluation of 27 randomized clinical trials and 181 observational studies of variable design and quality conducted over a 35-year period. These have been grouped into (1) early access and cardiac arrest prevention, (2) early high-quality CPR, and (3) early defibrillation.

Early access and cardiac arrest prevention

Early access for the victim of OHCA begins when a bystander contacts the EMS dispatcher, who then coordinates the emergency response to that cardiac arrest. The dispatcher's role in identifying possible cardiac arrest, dispatching responders, and providing instructions to facilitate bystander performance of chest compressions has been demonstrated in multiple countries with consistent improvement in cardiac arrest survival. Dispatchers should be educated to identify unconsciousness with abnormal breathing. This education should include recognition of, and significance of, agonal breaths across a range of clinical presentations and descriptions. If the victim is unconscious with abnormal or absent breathing, it is reasonable to assume that the patient is in cardiac arrest at the time of the call. On the basis of these assessments, dispatchers should provide instructions to callers for compression-only CPR for adults with suspected OHCA.

Two systematic reviews involved cardiac arrest prevention: one addressed deployment of search-and-rescue operations for drowning, and the other addressed education regarding opioid-associated life-threatening emergencies. In reviewing the evidence to support the rational and judicious deployment of search-and-rescue operations for drowning victims, evidence demonstrates that submersion duration can be used to predict outcome. In contrast, age, EMS response interval, water type (fresh/salt), water temperature, and witness status should not be used when making prognostic decisions. The systematic reviews in 2015 also demonstrated that rescuers should consider opioid overdose response education with or without naloxone distribution to persons at risk for opioid overdose in any setting.

Early high-quality cardiopulmonary resuscitation

Similar to the 2010 ILCOR BLS treatment recommendations, the importance of high-quality CPR was re-emphasized, with a goal of optimizing all measures of CPR quality, which include adequate compression rate and depth, allowing full chest recoil after each compression, minimizing interruptions in chest compressions, and avoiding excessive ventilation. The systematic reviews clearly showed that all rescuers should be providing chest compressions to all victims of cardiac arrest. Those with additional training, who are able and willing, should also give rescue breaths. Laypersons should initiate CPR for presumed cardiac arrest without concern of harm to patients not in cardiac arrest.

With respect to skills, laypersons and healthcare providers should compress the chest on the lower half of the sternum at a rate of at least 100 compressions per minute (not to exceed 120 compressions per minute) with a compression depth of approximately 2 inches (5 cm) while avoiding excessive chest compression depths of greater than 2.4 inches (6 cm) in an average-sized adult. All rescuers need to avoid leaning on the chest between compressions to allow full chest-wall recoil.

Rescuers must attempt to minimize the frequency and duration of interruptions in compressions to maximize the number of compressions actually delivered per minute. For adult patients receiving CPR with no advanced airway, the interruption of chest compressions for delivery of 2 breaths should be less than 10 s, and the chest compression fraction (i.e., total CPR time devoted to compressions) should be as high as possible, and at least 60%. Results from systematic reviews propose the use of real-time audiovisual feedback and prompt devices during CPR in clinical practice as part of a comprehensive system of care for patients in cardiac arrest.

With respect to sequencing, a compression-ventilation ratio of 30:2 is recommended, commencing CPR with compressions rather than ventilations, and pausing chest compressions every 2 min to assess the cardiac rhythm.

Other highlights in 2015 included evidence from EMS systems that use bundles of care focusing on providing high-quality, minimally interrupted chest compressions while transporting the patient from the scene of cardiac arrest to the hospital system of care. Where similar EMS systems* have adopted bundles of care involving minimally interrupted cardiac resuscitation,† the bundle of care is a reasonable alternative to conventional CPR for witnessed shockable OHCA.

The task force noted a large ongoing trial of continuous chest compressions by EMS staff compared with conventional (30 compressions to 2 breaths) CPR (https://clinicaltrials.gov/ct2/show/NCT01372748). Until the results of this study are available, based on the available evidence, it is reasonable for EMS systems that have already introduced bundles of care including minimally interrupted chest compressions to continue to use them for adult patients with a witnessed cardiac arrest and an initial shockable rhythm.

Early defibrillation

Rapid defibrillation with CPR is the treatment of choice for VF/pVT in the out-of-hospital and in-hospital settings. The 2015 CoSTR highlights the evidence surrounding the clinical benefit of the use of automatic external defibrillators in the out-of-hospital setting by laypeople and healthcare providers alike.

At the system level, one of the major 2015 highlights is the affirmation of the global importance of the implementation of public access defibrillation programs for patients with OHCAs.

At the rescuer level for an unmonitored cardiac arrest, the 2015 CoSTR advises a short period of CPR followed by rhythm analysis and shock delivery, if indicated, as soon as the defibrillator is ready for use. With respect to the timing of rhythm check, rescuers must resume chest compressions after shock delivery for adults in cardiac arrest in any setting. CPR should be continued for 2 min before reassessing for signs of life.

Advanced life support

The topics reviewed by the ILCOR ALS Task Force are grouped as follows: (1) defibrillation strategies for VF or pVT; (2) airway, oxygenation, and ventilation; (3) circulatory support during CPR; (4) physiologic monitoring during CPR; (5) drugs during CPR; (6) cardiac arrest in special circumstances; and (7) post resuscitation care.

The systematic reviews showed that the quality of evidence for many ALS interventions is low or very low, and this led to predominantly weak recommendations. For some issues, despite a low quality of evidence, the values and preferences of the task force led to a strong recommendation for an intervention. This was especially true when there was consensus that not undertaking the intervention could lead to harm. Treatment recommendations were left unchanged unless there were compelling reasons for a change. The rationale for any change is addressed in the values, preferences, and insights that follow treatment recommendations. The most important developments and recommendations in ALS since the 2010 ILCOR review are described below.

Defibrillation strategies for VF or pulseless VT

There were no major developments since 2010. We suggest that if the first shock is not successful and the defibrillator is capable of delivering shocks of higher energy, it is reasonable to increase the energy for subsequent shocks.

Airway, oxygenation, and ventilation

We suggest using the highest possible inspired oxygen concentration during CPR. The evidence showed equipoise between the choice of an advanced airway or a bag-mask device for airway management during CPR, and the choice between a supraglottic airway or tracheal tube as the initial advanced airway during CPR. The role of waveform capnography during ALS is emphasized, including to confirm and to continuously monitor the position of a tracheal tube during CPR.

Circulatory support during CPR

We recommend against the routine use of the impedance threshold device in addition to conventional CPR but could not achieve consensus for or against the use of the impedance threshold device when used together with active compression-decompression CPR. We suggest against the routine use of automated mechanical chest compression devices but suggest that they are a reasonable alternative to use in situations where sustained high-quality manual chest compressions are impractical or compromise provider safety. We suggest that extracorporeal CPR is a reasonable rescue therapy for selected patients with cardiac arrest when initial conventional CPR is failing in settings where this can be implemented.

Physiologic monitoring during CPR

Using physiologic measurement in addition to clinical signs and ECG monitoring has the potential to help guide interventions during ALS. We have not made a recommendation for any particular physiologic measure to guide CPR, because the available evidence would make any estimate of effect speculative. We recommend against using end-tidal carbon dioxide ($ETCO_2$) threshold or cutoff values alone to predict mortality or to decide to stop a resuscitation attempt. We suggest that if cardiac ultrasound can be performed without interfering with the standard advanced cardiovascular life support protocol, it may be considered as an additional diagnostic tool to identify potentially reversible causes of cardiac arrest.

Drug therapy during CPR

We suggest that standard-dose (defined as 1 mg) epinephrine be administered to patients in cardiac arrest after considering the observed benefit in short-term outcomes (ROSC and admission to hospital) and our uncertainty about the benefit or harm on survival to discharge and neurologic outcome. We suggest the use of amiodarone in adult patients with refractory VF/pVT to improve rates of ROSC. These statements are not intended to change current practice until there are high-quality data on long-term outcomes.

Cardiac arrest in special circumstances

The systematic review found a very low quality of evidence for specific interventions for ALS in pregnant women. We suggest delivery of the fetus by perimortem cesarean delivery for women in cardiac arrest in the second half of pregnancy. As a result of the lack of comparative studies, the task force is unable to make any evidence-based treatment recommendation about the use of intravenous lipid emulsion to treat toxin-induced cardiac arrest. We recommend the use of naloxone by intravenous, intramuscular, subcutaneous, intraosseous, or intranasal routes in respiratory arrest associated with opioid toxicity, but make no recommendation on modifying standard ALS in opioid-induced cardiac arrest.

Post-cardiac arrest care

We recommend avoiding hypoxia and also suggest avoiding hyperoxia in adults with ROSC after cardiac arrest. We suggest 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. We suggest maintaining the $Paco_2$ within a normal physiologic range as part of a post-ROSC bundle of care. We suggest that hemodynamic goals (e.g., mean arterial pressure, systolic blood pressure) be considered during postresuscitation care and as part of any bundle of postresuscitation interventions.

We recommend selecting and maintaining a constant target temperature between 32 °C and 36 °C for those patients in whom temperature control is used. In adults who remain unresponsive after OHCA, we recommend TTM for those with an initial shockable rhythm and suggest TTM for those with an initial nonshockable rhythm. We suggest TTM for adults with IHCA with any initial rhythm who remain unresponsive after ROSC. If TTM is used, we suggest a duration of at least 24 h. We recommend against routine use of prehospital cooling with rapid infusion of large volumes of cold intravenous fluid immediately after ROSC.

We suggest prevention and treatment of fever in persistently comatose adults after completion of TTM between 32 °C and 36 °C.

We recommend the treatment of seizures in post-cardiac arrest patients but suggest that routine seizure prophylaxis is not used in these patients. We suggest no modification of standard glucose management protocols for adults with ROSC after cardiac arrest.

In comatose post-cardiac arrest patients treated with TTM, we suggest that clinical criteria alone are not used to estimate prognosis after ROSC. We suggest prolonging the observation of clinical signs when interference from residual sedation or paralysis is suspected, to minimize results that inaccurately suggest a poor outcome. We recommend that the earliest time to prognosticate a poor neurologic outcome is 72 h after ROSC, and the interval should be extended longer if the residual effect of sedation and/or paralysis confounds the clinical examination. We suggest that multiple modalities of testing (clinical examination, neurophysiologic measures, imaging, or blood markers) be used to estimate prognosis instead of relying on single tests or findings.

We recommend that all patients who have restoration of circulation after CPR and who subsequently progress to death be evaluated as potential organ donors.

Acute coronary syndromes

The ACS Task Force reviewed the evidence related specifically to the diagnosis and treatment of ACS in the out-of-hospital setting and during the first hours of care in -hospital, typically in the ED. The topics reviewed by the ACS Task Force are grouped as follows: (1) diagnostic interventions in ACS, (2) therapeutic interventions in ACS, (3) reperfusion decisions in STEMI, and (4) hospital reperfusion decisions after ROSC. The most important developments and recommendations in ACS since the 2010 ILCOR review are described below.

Diagnostic interventions in ACS

Prehospital ECG acquisition may not only facilitate earlier diagnosis of STEMI and provide the opportunity for rapid prehospital and in-hospital reperfusion, but there is evidence of a substantial mortality benefit. We recommend prehospital 12-lead ECG acquisition with hospital notification for adult patients with suspected STEMI. Nonphysicians may perform ECG interpretation to recognize STEMI in a system where there is a strong initial education program, ongoing oversight, possible adjunctive computer interpretation, and a quality assurance program. The computer-assisted ECG interpretation can be used as an adjunct or in conjunction with the interpretation of a physician or other trained professional. In this way, recognition of STEMI by the computer interpretation can be verified by individual interpretation, and lack of recognition by the computer would not be used solely to rule out STEMI. When STEMI is recognized prehospital and primary PCI is the planned reperfusion strategy, prehospital STEMI activation of the catheterization laboratory reduces treatment delays and mortality.

There is renewed focus on the use of troponins to exclude the likelihood of ACS and enable safe discharge from the ED. The use of troponins at 0 and 2 h as a stand-alone measure for excluding the diagnosis of ACS is strongly discouraged. The diagnosis of MACE (defined as future ACS or major adverse cardiac events within the next month) may be excluded by combining negative (defined as less than 99th percentile) hs-cTnI measured at 0 and 2 h with low risk stratification or by combining cTnI or cTnT measured at 0 and 3 to 6 h with very-low-risk stratification.

Therapeutic interventions in ACS

Adenosine diphosphate receptor antagonists and UFH can be administered either in the prehospital or in-hospital setting for suspected STEMI patients with a planned primary PCI approach. They have been shown to be safe and effective when given prehospital, although the benefit of prehospital administration is insufficiently clear to recommend this as routine practice. Prehospital enoxaparin may be used as an alternative to prehospital UFH as an adjunct for primary PCI for STEMI. There is insufficient evidence to suggest prehospital administration of bivalirudin compared with prehospital administration of UFH in identified STEMI patients to recommend a change in existing practice.

We suggest withholding oxygen in normoxic patients with ACS. This is based on absence of a detectable difference in mortality and potential benefit in reduced infarct size when oxygen is withheld. Although much of the evidence for oxygen use in ACS comes from studies before the modern reperfusion era, there is 1 recently published RCT and 2 RCTs that have yet to be published that will provide further evidence on this topic.[107]

Reperfusion decisions in STEMI

STEMI systems-of-care decisions will depend on the regional resources, including the capability of the local prehospital system and availability of PCI centers. When fibrinolysis is the planned treatment strategy for patients with STEMI, prehospital fibrinolysis is preferable to in-hospital fibrinolysis, where the transport times are commonly greater than 30 min, because it is associated with decreased mortality without evidence of increased intracerebral or major hemorrhage. Prehospital fibrinolysis requires knowledgeable prehospital personnel using well-established protocols, comprehensive training programs, and quality assurance programs under medical oversight. In geographic regions where PCI facilities exist and are available, direct triage and transport for PCI is preferred to prehospital fibrinolysis because it is associated with less intracranial hemorrhage, although it has not been shown to provide a survival benefit.

When making individual decisions about primary PCI versus fibrinolysis, important features include time from symptom onset, anticipated time (delay) to PCI, and other patient factors such as comorbidities, infarct location, and infarct size. Fibrinolysis is most effective in terms of myocardial salvation and survival in patients with STEMI presenting within 2 to 3 h after the onset of symptoms. In patients with STEMI presenting less than 2 h after symptom onset, primary PCI is preferred only when it can be performed with a time delay of less than 60 min. In patients presenting 2 to 3 h after symptom onset, either fibrinolysis or primary PCI can be selected as reperfusion strategy, provided that the primary PCI delay will be within 60 to 120 min. In patients with STEMI presenting 3 to 6 h after symptom onset, primary PCI is the treatment of choice when it can be accomplished with a delay of no more than 120 min. In patients presenting more than 6 h after symptom onset, primary PCI may represent the best option for reperfusion even if this can only be accomplished with a long delay to primary PCI (e.g., more than 120 min). If fibrinolysis is chosen, it should be followed by routine early (within 3–24 h) angiography and PCI if indicated.

Adult patients presenting with STEMI in the ED of a non-PCI-capable hospital should be transferred emergently to a PCI center for primary PCI if this can be accomplished within an appropriate timeframe as discussed above. This is associated with a reduced incidence of mortality, reinfarction, and stroke with no additional harm in terms of major hemorrhage in comparison with immediate in-hospital fibrinolysis and transfer only for rescue PCI. When these patients cannot be transported to PCI in a timely manner, fibrinolytic therapy followed by routine transfer for angiography within 3 to 6 and up to 24 h may represent an equally effective and safe alternative to immediate transfer to primary PCI. Routine transport of patients with STEMI undergoing fibrinolytic therapy in the ED of a non-PCI hospital for early routine angiography in the first 3 to 6 h (or up to 24 h) is associated with less reinfarction and may be preferred to fibrinolysis, and then transfer only for ischemia-guided angiography. The routine use of PCI immediately (within 2 h) after fibrinolysis is strongly discouraged because it is associated with increased incidence of major and intracranial bleeding without any expected additional benefit to primary PCI alone.

Hospital reperfusion decisions after ROSC

The majority of patients who have an OHCA have underlying ischemic heart disease. Acute coronary artery occlusion is known to be the precipitating factor in many of these patients. It may be manifested by ST-segment elevation or left bundle branch block on post-ROSC 12-lead ECG but may also be present in the absence of these findings.

Patients who experience ROSC after OHCA and remain comatose with ST-elevation on post-ROSC 12-lead ECG should be transferred immediately for cardiac catheterization laboratory evaluation. This has been associated with considerable benefit in terms of survival to hospital discharge and neurologically intact survival in select groups of patients in comparison with cardiac catheterization later in hospital stay or no catheterization. Emergency cardiac catheterization is suggested for select adult patients who have no ST-elevation on ECG but remain comatose following ROSC from OHCA of suspected cardiac origin.

Pediatric basic and advanced life support

The Pediatric Task Force evaluated 21 PICO questions by way of systematic reviews. They are grouped here into categories of pre-cardiac arrest care, BLS care during cardiac arrest, ALS care during cardiac arrest, and post-cardiac arrest care. The most important evidence-based treatment recommendations chosen by the task force co-chairs are listed here.

Pre-cardiac arrest care

Response systems and assessment. The Pediatric Task Force suggested the use of pediatric rapid response team/medical emergency team systems within hospitals that care for children. The use of early warning scores in pediatrics was assessed, but the evidence was so limited that no specific recommendation could be made.

Atropine for emergent tracheal intubation. The task force concluded that, in light of the limited literature available, no specific recommendation could be made for the use of atropine during emergency tracheal intubation.

Prearrest care of pediatric dilated cardiomyopathy or myocarditis. The task force concluded that, in light of the limited literature available, no specific recommendation could be made.

Prearrest care of shock. The use of restricted volumes of isotonic crystalloid may lead to improved outcomes from pediatric septic shock in specific settings. For children with febrile illnesses, particularly without signs of overt septic shock, a cautious approach to fluid therapy should be combined with frequent patient reassessment.[76]

BLS care during cardiac arrest

Sequence of chest compressions and ventilation: Compressions–airway–breathing versus airway-breathing-compressions. The task force concluded that, in light of the limited literature available, no specific recommendation could be made. The task force acknowledged the equipoise that exists to allow resuscitation councils to decide on using either compressions–airway–breathing (C–A–B) or airway–breathing–compressions (A–B–C) in their guidelines.

Chest compression depth. The task force suggested that rescuers compress the chests of *infants* in cardiac arrest by at least one third the anterior-posterior dimension or approximately 1.5 in. (4 cm), and compress the chest of *children* in cardiac arrest by at least one third the anterior-posterior dimension or approximately 2 in. (5 cm).

Compression-only CPR versus conventional CPR (i.e., compressions plus breaths). The pediatric task force recommends that rescuers provide rescue breaths and chest compressions for pediatric IHCA and OHCA, because most pediatric cardiac arrests are caused by asphyxia. If rescuers cannot provide rescue breaths, they should at least perform chest compressions.

Pediatric advanced life support during cardiac arrest

Energy doses for defibrillation. The task force suggested the routine use of an initial dose of 2 to 4 $J\,kg^{-1}$ of monophasic or biphasic defibrillation waveforms for infants or children in VF or pVT cardiac arrest. There was insufficient evidence from which to base a recommendation for second and subsequent defibrillation doses.

The use of invasive blood pressure monitoring or $ETCO_2$ *monitoring to guide CPR quality.* The task force suggested that, in light of the limited literature available, no specific recommendation could be made for the routine use of invasive blood pressure or $ETCO_2$ monitoring to guide CPR quality.

The use of vasopressors and antiarrhythmics in cardiac arrest. The task force suggested that, in light of the limited pediatric literature available, no specific recommendation could be made regarding the use of vasopressors during pediatric cardiac arrest. The task force considered that the short-term outcomes of ROSC and survival to hospital admission overrode any uncertainty of the absolute effect on long-term survival and neurologic outcome with the use of epinephrine. Consensus by the task force was that providers continue to use epinephrine for pediatric cardiac arrest per their current council-specific practice, albeit that the evidence in pediatrics is poor.

Although the use of lidocaine or amiodarone for treatment of shock-resistant pediatric VF/pVT improves short-term outcomes, there are few data on their effects on long-term outcomes.[77]

Extracorporeal membrane oxygenation for CPR. The task force suggested that extracorporeal membrane oxygenation with resuscitation may be considered for infants and children with cardiac diagnoses who have IHCA in settings that provide the expertise, resources, and systems to optimize the use of extracorporeal membrane oxygenation during and after resuscitation. The task force believes that there was insufficient evidence from which to suggest for or against the routine use of extracorporeal membrane oxygenation with resuscitation in infants and children *without cardiac diagnoses* who have IHCA.

Intra-arrest prognostication. The task force suggested that for infants and children in IHCA, predictors of positive patient outcome such as age younger than 1 year and the presence of an initial shockable rhythm were helpful in aiding prognostication. For infants and children in OHCA, age older than 1 year and the presence of VF/pVT as the presenting rhythm were important predictors of positive outcome. Duration of cardiac arrest was not found to be helpful by itself. Importantly, the task force considers it obligatory to assimilate multiple factors to help guide prognostication and decision making during resuscitation, while not adhering to unproven expectations of outcomes.

Post-cardiac arrest care

Postresuscitation care begins when a patient develops sustained ROSC. For children remaining unconscious after OHCA, outcomes are improved when fever is prevented, and a period of moderate therapeutic hypothermia or strict maintenance of normothermia is provided.[75]

Post-ROSC Pao$_2$ and post-ROSC ventilation. The task force suggested that rescuers measure the patient's Pao$_2$ after ROSC and target a value appropriate to the specific patient's condition. In the absence of specific patient data, they suggested that rescuers target normoxemia after ROSC. The task force suggested that rescuers measure Paco$_2$ after ROSC and target a value appropriate to the specific patient's condition. The evidence was insufficient to make a recommendation for a specific Paco$_2$ target.

Post-ROSC fluid/inotropes. The task force made a strong recommendation that for infants and children after ROSC, parenteral fluids and/or inotropes or vasopressors should be used to maintain a systolic blood pressure of at least greater than fifth percentile for age.

Post-ROSC electroencephalogram as a prognosticator. The task force suggested that the use of electroencephalogram within the first 7 days after pediatric cardiac arrest may assist in prognostication. The evidence surrounding the use of electroencephalogram by itself as a prognostic tool after pediatric cardiac arrest was thought to be insufficient to make a recommendation.

Post-ROSC predictive factors. The task force agreed that multiple variables should be used to predict outcomes for infants and children after cardiac arrest, and that it was unclear what the impact of evolving post-ROSC care (therapeutic hypothermia or TTM, fever avoidance, prevention of hypotension/optimizing cardiovascular function) will have on tentative predictors of outcome.

Neonatal resuscitation

Since the last publication of CoSTR, several controversial neonatal resuscitation issues have been identified. The highlights of these topics are below.

Initial stabilization

ECG Assessment of heart rate. Neonatal resuscitation success has traditionally been determined by detecting an increase in heart rate through auscultation. The data suggest that the ECG provides a more accurate heart rate in the first 3 min of life, but there were no available data to determine whether this changes outcome.

Delayed cord clamping and milking of the umbilical cord. Delayed umbilical cord clamping can be associated with increased placental transfusion and cardiac output and more stable neonatal blood pressure. The existing RCTs had small sample sizes and enrolled very few extremely premature infants or infants who required resuscitation. Although delayed cord clamping is suggested for preterm infants not requiring immediate resuscitation after birth, there is insufficient evidence to recommend an approach to cord clamping for preterm infants who do require resuscitation immediately after birth,

There is some evidence that milking the umbilical cord (from the placenta toward the infant) may have beneficial effects similar to delayed cord clamping, so it may be a rapid alternative to delayed cord clamping. However, there is insufficient published human evidence of benefit, particularly in very premature (less than 29 weeks of gestation) infants. Cord milking may be considered on an individual basis or in a research setting, because it may improve initial mean blood pressure, hematologic indices, and intracranial hemorrhage. This technique should be studied in infants requiring resuscitation.

Temperature management

Maintaining temperature. The admission temperature of newly born nonasphyxiated infants is a strong predictor of mortality and morbidity at all gestations, and it should be recorded as a predictor of outcomes as well as a quality indicator. The temperature of newly born nonasphyxiated infants should be maintained between 36.5 °C and 37.5 °C after birth through admission and stabilization.

To maintain the temperature of preterm infants of less than 32 weeks of gestation under radiant warmers in the hospital delivery room, a combination of interventions (including an environmental temperature of 23 °C to 25 °C, warm blankets, plastic wrapping without drying, cap, and thermal mattress) are effective in reducing hypothermia (temperature less than 36.0 °C). However, the effect of any one intervention has not been established.

In a resource-limited setting, it can be difficult to maintain the infant's temperature, especially for the first 1 to 2 h after birth, and there is a dose-dependent increase in mortality for temperatures below 36.5 °C. Premature infants demonstrate a 12-fold increase in mortality compared with term babies. Once a well baby of more than 30 weeks of gestation has been dried, the infant's legs, torso, and arms may be put in a clean food-grade plastic bag and swaddled or can be nursed with skin-to-skin contact with the mother or with kangaroo mother care; these approaches are favored over swaddling or placement in an open cot, crib, or incubator.

Rate of rewarming the newborn. When the infant is unintentionally hypothermic (temperature less than 36 °C) at hospital admission, there is insufficient evidence to determine if rapid (0.5 °C h^{-1} or greater) or slow (less than 0.5 °C h^{-1}) rewarming is more effective and associated with better outcome.

Respiratory support in the delivery room

Several randomized clinical trials and animal studies have provided additional information about the potential effect of several ventilation strategies designed to establish functional residual capacity immediately after birth.

For spontaneously breathing preterm infants with respiratory distress requiring respiratory support in the delivery room, the task force suggests that the initial use of *continuous positive airway pressure* (CPAP) rather than immediate intubation and positive-pressure ventilation may be sufficient to augment the infant's respiratory effort with a low risk of adverse outcome. It is important to note that infants included in the studies were likely to have been treated with antenatal steroids, so this approach should be studied in infants who have not received antenatal steroids and in high-risk preterm infants with lower gestational age.

Administration of a *sustained positive-pressure inflation* to preterm infants who have not established spontaneous respiration at birth may reduce the need for intubation at 72 h, but the optimal method to administer sustained lung inflations and long-term effects of the inflations have not been established. For this reason, the task force suggests against the routine use of initial sustained inflation (greater than 5 s duration) for preterm infants without spontaneous respirations immediately after birth, but a sustained inflation may be considered in individual clinical circumstances or research settings.

There is benefit to using *positive end-expiratory pressure* (PEEP) to assist in establishment of a functional residual capacity during transition of the fluid-filled lung to an air-breathing organ. The task force reviewed evidence regarding the effect of the use of PEEP during intermittent mandatory ventilation and the value of specific devices to maintain the PEEP. The task force suggests the use of PEEP maintained with either a self-inflating bag, a flow-inflating bag, or a T-piece for premature newborns during delivery room resuscitation. No recommendation is possible for term infants because of insufficient data. There is also insufficient evidence to support the use of one device over another.

Intubation and tracheal suctioning in nonvigorous infants born through meconium-stained amniotic fluid versus no intubation for tracheal suctioning

Aspiration of meconium before delivery, during birth, or during resuscitation can cause severe meconium aspiration syndrome, but it is unclear if intervention at or after birth can affect the outcome. For more than 25 years, providers routinely performed tracheal intubation and direct tracheal suctioning for all meconium-stained newborns, until a randomized trial showed it was unnecessary in infants who were vigorous at birth.[108] The practice of direct tracheal suctioning of infants who had respiratory compromise at birth (i.e., they were depressed/nonvigorous at birth) has persisted, but the practice is controversial, with only a very low quality of evidence (i.e., historic controls) to suggest benefit. After the 2015 systematic review, the Neonatal Task Force concluded that there is insufficient published evidence to support routine tracheal intubation for suctioning of meconium in even nonvigorous infants born through meconium-stained amniotic fluid, because it likely delays ventilation.

Oxygen concentration for initiating resuscitation of premature newborns

High concentrations of inspired oxygen can be toxic to newborn lungs, so the oxygen concentration for term babies is generally started at 21% (room air). There has been ongoing controversy regarding the optimal inspired oxygen concentration for resuscitation of preterm babies. After the systematic review, the Neonatal Task Force recommends *against* initiating resuscitation of preterm newborns (less than 35 weeks' gestational age) with high-oxygen concentrations (65–100%) and instead recommends initiating resuscitation with a low-oxygen concentration (21–30%).

Circulatory support: Chest compressions

Although the evidence supporting the 2-thumb over the 2-finger technique of chest compressions is based on manikin rather than human data, the 2-thumb technique with fingers encircling the chest generated higher blood pressure and less fatigue than use of 2 fingers. As a result, the 2 thumb-encircling hands technique is the preferred technique for newborn chest compressions during 2-rescuer CPR. These chest compressions should still be delivered over the lower third of sternum, using a 3:1 compression-to-ventilation ratio. This ratio has been shown to deliver more breaths than the 15:2 ratio used for 2-rescuer pediatric CPR in animal models and in a manikin study. The task force considers the 3:1 ratio appropriate, because asphyxia is the predominant cause of cardiovascular collapse in the newborn and effective resuscitation requires significant focus on ventilation.

Oxygen delivery during CPR (neonatal)

Despite animal evidence showing no advantage to the use of 100% oxygen, by the time resuscitation of a newborn has reached the stage of chest compressions, the rescuers should already have attempted to achieve ROSC by using effective ventilation with low-concentration oxygen. Thus, once chest compressions are needed, it would seem prudent to try increasing the supplementary oxygen concentration. If used, the supplementary oxygen should be weaned as soon as the heart rate has recovered. It is important to note that there are no human data to inform this question.

Assisted-ventilation devices and CPR feedback devices

Tracheal intubation is a difficult skill to learn and perform, and it is difficult to maintain competence in the technique. After review of 3 randomized trials involving 469 patients, the task force suggests that the laryngeal mask may be used as an alternative to tracheal intubation during resuscitation of the late-preterm and term newborn (more than 34 weeks of gestation) if ventilation via the face mask or intubation is unsuccessful.

Although use of flow and volume monitors and capnography are feasible, because there is no evidence that they are effective in improving important outcomes, the task force suggests against the routine use of flow and volume monitoring or capnography for babies who receive positive-pressure ventilation at birth, until more evidence becomes available.

Use of CPR feedback devices during neonatal cardiac arrest

In asystolic/bradycardic neonates, the task force suggests against the routine use of any single feedback device such as $ETCO_2$ monitors or pulse oximeters for detection of ROSC until more evidence becomes available.

For the critical outcomes of improved perfusion, decreased time to ROSC, decreased hands-off time, increased survival rates, or "improved neurologic outcomes," no specific data were identified.

Induced hypothermia in resource-limited settings

The task force suggests that newly born infants at term or near term with evolving moderate-to-severe hypoxic-ischemic encephalopathy in low-income countries and/or other settings with *limited resources* may be treated with therapeutic hypothermia.

Cooling should be considered, initiated, and conducted only under clearly defined protocols with treatment in neonatal care facilities with the capabilities for multidisciplinary care and availability of adequate resources to offer intravenous therapy, respiratory support, pulse oximetry, antibiotics, anticonvulsants, and pathology testing. Treatment should be consistent with the protocols used in the randomized clinical trials in developed countries, i.e., cooling to commence within 6 h, strict temperature control at 33 °C to 34 °C for 72 h, and rewarming over at least 4 h.

Prognostication

Delivery room assessment at less than 25 weeks of gestation and prognostic score. There is insufficient evidence to support the prospective use of any delivery room prognostic score presently described over estimated gestational age assessment alone in preterm infants of less than 25 weeks of gestation. No score has been shown to improve the ability to estimate the likelihood of survival through either 30 days or in the first 18 to 22 months after birth.

In individual cases, when constructing a prognosis for survival at gestation below 25 weeks, it is reasonable to consider variables including perceived accuracy of gestational age assignment, the presence or absence of chorioamnionitis, and the level of care available at the delivery facility. It is also recognized that decisions about appropriateness of resuscitation of those below 25 weeks of gestation will be influenced by region-specific guidelines established by regional resuscitation councils.

Apgar score of 0 for 10 or more minutes. An Apgar score of 0 at 10 min is a strong predictor of mortality and morbidity in late-preterm and term infants. The task force suggests that, in babies with an Apgar score of 0 after 10 min of resuscitation, if the heart rate remains undetectable, it may be reasonable to stop resuscitation; however, the decision to continue or discontinue resuscitative efforts should be individualized. Variables to be considered may include whether the resuscitation was considered to be optimal; availability of advanced neonatal care, such as therapeutic hypothermia; specific circumstances before delivery (e.g., known timing of the insult); and wishes expressed by the family.

Among infants of 35 weeks of gestation or more with an Apgar score of 0 for 10 or more minutes, the likelihood of dying or having severe or moderate developmental disabilities at 18 to 24 months is very high. Studies that included 69 infants with an Apgar score of 0 at 10 min after birth who were successfully resuscitated and randomized to hypothermia or normothermia, and case series of 21 additional infants who were managed with therapeutic hypothermia, suggest improvement in outcome compared with previously reported cohorts. Among these 90 infants, 45 (50%) died, and 22 (24%) survived without major or moderate disability at 18 to 24 months. However, the number of infants with no heart rate at 10 min who died in the delivery room is unknown.

Predicting death or disability in resource-limited settings of newborns of more than 34 weeks of gestation based on apgar score and/or absence of breathing. Absence of spontaneous breathing or an Apgar score of 1 to 3 at 20 min of age, in babies of more than 34 weeks of gestation but with a detectable heart rate, are strong predictors of mortality or significant morbidity. In settings where *resources are limited*, we suggest that it may be reasonable to stop assisted ventilation in babies with no spontaneous breathing despite presence of heart rate or Apgar score of 1 to 3 at 20 or more minutes. Importantly, each of the studies reviewed was conducted in a setting where therapeutic hypothermia was likely to be available.

Resuscitation training

Frequency. The task force suggests that training should be recurrent and considered more frequently than once per year. This retraining may be composed of specific tasks and/or behavioral skills, depending on the needs of the trainees.

Neonatal resuscitation instructors. The task force suggests that training of resuscitation instructors incorporate timely, objective, structured, individually targeted verbal and/or written feedback. There was no evidence identified to show improvement in critical outcomes. There was some evidence to show that training instructors improved some important outcomes. While common sense dictates that instructors be properly prepared before engaging learners, it is clear that such instruction must be based on specific learning objectives targeting the specific skills that are necessary to facilitate learning.

Education, implementation, and teams

The ILCOR EIT Task Force organized its work into 3 major sections: (1) BLS training, (2) ALS training, and (3) implementation.

There remains considerable variability in cardiac arrest survival in and out of hospital and, therefore, substantial opportunity to save many more lives.[109–111] The Formula for Survival[112] postulates that optimal survival from cardiac arrest requires high-quality science, education of lay providers and healthcare professionals, and a well-functioning Chain of Survival[113] (implementation). Organizations providing care for cardiac arrest victims should train healthcare providers in teams, using evidence-informed educational practice and tailoring the training to the required skills of the practitioner and team. Additionally, organizations should implement systems-level processes such as data-driven continuous quality improvement to optimize survival from cardiac arrest. The most important developments and recommendations in EIT since the 2010 ILCOR review are described below.

Basic life support training

BLS is critically important to the care of cardiac arrest victims, but, unfortunately, only a minority of cardiac arrest victims actually receive bystander CPR. Recent training in CPR,[114] along with dispatcher-assisted CPR,[115] may help overcome barriers and save more lives. For healthcare professionals, the quality of CPR delivered is critical because poor compliance with recommended guidelines has been associated with lower survival.[116,117] Suboptimal CPR[118] harms patients and is preventable.[119] Quality improvement processes are needed to try to minimize its occurrence.

Video- or computer-based instruction may enable more rescuers to be trained in CPR. Despite heterogeneity in the delivery of video- and/or computer-based instruction, and in the evaluation methods among different studies, we suggest that video- and/or computer-based self-instruction with synchronous or asynchronous hands-on practice may be an effective alternative to instructor-led courses.

Although use of an AED does not require formal training, it may be helpful for the lay rescuer to have consolidated some of these skills through an instructional program. For lay providers learning AED skills, self-instruction combined with short, instructor-led training may be acceptable to replace longer traditional courses. For healthcare providers learning AED skills, self-directed training (as short as 40 min) may be useful in place of traditional training.

CPR skills are known to deteriorate within the weeks to months after resuscitation training, well before the current recertification timeline for resuscitation organizations. We suggest that individuals likely to encounter cardiac arrest consider more frequent retraining to optimize their skills so they are best prepared to deal with an arrest. Part of the decay in skills may be related to poor training in the initial course or retraining sessions. Instructors are often unable to identify poor-quality compressions, which limits the quality of corrective feedback that is provided. We suggest the use of feedback devices that provide directive feedback on compression rate, depth, release, and hand position during training. If feedback devices are not available, we suggest the use of tonal guidance (examples include music and metronome) during training to improve compression rate.

The ILCOR EIT Task Force recommends BLS training for individuals (family or caregivers) caring for high-risk populations, based on the willingness to be trained and the fact that there is low risk of harm and high potential of benefit. We placed lesser value on associated costs and the potential that skills may not be retained without ongoing CPR training. Because cardiac arrest is life threatening, the likelihood of benefit is high relative to possible harm.

Communities may train bystanders in compression-only CPR for adult OHCA as an alternative to training in conventional CPR. In making this recommendation, we took into account that willingness to perform bystander CPR in the community may be increased when compression-only CPR is offered as an alternative technique.[120–123] Communities should consider existing bystander CPR rates and other factors such as local epidemiology of OHCA and cultural preferences when deciding on the optimal community CPR training strategy.

Advanced life support training

Published data suggest that without ongoing education, the skills learned in ALS courses are lost over a period of months.[114,124] Coupled with increasing pressures from administrators to justify the time and costs of training away from the clinical workplace, there needs to be thoughtful evidence-based decision making in educational practice.

Primarily on the basis of studies demonstrating improved skill performance at course conclusion, we suggest the use of high-fidelity manikins when training centers/organizations have the infrastructure, trained personnel, and resources to maintain the program. If high-fidelity manikins are not available, we suggest the use of low-fidelity manikins is acceptable for standard ALS training in an educational setting. In making these recommendations, we took into account the well-documented, self-reported participant preference for high-fidelity manikins (versus low-fidelity manikins) and the likely impact of this preference on willingness to train.[124] We considered the positive impact of skill acquisition at course completion, as well as the lack of evidence of sustained impact on the learner. We also considered the relative costs of high- versus low-fidelity manikins.

The ILCOR EIT Task Force suggested that team and leadership training be included as part of ALS training for healthcare providers. In making this recommendation, we placed emphasis on the potential benefit, lack of harm, and high level of acceptance of team and leadership training and lesser value on associated costs.

Compared with standard retraining intervals of 12 to 24 months, the ILCOR EIT Task Force suggested that more frequent manikin-based refresher training for students of ALS courses may better maintain competence. The optimal frequency and duration of this retraining has not yet been determined. We consider the rapid decay in skills after standard ALS training may compromise patient care. Refresher training, in the form of frequent, low-dose in situ training with the use of manikins, offers promise.[125] The potential cost savings of integrating these sessions into daily workflow rather than removing staff for standard refresher training may be important, as might a reduced total time of retraining. A recent study demonstrates improved learning from “frequent, low-dose” compared with “comprehensive, all-at-once” instruction and a learner preference for this format.[126]

Implementation

Barriers within an organization may delay implementation of guidelines into practice by years, and modifying caregiver behaviors may take several years more.[127–132] Publishing guidelines is not sufficient without including the tools to get them implemented.

The ILCOR EIT Task Force suggested that OHCA patients should be considered for transport to a specialist cardiac arrest center as part of a regionalized system of care. In making this recommendation, the task force recognized that the development of cardiac arrest centers be considered as a health improvement initiative, without supportive evidence from randomized trials, such as has been performed for other conditions (e.g., myocardial infarction, stroke, major trauma).

Technology, including social media, may serve to notify citizen CPR responders of cardiac arrests, thereby shortening the time to onset of bystander CPR and defibrillation, which can be achieved before EMS arrives. Despite limited evidence, the EIT Task Force suggested that individuals in close proximity to a suspected OHCA who are willing and able to perform CPR be notified of the event via technology or social media. In making this recommendation, we place value on the time-sensitive benefit of CPR and AED use in OHCA and the limitations of optimized EMS systems to improve response times. We also recognize that there are individuals willing and able to provide BLS in most communities and these novel technologies can help to engage these individuals.

Performance measurement and quality-improvement initiatives in organizations that treat cardiac arrest may be critical in preventing cardiac arrest and improving outcomes from cardiac arrest, and should be implemented. Greater value is placed on the potential for lives saved and the concept that you can only improve what you can measure, and lesser value is placed on the costs associated with performance measurement and quality-improvement interventions. Assessing clinical performance and using a system to continuously assess and improve quality can improve compliance with guidelines.

One potential quality-improvement activity might be team-based debriefing of CPR team performance. Data-driven, performance-focused debriefing of rescuers after IHCA in both adults and children may help to improve subsequent performance. Data-driven, performance-focused debriefing of rescuers after OHCA in both adults and children may also be helpful.

Prevention of cardiac arrest is an important step in our goal to save more lives. We suggest hospitals consider the introduction of an early warning scoring system or rapid response team/medical emergency team system to reduce the incidence of IHCA and in-hospital mortality. This recommendation places a high value on the prevention of IHCA and death relative to the cost of the system. Such a system should provide elements of care that include (1) staff education about the signs of patient deterioration; (2) appropriate and regular vital signs monitoring of patients; (3) clear guidance (e.g., via calling criteria or early warning scores) to assist staff in the early detection of patient deterioration; (4) a clear, uniform system of calling for assistance; and (5) a clinical response to calls for assistance. The best method for the delivery of these components is unclear.[124]

First aid

Important medical topics reviewed for 2015 include use of supplementary oxygen for purposes other than patients with chest pain, positioning for shock and recovery, use of bronchodilators for patients with asthma who have acute shortness of breath, use of a second dose of epinephrine for anaphylaxis, and the administration of aspirin for chest pain.

- No evidence was found to support a change in current practice for the use of supplementary oxygen by first aid providers.
- The position recommended for the patient in shock remains the supine position, although there is some evidence suggesting passive raising of the legs between 30° and 60° may have a transient (7 min or less) benefit.
- There is a change in recommendations for the position of a normally breathing, unresponsive person. Because a potential need has been shown for advanced airway management in the supine position versus a lateral recumbent position, we are now recommending that the lateral recumbent position be used as a “recovery” position.
- Assisting with the administration of inhaled bronchodilators is recommended for patients with asthma who have acute shortness of breath.
- Although questions remain regarding the ability of a first aid provider to recognize anaphylaxis, the use of a second dose of epinephrine via autoinjector is beneficial when a first dose fails to improve symptoms. Adverse effects were not reported in studies included, although this may reflect the administration of epinephrine with an autoinjector, thus limiting opportunity for an inadvertent overdose injection.

- The use of aspirin for chest pain has been previously reviewed; however, the task force agreed that this topic should be looked at again in light of the newly implemented GRADE methodology and the emergence of newer medications used for acute myocardial infarction. Thus, the original question asking if aspirin should be administered for patients with myocardial infarction was reviewed, followed by a review of the early (i.e., prehospital) use of aspirin for chest pain versus delayed (i.e., in-hospital) administration of aspirin.
- A new review topic is the use of Stroke Assessment Systems to aid with recognition of stroke, with findings that will have enormous implications for first aid and public health. This review found a significant decrease in time between symptom onset and arrival at hospital or ED with the use of these assessment "tools"—use of such tools may reduce the degree of damage from stroke when treatment is initiated early.
- A new review looks at use of oral dietary sugars for symptomatic hypoglycemia in diabetics. The studies for this review administered various forms of dietary sugars – such as specific candies, dried fruit strips, juice, or milk – in a dose-equivalent amount compared with glucose tablets to diabetics with symptomatic hypoglycemia who were conscious and able to swallow and follow commands. It was concluded that, as a group, dietary sugar products were not as effective as glucose tablets for relief of hypoglycemia, but all studied forms showed benefit and potential usefulness in cases where glucose tablets are not available.

First aid trauma emergencies

Important trauma topics reviewed for 2015 included the first aid management of hemorrhage, angulated fractures, open chest wounds, burns (cooling of burns and burns dressings), and dental avulsion. Two additional important trauma topics were cervical spinal motion restriction and the recognition of concussion by first aid providers.

The correct management of hemorrhage and the enhancement of hemostasis in the first aid setting are essential to maintaining the circulating blood volume in acute trauma. Three PICO reviews focused on critical interventions for severe bleeding:

- There was inadequate evidence to support the use of proximal pressure points or limb elevation to control bleeding. The use of localized cold therapy is suggested for closed bleeding in extremities to aid hemostasis, but there was no evidence to support this therapy for open bleeding.
- The use of hemostatic dressings in first aid is supported when standard first aid hemorrhage control (e.g., direct wound pressure) fails to control severe bleeding or cannot be applied.
- Similarly, the evidence supports the use of tourniquets in the civilian setting when standard first aid hemorrhage control (e.g., direct wound pressure) fails to control severe external limb bleeding.

The task force recognized that the use of hemostatic dressings and tourniquets will have cost and training implications. However, the task force thought that these costs would be moderate and justified considering the benefit of maintaining circulating blood volume in the management of trauma.

There was no evidence to support the straightening of an angulated fracture in the first aid situation, and the task force did not make a recommendation. The task force recognized the need to protect the victim from further injury by splinting the fracture in position to reduce pain or to enable safe extrication and transportation.

The application of an occlusive dressing or device by first aid providers to an open chest wound may lead to an unrecognized tension pneumothorax. The task force suggested that these wounds be left open with local control of bleeding, rather than risk occlusion.

There is a growing body of scientific evidence showing complications related to use of cervical collars. This evidence, combined with concern for potential secondary injury due to neck movement during attempts to apply a collar, has led to a suggestion (weak recommendation) against the use of cervical collars by first aid providers. The task force acknowledges that first aid providers may not be able to distinguish between high- and low-risk criteria for spinal injuries, and recognizes the possible need for alternative methods of cervical spine motion restriction or stabilization, but these were not formally reviewed. The task force thought that formal spinal motion restriction in high-risk individuals is best accomplished by trained emergency medical rescuers or healthcare professionals.

The recognition of concussion after head trauma is a common challenge for first aid. No simple concussion scoring system was found that would assist the first aid provider in making this important diagnosis; however, there are more advanced scoring systems for use by healthcare professionals.

The correct first aid management of burns is critical to their eventual outcome. Cooling burns is a widespread first aid practice, but it is supported by only a low quality of scientific evidence. No evidence was found as to the preferred method of cooling, the temperature of the coolant, or the duration of cooling. It was recommended that active cooling begin as soon as possible by using cool or nonfreezing water or cooling adjuncts such as gel pads.

A comparison of wet with dry dressings for thermal burns yielded no recommendation. There were no studies comparing plastic wrap, considered a dry dressing, with a wet dressing.

It is widely recommended that an avulsed tooth be replanted immediately in the conscious victim. However, first aid providers may not have the skills or the willingness to undertake this procedure. This review suggests a series of commercially available storage solutions and simple household mediums, when available, for the short-term storage of an avulsed tooth until reimplantation can be accomplished.

Education

Education in first aid continues to be a topic with few scientific studies. In the 2010 review of educational topics, no evidence was found to support or recommend any method of evaluating or monitoring a first aid trainee's educational progress or the specific frequency of retraining to retain skills and knowledge.[133] The task force decided to investigate the basic question, is there documented evidence of benefit in terms of patient outcomes as a result of first aid training?

Many questions remain and research is desperately needed, particularly in the realm of teaching techniques for first aid and methods to evaluate the retention of skills.

Future directions

The science of resuscitation is evolving rapidly. It would not be in the best interests of patients if we waited 5 or more years to inform healthcare professionals of therapeutic advances in this field. ILCOR members will continue to review new science and, when necessary, publish interim advisory statements to update treatment guidelines so that resuscitation practitioners may provide state-of-the-art patient care. Existing gaps in our knowledge will be closed only by continuing high-quality research into all facets of CPR. Readers are encouraged to review the information on the SEERS site to learn of new developments and recommendations for resuscitation and first aid (https://volunteer.heart.org/apps/pico/Pages/default.aspx SEERS).

Disclosures

2015 CoSTR Part 1: Executive summary: writing group disclosures.

	Employment	Research grant	Other research support	Speakers' Bureau/Honoraria	Expert witness	Ownership interest	Consultant/Advisory Board	Other
Writing group member								
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						None	American Heart Association[†]	None

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

[*] Modest.

[†] Significant.

Acknowledgments

We acknowledge the considerable contributions made by the late Professor Ian Jacobs, PhD, to this 2015 CoSTR. Professor Jacobs led ILCOR with passion and vision from 2011 to October 19, 2014.

Appendix A.

CoSTR evidence-based PICO worksheets: master Appendix.

Part	Task force	PICO ID	Short title	PICO question	Evidence reviewers
Part 3	BLS	BLS 343	Chest compression rate	Among adults and children who are in cardiac arrest in any setting (P), does any specific rate for external chest compressions (I), compared with a compression rate of about 100 min^{-1} (C), change survival with neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year; ROSC; CPR quality (O)?	Julie Considine, Nicolas Mpotos, Swee Lim
		BLS 345	Rhythm check timing	Among adults and children who are in cardiac arrest in any setting (P), does checking the cardiac rhythm immediately after defibrillation (I), compared with immediate resumption of chest compressions with delayed check of the cardiac rhythm (C), change survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year; ROSC; recurrence of VF (O)?	Giuseppe Ristagno, Husein Lockhat
		BLS 346	Timing of CPR cycles	Among adults who are in cardiac arrest in any setting (P), does pausing chest compressions at another interval (I), compared with pausing chest compressions every 2 minutes to assess the cardiac rhythm (C), change survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year; ROSC; coronary perfusion pressure; cardiac output (O)?	Joshua Reynolds, Violetta Raffay
		BLS 347	Public-access defibrillation	Among adults and children who are in cardiac arrest outside of a hospital (P), does implementation of a public-access AED program (I), compared with traditional EMS response (C), change survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year; ROSC; time to first shock; bystander CPR rates; bystander use of AED; time to commence CPR (O)?	Andrew Travers, Ian Drennan
		BLS 348	Check for circulation during BLS	Among adults and children who are in cardiac arrest in any setting (P), does interruption of CPR to check circulation (I), compared with no interruption of CPR (C), change survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year; ROSC; chest compression fraction (O)?	Martin Botha, Andrea Scapigliati
		BLS 352	Passive ventilation technique	Among adults and children who are in cardiac arrest in any setting (P), does addition of any passive ventilation technique (e.g., positioning the body, opening the airway, passive oxygen administration) to chest compression – only CPR (I), compared with just chest compression – only CPR (C), change survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year; ROSC; bystander initiated CPR; oxygenation (O)?	Emmanuelle Bourdon, Volker Wenzel
		BLS 353	Harm from CPR to victims not in cardiac arrest	Among adults and children who are not in cardiac arrest outside of a hospital (P), does provision of chest compressions from lay rescuers (I), compared with no use of chest compressions (C), change survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; harm (e.g., rib fracture); complications; major bleeding; risk of complications (e.g., aspiration); survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival to admission (O)?	Raul Gazmuri, Hermann Brugger
		BLS 357	Hand position during compressions	Among adults and children who are receiving chest compressions in any setting (P), does delivery of chest compressions on the lower half of the sternum (I), compared with any other location for chest compressions (C), change survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year; ROSC; cardiac output; harm (eg, rib fracture); coronary perfusion pressure (O)?	Ian Drennan, Sung Phil Chung
		BLS 358	Minimizing pauses in chest compressions	Among adults and children who are in cardiac arrest in any setting (P), does minimization of pauses in chest compressions for cardiac rhythm analysis or ventilations (I), compared with prolonged pauses in chest compressions for rhythm analysis or ventilations (C), change survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year; ROSC; time to first shock; CPR quality; rhythm control (O)?	Rudolph Koster, Tetsuya Sakamoto

Appendix A (*Continued*)

Part	Task force	PICO ID	Short title	PICO question	Evidence reviewers
		BLS 359	Dispatcher instruction in CPR	Among adults and children who are in cardiac arrest outside of a hospital (P), does the ability of a dispatch system to provide CPR instructions (I), compared with a dispatch system where no CPR instructions are ever provided (C), change survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year; ROSC; delivery of bystander CPR; time to first shock; time to commence CPR; CPR parameters (O)?	Christian Vaillancourt, Michael Sayre
		BLS 360	EMS chest compression—only versus conventional CPR	Among adults who are in cardiac arrest outside of a hospital (P), does provision of chest compressions with delayed ventilation by EMS (I), compared with chest compressions with early ventilation by EMS (C), change survival with favorable neurologic outcome; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year; ROSC; time to first shock; time to first compressions; CPR quality (O)?	David Stanton, Andrew Travers
		BLS 361	Feedback for CPR quality	Among adults and children who are in cardiac arrest in any setting (P), does real-time feedback and prompt device regarding the mechanics of CPR quality (e.g., rate and depth of compressions and/or ventilations) (I), compared with no feedback (C), change survival with favorable neurologic outcome; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year; ROSC; bystander CPR rates; time to first compressions; time to first shock; CPR quality (O)?	Julie Considine, Joyce Yeung
		BLS 362	Compression ventilation ratio	Among adults and children who are in cardiac arrest in any setting (P), does delivery of CPR with another specific compression-ventilation ratio (I), compared with CPR that uses a 30:2 compression-ventilation ratio (C), change survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year; ROSC; hands-off time (O)?	Bo Lofgren, Jason Buick
		BLS 363	CPR before defibrillation	Among adults and children who are in VF or pulseless VT (pVT) in any setting (P), does a prolonged period of chest compressions before defibrillation (I), compared with a short period of chest compressions before defibrillation (C), change survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year; ROSC; rhythm control (O)?	Mohamud Daya, Jan-Thorsten Graesner
		BLS 366	Chest compression depth	Among adults who are in cardiac arrest in any setting (P), does a different chest compression depth during CPR (I), compared with chest compression depth to 5 cm (2 in.) (C), change survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year; ROSC; CPR quality; coronary perfusion pressure; cardiac output; bystander CPR performance (O)?	Ahamed Idris, Koen Monsieurs
		BLS 367	Chest wall recoil	Among adults and children who are in cardiac arrest in any setting (P), does maximizing chest wall recoil (I), compared with ignoring chest wall recoil (C), change Survival with Favorable neurological/functional outcome at discharge, 30 days, 60 days, 180 days AND/OR 1 year, Survival only at discharge, 30 days, 60 days, 180 days AND/OR 1 year, ROSC, coronary perfusion pressure, cardiac output (O)?	Tyler Vadeboncoeur, Keith Couper
		BLS 372	Chest compression–only CPR versus conventional CPR	Among adults who are in cardiac arrest outside of a hospital (P), does provision of chest compressions (without ventilation) by untrained/trained laypersons (I), compared with chest compressions with ventilation (C), change survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year; ROSC; bystander CPR performance; CPR quality (O)?	Andrew Travers, E. Brooke Lerner
		BLS 373	Analysis of rhythm during chest compression	Among adults and children who are in cardiac arrest in any setting (P), does analysis of cardiac rhythm during chest compressions (I), compared with standard care (analysis of cardiac rhythm during pauses in chest compressions) (C), change survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year; ROSC; time to first shock; time to commence CPR; CPR quality (O)?	Alfredo Sierra, Kevin Nation
		BLS 661	Starting CPR	Among adults and children who are in cardiac arrest in any setting (P), does CPR beginning with compressions first (30:2) (I), compared with CPR beginning with ventilation first (2:30) (C), change survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year; ROSC (O)?	Carl McQueen, Julie Considine

Appendix A (*Continued*)

Part	Task force	PICO ID	Short title	PICO question	Evidence reviewers
		BLS 740	Dispatcher recognition of cardiac arrest	Among adults and children who are in cardiac arrest outside of a hospital (P), does the description of any specific symptoms to the dispatcher (I), compared with the absence of any specific description (C), change the likelihood of cardiac arrest recognition (O)?	Manya Charette, Mike Smyth
		BLS 811	Resuscitation care for suspected opioid-associated emergencies	Adults and children with suspected opioid-associated cardiac/respiratory arrest in the pre-hospital setting (P), does bystander naloxone administration (intramuscular or intranasal), in addition to standard CPR (I), compared with conventional CPR (I), compared with conventional CPR only (C), change survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year; ROSC (O)?	Theresa Olasveengen, Aaron Orkin
		BLS 856	Drowning search and rescue	In adults and children who are submerged in water (P), does any particular factors in search and rescue operations (e.g., duration of submersion, salinity of water, water temperature, age of victim) (I), compared with no factors (C), change Survival with Favorable neurological/functional outcome at discharge, 30 days, 60 days, 180 days AND/OR 1 year, Survival only at discharge, 30 days, 60 days, 180 days AND/OR 1 year, ROSC (O)?	Joost Bierens, Linda Quan
		BLS 891	Opioid overdose response education	Adults and children at risk of suspected cardiac/respiratory arrest due to opioids in the prehospital setting (P), does opioid overdose response education with or without naloxone distribution (I), compared with no overdose response education or overdose prevention education only (C), change survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year; ROSC (O)?	Aaron Orkin, Theresa Olasveengen
Part 4	ALS	ALS 428	Antiarrhythmic drugs for cardiac arrest	Among adults who are in cardiac arrest in any setting (P), does administration of antiarrhythmic drugs (e.g., amiodarone, lidocaine, other) (I), compared with not using antiarrhythmic drugs (no drug or placebo) (C), change survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year; ROSC (O)?	Katie Dainty, Thomas Pellis, Steve Lin
		ALS 431	Postresuscitation seizure prophylaxis	Among adults with ROSC after cardiac arrest in any setting (P), does seizure prophylaxis (I), compared with no prophylaxis (C), reduce the incidence of seizures, or improve survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year (O)?	Romergryko Geocadin, William Stacey
		ALS 433	Steroids for cardiac arrest	Among adults who are in cardiac arrest in any setting (P), does corticosteroid or mineralocorticoid administration during CPR (I), compared with not using steroids (C), change survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year; ROSC (O)?	Sarah Todhunter, Tonia Nicholson
		ALS 435	Cardiac arrest associated with pulmonary embolism	Among adults who are in cardiac arrest due to PE or suspected PE in any setting (P), does any specific alteration in treatment algorithm (e.g., fibrinolytics, or any other) (I), compared with standard care (according to 2010 treatment algorithm) (C), change survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year; ROSC (O)?	Wolfgang Wetsch, Bernd Boettiger
		ALS 436	Cardiac arrest during pregnancy	Among pregnant women who are in cardiac arrest in any setting (P), do any specific interventions (I), compared with standard care (usual resuscitation practice) (C), change survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year; ROSC (O)?	Carolyn Zelop, Jill Mhyre
		ALS 441	Opioid toxicity	Among adults who are in cardiac arrest or respiratory arrest due to opioid toxicity in any setting (P), does any specific therapy (e.g., naloxone, bicarbonate, or other drugs) (I), compared with usual ALS (C), change survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year; ROSC (O)?	Allan Mottram, Fred Severyn, Mohammed Alhelail
		ALS 448	Oxygen dose after ROSC in adults	Among adults who have ROSC after cardiac arrest in any setting (P), does an inspired oxygen concentration titrated to oxygenation (normal oxygen saturation or partial pressure of oxygen) (I), compared with the use of 100% inspired oxygen concentration (C), change survival to 30 days with good neurologic outcome, survival to hospital discharge with good neurologic outcome, improve survival, survival to 30 days, survival to hospital discharge (O)?	Jasmeet Soar, Michael Donnino

Appendix A (*Continued*)

Part	Task force	PICO ID	Short title	PICO question	Evidence reviewers
		ALS 449	Organ donation	In adults and children who are receiving an organ transplant in any setting (P), do organs retrieved from a donor who has had CPR (I), compared with organs retrieved from a donor who did not have CPR (C), have improved immediate graft function (30 days), 1-year graft function, or 5-year graft function (O)?	Stephen West, Clifton Callaway
		ALS 450	Prognostication in comatose patients treated with hypothermic TTM	Among adults with ROSC who are treated with hypothermia (P), does any clinical variable when abnormal (e.g., clinical exam, EEG, somatosensory evoked potentials [SSEPs], imaging, other) (I), compared with any clinical variable when normal (C), reliably predict death or poor neurologic outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; death only at discharge, 30 days, 60 days, 180 days, and/or 1 year (O)?	Claudio Sandroni, Eyal Golan
		ALS 459	$ETCO_2$ to predict outcome of cardiac arrest	Among adults who are in cardiac arrest in any setting (P), does any $ETCO_2$ level value, when present (I), compared with any $ETCO_2$ level below that value (C), change survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year; ROSC (O)?	Brian O'Neil, Edison Paiva
		ALS 469	Confirmation of correct tracheal tube placement	Among adults who are in cardiac arrest, needing/with an advanced airway, in any setting (P), does use of devices (e.g., 1. Waveform Capnography, 2. CO_2 Detection Device, 3. Esophageal detector device or 4. Tracheal ultrasound) (I), compared with not using devices (C), change placement of the ET tube between the vocal cords and the carina, success of intubation (O)?	Sarah Heikal, Markus Skifvars
		ALS 470	Defibrillation strategies for ventricular fibrillation (VF) or pulseless ventricular tachycardia (pVT)	Among adults who are in ventricular fibrillation or pulseless ventricular tachycardia in any setting (P), does any specific defibrillation strategy (e.g., 1. energy dose, or 2. shock waveform) (I), compared with standard management (or other defibrillation strategy) (C), change Survival with Favorable neurological/functional outcome at discharge, 30 days, 60 days, 180 days AND/OR 1 year, Survival only at discharge, 30 days, 60 days, 180 days AND/OR 1 year, ROSC, termination of arrhythmia (O)?	Giuseppe Ristagno, Charles Deakin
		ALS 479	Cardiac arrest during coronary catheterization	Among adults who have a cardiac arrest in the cardiac catheterization laboratory (P), does any special intervention or change in care (e.g., catheterization during CPR, cardiopulmonary bypass, balloon pump, different timing of shocks) (I), compared with standard resuscitation care (e.g., CPR, drugs, and shocks according to 2010 treatment algorithm) (C), change survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year; ROSC (O)?	Ian Drennan, Peter Kudenchuk
		ALS 493	Postresuscitation antiarrhythmic drugs	Among adults with ROSC after cardiac arrest in any setting (P), do prophylactic antiarrhythmic drugs given immediately after ROSC (I), compared with not giving antiarrhythmic drugs (C), change survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; development of cardiac arrest; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year; recurrence of VF; incidence of arrhythmias (O)?	Thomas Pellis, Steve Lin
		ALS 570	Postresuscitation hemodynamic support	Among adults with ROSC after cardiac arrest in any setting (P), does titration of therapy to achieve a specific hemodynamic goal (e.g., MAP greater than 65 mmHg) (I), compared with no hemodynamic goal (C), change survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival at discharge, 30 days, 60 days, 180 days, and/or 1 year (O)?	Michael Fries, Michael Parr
		ALS 571	Postresuscitation ventilation strategy	Among adults with ROSC after cardiac arrest in any setting (P), does ventilation to a specific $Paco_2$ goal (I), compared with no specific strategy or a different $Paco_2$ goal (C), change survival at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year (O)?	Asger Granfeldt, Bo Lofgren
		ALS 579	Impedance threshold device	Among adults who are in cardiac arrest in any setting (P), does use of an inspiratory ITD during CPR (I), compared with no ITD (C), change survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year; ROSC (O)?	Peter Morley, Jasmeet Soar
		ALS 580	Glucose control after resuscitation	Among adults with ROSC after cardiac arrest in any setting (P), does a specific target range for blood glucose management (e.g., strict 4–6 mmol L^{-1}) (I), compared with any other target range (C), change survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year (O)?	Janice Zimmerman, Jonathon Sullivan

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Part	Task force	PICO ID	Short title	PICO question	Evidence reviewers
		ALS 656	Monitoring physiological parameters during CPR	Among adults who are in cardiac arrest in any setting (P), does the use of physiological feedback regarding CPR quality (e.g., arterial lines, $ETCO_2$ monitoring, SpO_2 waveforms, or others) (I), compared with no feedback (C), change survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year; ROSC; change in physiologic values by modifications in CPR (O)?	Amit Chopra, Natalie Wong
		ALS 658	Ultrasound during CPR	Among adults who are in cardiac arrest in any setting (P), does use of ultrasound (including echocardiography or other organ assessments) during CPR (I), compared with conventional CPR and resuscitation without use of ultrasound (C), change survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year; ROSC (O)?	Katherine Berg, Lars Wiuff Andersen
		ALS 659	Epinephrine versus vasopressin	Among adults who are in cardiac arrest in any setting (P), does use of epinephrine (I), compared with vasopressin (C), change survival to 30 days with good neurologic outcome, survival to 30 days, survival to hospital discharge with good neurologic outcome, survival to hospital discharge, ROSC (O)?	Laurie Morrison, Clifton Callaway, Steve Lin
		ALS 713	Prognostication in absence of TTM	Among adults who are comatose after cardiac arrest and are not treated with TTM (P), does any clinical finding when normal (e.g., clinical exam, EEG, SSEPs, imaging, other) (I), compared with any clinical finding when abnormal (C), reliably predict death or poor neurologic outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; death only at discharge, 30 days, 60 days, 180 days, and/or 1 year (O)?	Claudio Sandroni, Tobias Cronberg
		ALS 714	SGAs versus tracheal intubation	Among adults who are in cardiac arrest in any setting (P), does SGA insertion as first advanced airway (I), compared with insertion of a tracheal tube as first advanced airway (C), change survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year; ROSC; CPR parameters; development of aspiration pneumonia (O)?	Jerry Nolan, Charles Deakin
		ALS 723	ECPR versus manual or mechanical CPR	Among adults who are in cardiac arrest in any setting (P), does the use of ECPR techniques (including extracorporeal membrane oxygenation or cardiopulmonary bypass) (I), compared with manual CPR or mechanical CPR (C), change survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year; ROSC (O)?	Mayuki Aibiki, Tzong-luen Wang
		ALS 778	SDE versus HDE	In adult patients in cardiac arrest in any setting (P), does HDE (at least 0.2 mg kg^{-1} or 5 mg bolus dose) (I), compared with SDE (1 mg bolus dose) (C), change survival to 180 days with good neurologic outcome, survival to 180 days, survival to hospital discharge with good neurologic outcome, survival to hospital discharge, ROSC (O)?	Laurie Morrison, Clifton Callaway, Steve Lin
		ALS 782	Mechanical CPR devices	Among adults who are in cardiac arrest in any setting (P), do automated mechanical chest compression devices (I), compared with standard manual chest compressions (C), change survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year; ROSC (O)?	Steven Brooks, Laurie Morrison
		ALS 783	Basic versus advanced airway	Among adults who are in cardiac arrest in any setting (P), does insertion of an advanced airway (tracheal tube or SGA) (I), compared with basic airway (bag-mask device with or without oropharyngeal airway) (C), change survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year; ROSC; CPR parameters; development of aspiration pneumonia (O)?	Jerry Nolan, Jan-Thorsten Graesner
		ALS 784	Timing of administration of epinephrine	Among adults who are in cardiac arrest in any setting (P), does early epinephrine delivery by IV or IO route (e.g., less than 10 min after the beginning of resuscitation) (I), compared with delayed timing of epinephrine delivery (e.g., more than 10 min after the beginning of resuscitation) (C), change survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year; ROSC (O)?	Tonia Nicholson, Michael Donnino
		ALS 788	Epinephrine versus placebo	Among adults who are in cardiac arrest in any setting (P), does the use of epinephrine (I), compared with placebo or not using epinephrine (C), change survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year; ROSC (O)?	Laurie Morrison, Clifton Callaway, Steve Lin

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Part	Task force	PICO ID	Short title	PICO question	Evidence reviewers
		ALS 789	Epinephrine versus vasopressin in combination with epinephrine	Among adults who are in cardiac arrest in any setting (P), does use of both vasopressin and epinephrine (I), compared with using epinephrine alone (C), change survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year; ROSC (O)?	Clifton Callaway, Laurie Morrison, Steve Lin
		ALS 790	Targeted temperature management	Among patients with ROSC after cardiac arrest in any setting (P), does inducing mild hypothermia (target temperature 32 °C–34 °C) (I), compared with normothermia (C), change survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year (O)?	Joshua Reynolds, Katherine Berg
		ALS 791	Duration of TTM	In patients with ROSC after cardiac arrest in any setting (P), does induction and maintenance of hypothermia for any duration other than 24 h (I), compared with induction and maintenance of hypothermia for a duration of 24 h (C), change survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year (O)?	Theodoros Xanthos, Lars Wiuff Andersen
		ALS 802	Timing of induced hypothermia	Among patients with return of pulses after cardiac arrest in any setting (P), does induction of hypothermia before some time point (e.g., 1 h after ROSC or before hospital arrival) (I), compared with induction of hypothermia after that time point (C), change survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year (O)?	Theodoros Xanthos, Michael Cocchi
		ALS 808	Ventilation rate during continuous chest compression	Among adults with cardiac arrest with a secure airway receiving chest compressions (in any setting, and with standard tidal volume) (P), does a ventilation rate of 10 breaths/min (I), compared with any other ventilation rate (C), change survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year; ROSC (O)?	Koen Monsieurs, Jasmeet Soar, Gino Vissers
		ALS 834	Lipid therapy for cardiac arrest	In adult patients with cardiac arrest due to suspected drug toxicity (e.g., local anesthetics, tricyclic antidepressants, others) (P), does administration of IV lipid (I), compared with no IV lipid (C), change survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year; ROSC (O)?	Eric Lavonas, Mohammed Alhelail
		ALS 868	Seizure treatment	Among adults with ROSC after cardiac arrest in any setting (P), does effective seizure treatment (I), compared with no seizure control (C), change survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year (O)?	Romergryko Geocadin, William Stacey
		ALS 879	Prevention of fever after cardiac arrest	Among adults with ROSC after cardiac arrest in any setting (P), does prevention of fever to maintain strict normothermia (I), compared with no fever control (C), change survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year (O)?	Katherine Berg, Lars Wiuff Andersen
		ALS 889	Oxygen dose during CPR	In adults with cardiac arrest in any setting (P), does administering a maximal oxygen concentration (e.g., 100% by face mask or closed circuit) (I), compared with no supplementary oxygen (e.g., 21%) or a reduced oxygen concentration (e.g., 40%–50%) (C), change survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year; ROSC (O)?	Anthony Lagina, Jasmeet Soar
Part 5	ACS	ACS 332	ED Fibrinolysis and transport only for rescue PCI versus transport for PCI	Among adult patients with STEMI in the ED (of a non–PCI-capable hospital) (P), does transfer to a PCI center (I), compared with immediate in-hospital fibrinolysis and only transfer for ischemia-driven PCI (rescue PCI) in first 24 h (C), change short-term survival, stroke, major bleeding, reinfarction (O)?	Nikolaos Nikolaou, Abdulaziz Alali
		ACS 334	ED fibrinolysis and then routine early angiography versus only rescue PCI	Among adult patients with STEMI in the ED (of a non–PCI-capable hospital) who have received immediate in-hospital fibrinolysis (P), does routine transport for angiography at 3 to 6 h (or up to 24 h) (I), compared with only transfer for ischemia-driven PCI (rescue PCI) in first 24 h (C), change death, intracranial hemorrhage, major bleeding, stroke, reinfarction (O)?	Michelle Welsford, Robert O'Connor
		ACS 335	Prehospital ADP-receptor antagonists in STEMI	Among adult patients with suspected STEMI outside of the hospital (P), does prehospital administration of an ADP-receptor antagonist (clopidogrel, prasugrel, or ticagrelor) in addition to usual therapy (I), compared with administration of an ADP-receptor antagonist in-hospital (C), change death, intracranial hemorrhage, revascularization, stroke, major bleeding, reinfarction (O)?	Karen Woolfrey, Daniel Pichel

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Part	Task force	PICO ID	Short title	PICO question	Evidence reviewers
		ACS 336	Prehospital ECG	Among adult patients with suspected STEMI outside of a hospital (P), does prehospital 12-lead ECG with transmission or notification (I), compared with no ECG or no transmission/notification (C), change death, or time to treatment (first medical contact-to-balloon time, first medical contact-to-needle time, door-to-balloon time, door-to-needle time) (O)?	Michelle Welsford, Abdulaziz Alali
		ACS 337	Delayed PCI versus fibrinolysis stratified by time from symptoms	Among patients with STEMI stratified by time from symptom onset to presentation when fibrinolysis is readily available (P), does delayed PCI (I), compared with fibrinolysis (C), change mortality, reinfarction, major bleeding, intracranial hemorrhage (O)?	Anthony Scott, Hiroshi Nonogi
		ACS 338	Prehospital fibrinolysis versus ED fibrinolysis	Among adults who are suspected of having STEMI outside of a hospital (P), does prehospital fibrinolysis (I), compared with in-hospital fibrinolysis(C), change death, intracranial hemorrhage, revascularization, major bleeding, stroke, reinfarction (O)?	Chris Ghaemmaghami, Darren Walters
		ACS 340	PCI after ROSC with ST elevation	Among adult patients with ROSC after cardiac arrest with evidence of ST elevation on ECG (P), does emergency cardiac catheterization laboratory evaluation* (I), compared with cardiac catheterization later in the hospital stay or no catheterization (C), change hospital mortality and neurologically favorable survival (O)?	Darren Walters, Chris Ghaemmaghami
		ACS 341	Prehospital triage to PCI center versus prehospital fibrinolysis	Among adult patients with suspected STEMI outside of a hospital (P), does direct triage and transport to a PCI center (I), compared with prehospital fibrinolysis (C), change death, intracranial hemorrhage, major bleeding (O)?	Michelle Welsford, Michael Longeway
		ACS 559	Computer-assisted ECG STEMI interpretation	Among adult patients with suspected STEMI outside of a hospital (P), does the use of computer-assisted ECG interpretation (I), compared with physician ECG interpretation and/or clinical diagnosis of STEMI (C), change identification of STEMI on an ECG with acceptable rates of FNs to allow earlier identification and FPs, minimizing unnecessary intervention (O)?	Chi Keong Ching, Catherine Patocka
		ACS 562	Prehospital anticoagulants versus none in STEMI	Among adult patients with suspected STEMI outside of hospital transferred for primary PCI (P), does any anticoagulant administered prehospital (e.g., bivalirudin, dalteparin, enoxaparin, fondaparinux, UFH) (I), compared with no anticoagulant administered prehospital (C), change death, intracranial hemorrhage, revascularization, major bleeding, stroke, reinfarction (O)?	Farzin Beygui, Vincent Roule
		ACS 568	Prehospital anticoagulants vs UFH for STEMI	Among adult patients with suspected STEMI outside of a hospital transferred for primary PCI (P), does any anticoagulants prehospital (e.g., bivalirudin, dalteparin, enoxaparin, fondaparinux) (I), compared with UFH pre-hospital (C), change death, ICH, revascularization, major bleeding, stroke, reinfarction (O)?	Farzin Beygui, Vincent Roule
		ACS 737	Biomarkers to rule out ACS	In patients presenting to the ED with chest pain suspected to be of cardiac etiology (P), does a negative troponin test at presentation and 1, 2, 3, and 6 h (I), compared with a positive test (C), exclude the diagnosis of ACS (O)?	Robert O'Connor, Michelle Welsford
		ACS 779	ED fibrinolysis and routine early angiography versus transport for PCI	Among adult patients with STEMI in the ED of a non–PCI-capable hospital (P), does immediate in-hospital fibrinolysis and routine transfer for angiography at 3 to 6 h (or up to 24 h) (I), compared with transfer to a PCI center (C), change 30-day mortality, stroke, major bleeding, reinfarction (O)?	Nikolaos Nikolaou, Farzin Beygui
		ACS 873	Prehospital STEMI activation of the catheterization laboratory	Among adult patients with suspected STEMI outside of a hospital (P), does prehospital activation of catheterization laboratory (I), compared with no prehospital activation of the catheterization laboratory (C), change mortality, major bleeding, stroke, reinfarction (O)?	Karen Woolfrey, Daniel Pichel
		ACS 882	ED fibrinolysis and immediate PCI versus immediate PCI alone	Among adults who are having STEMI in the ED (P), does fibrinolytic administration combined with immediate PCI (I), compared with immediate PCI alone (C), change death, intracranial hemorrhage, reinfarction, urgent target vessel revascularization, major bleeding (O)?	Hiroshi Nonogi, Anthony Scott
		ACS 884	Non-physician STEMI ECG interpretation	Among adult patients with suspected STEMI outside of a hospital (P), do nonphysicians (e.g., nurses and paramedics) (I), compared with physicians (C), change identification of STEMI on an ECG with acceptable rates of FNs to allow earlier identification and FPs, minimizing unnecessary angiography (O)?	Chi Keong Ching, Catherine Patocka

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Part	Task force	PICO ID	Short title	PICO question	Evidence reviewers
		ACS 885	PCI after ROSC without ST elevation	Among adult patients with ROSC after cardiac arrest without evidence of ST elevation on ECG (P), does emergency cardiac catheterization laboratory evaluation (I), compared with cardiac catheterization later in the hospital stay or no catheterization (C), change hospital mortality and neurologically favorable survival (O)?	Chris Ghaemmaghami, Darren Walters
		ACS 887	Supplementary oxygen in ACS	Among adult patients with suspected ACS and normal oxygen saturation in any setting (prehospital, emergency, or in-hospital) (P), does withholding oxygen (I), compared with routine supplementary oxygen (C), change death, infarct size, chest pain resolution, ECG resolution (O)?	Anthony Scott, Anthony Seto
Part 6	Peds	Peds 387	Post-ROSC TTM	Among infants and children who are experiencing ROSC after cardiac arrest in any setting (P), does the use of TTM (e.g., therapeutic hypothermia) (I), compared with the use of normothermia (C), change survival to hospital discharge, ICU LOS (O)?	Ian Maconochie, Mark Coulthard
		Peds 394	Chest compression depth	In infants and children receiving chest compressions (in or out of hospital) (P), does the use of any specific chest compression depth (I), compared with the depth specified in the current treatment algorithm (C), change survival to 180 days with good neurologic outcome, survival to hospital discharge, complication rate, or intermediate physiological endpoints (O)?	Gabrielle Nuthall, Fernanda Sá
		Peds 397	Pediatric METs and RRTs	For infants and children in the in-hospital setting (P), does the use of pediatric METs/RRTs (I), compared with not using METs/RRTs (C), change cardiac or pulmonary arrest frequency outside of the intensive care unit (ICU), overall hospital mortality (O)?	Kee Chong Ng, Dianne Atkins
		Peds 405	Energy doses for defibrillation	Among infants and children who are in VF or pVT in any setting (P), does a specific energy dose or regimen of energy doses for the initial or subsequent defibrillation attempt(s) (I), compared with 2 to 4 J kg^{-1} (C), change survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival to hospital discharge; ROSC; termination of arrhythmia (O)?	Robert Bingham, Stuart Dalziel
		Peds 407	ECPR for IHCA	In infants and children with IHCA (P), does the use of ECMO for resuscitation, also called ECPR (I), when compared with conventional resuscitative treatment (CPR without the use of ECMO) (C), change survival to 180 days with good neurologic outcome, survival to hospital discharge, or survival to intensive care discharge (O)?	Anne-Marie Guerguerian, Ericka Fink
		Peds 414	Chest compression–only CPR versus conventional CPR	Among infants and children who are in cardiac arrest in any setting (P), does compression-only CPR (I), compared with the use of conventional CPR (C), change neurologically intact survival at 1 year, survival to hospital discharge, improved ICU LOS, neurologically intact survival at 30 days (O)?	Jonathan Duff, Dominique Biarent
		Peds 424	Vasopressor use during cardiac arrest	Among infants and children in cardiac arrest (P), does the use of no vasopressor (epinephrine, vasopressin, combination of vasopressors) (I), compared with any use of vasopressors (C), change survival to 180 days with good neurologic outcome, survival to hospital discharge, ROSC (O)?	Vinay Nadkarni, David Kloeck
		Peds 544	Post-ROSC Pao_2	Among infants and children with ROSC after cardiac arrest (in- or out-of-hospital setting) (P), does the use of a targeted Pao_2 strategy (I), compared with a strategy of no targeted Pao_2 (C), change ICU LOS, survival to 180 days with good neurologic outcome, survival to hospital discharge, survival to ICU discharge, survival to 6 months (O)?	Allan de Caen, Amelia Reis
		Peds 545	Fluid resuscitation in septic shock	Among infants and children who are in septic shock in any setting (P), does the use of restricted volumes of resuscitation fluid (I1) when compared with nonrestricted volumes (C1), or the use of noncrystalloid fluids (I2) when compared with crystalloid fluids (C2), change survival to hospital discharge, need for mechanical ventilation or vasopressor support, complications, time to resolution of shock, hospital length of stay (LOS), ventilator-free days, total intravenous (IV) fluids administered (O)?	Richard Aickin, Peter Meaney
		Peds 709	Sequence of chest compressions and ventilations: C–A–B versus A–B–C	Among infants and children who are in cardiac arrest in any setting (P), does the use of a circulation-airway-breathing approach to initial management (I), compared with the use of an airway-breathing-circulation approach to initial management (C), change ROSC, survival to hospital discharge, survival to 180 days with good neurologic outcome, time to first compressions (O)?	Naoki Shimizu, Christoph Eich

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Part	Task force	PICO ID	Short title	PICO question	Evidence reviewers
		Peds 813	Post-ROSC predictive factors	Among infants and children with return of circulation (P), does the presence of any specific factors (I), compared with the absence of those factors (C), change survival to 180 days with good neurologic outcome; survival to 60 days with good neurologic outcome; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival to 30 days with good neurologic outcome; survival to hospital discharge with good neurologic outcome (O)?	Thomaz Bittencourt Couto, Marc Berg
		Peds 814	Intra-arrest prognostic factors	Among infants and children during cardiac arrest (P), does the presence of any specific intra-arrest prognostic factors (I), compared with the absence of these factors (C), change survival to 180 days with good neurologic outcome; survival to 60 days with good neurologic outcome; survival to hospital discharge with good neurologic outcome; survival to 30 days with good neurologic outcome; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year (O)?	Audrey Shibata, Steve Schexnayder
		Peds 815	Post-ROSC ventilation: $Paco_2$ goals	Among infants and children with ROSC after cardiac arrest in any setting (P), does ventilation to a specific $Paco_2$ target (I), compared with ventilation to no specific $Paco_2$ target (C), change survival with favorable neurologic outcome, survival to 180 days with good neurologic outcome, survival to 30 days with good neurologic outcome, the likelihood of a good quality of life after discharge from the hospital, survival to hospital discharge, survival to hospital discharge, survival to 30 days, survival to 60 days, survival to 6 months, survival to ICU discharge (O)?	Javier Urbano, Janice Tijssen
		Peds 818	PEWS	For infants and children in the in-hospital setting (P), does the use of a pediatric early warning score (I), compared with not using a pediatric early warning score (C), change overall hospital mortality, Cardiac arrest frequency outside of the ICU (O)?	Alexis Topjian, Antonio Rodriguez-Nunez
		Peds 819	Prearrest care of pediatric dilated cardiomyopathy or myocarditis	For infants and children with myocarditis or dilated cardiomyopathy and impending cardiac arrest (P), does a specific approach (I), compared with the usual management of shock or cardiac arrest (C), change survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival to hospital discharge; cardiac arrest frequency; ROSC (O)?	Graeme MacLaren, Ravi Thiagarajan
		Peds 820	Post-ROSC fluid/inotropes	In infants and children after ROSC (P), does the use of parenteral fluids and inotropes and/or vasopressors to maintain targeted measures of perfusion such as blood pressure (I), as compared with not using these interventions (C), change patient satisfaction; survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival to hospital discharge; harm to patient (O)?	Melissa Parker, Takanari Ikeyama
		Peds 821	Atropine for emergency intubation	In infants and children requiring emergency tracheal intubation (P), does the use of atropine as a premedication (I), compared with not using atropine (C), change survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 90 days, 180 days, and/or 1 year after event; the incidence of cardiac arrest; survival to hospital discharge; the incidence of peri-intubation shock or arrhythmias (O)?	Gene Ong, Jos Bruinenberg
		Peds 822	Post-ROSC EEG	For infants and children who have had cardiac arrests in the in-hospital or out-of-hospital setting (P), does any use of neuroelectrophysiology information (EEG) (I), compared with none (C), predict survival at 1 year with good neurologic outcome, survival to 180 days with good neurologic outcome, survival to 60 days with good neurologic outcome, survival to 6 months, survival to 30 days with good neurologic outcome, survival to hospital discharge with good neurologic outcome, survival with favorable neurologic outcome, survival to hospital discharge (O)?	Stuart Friess, Corsino Rey
		Peds 825	Amiodarone versus lidocaine for shock-resistant VF or pVT	In children and infants with shock-refractory VF or pVT (P), does amiodarone (I), compared with lidocaine (C), change survival to hospital discharge, ROSC, recurrence of VF, termination of arrhythmia, risk of complications (e.g., need for tube change, airway injury, aspiration) (O)?	Dianne Atkins, Mary McBride, Brad Marino
		Peds 826	Invasive blood pressure monitoring during CPR	In children and infants undergoing CPR (P), does using invasive hemodynamic monitoring to titrate to a specific systolic/diastolic blood pressure (I), compared with not using invasive hemodynamic monitoring to titrate to a specific systolic/diastolic blood pressure (C), change survival to hospital discharge, 60 days after event, 180 days after event with favorable neurologic outcome, or the likelihood of ROSC or survival to hospital discharge (O)?	Tia Raymond, Jonathan Egan

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Part	Task force	PICO ID	Short title	PICO question	Evidence reviewers
		Peds 827	$ETCO_2$ monitoring during CPR	In infants and children in cardiac arrest (P), does adjustment of chest compression technique to achieve a specific $ETCO_2$ threshold (I), compared with not using $ETCO_2$ to adjust chest compression technique (C), change survival to 180 days with good neurologic outcome, the likelihood of survival to discharge, ROSC (O)?	Remigio Veliz, Monica Kleinman
Part 7	NRP	NRP 589	Temperature maintenance in the delivery room—prognosis	In nonasphyxiated babies at birth (P), does maintenance of normothermia (core temperature 36.5 °C or greater and 37.5 °C or less) from delivery to admission (I), compared with hypothermia (less than 36 °C) or hyperthermia (greater than 37.5 °C) (C), change survival to hospital discharge, respiratory distress, survival to admission, hypoglycemia, intracranial hemorrhage, or infection rate (O)?	Jonathan Wyllie, Jeffrey Perlman
		NRP 590	CPAP and IPPV—intervention	In spontaneously breathing preterm infants with respiratory distress requiring respiratory support in the delivery room (P), does the use of CPAP (I), compared with intubation and IPPV (C), improve outcome (O)?	Tetsuya Isayama, Ben Stenson
		NRP 599	Maintaining infant temperature during delivery room resuscitation—intervention	Among preterm neonates who are under radiant warmers in the hospital delivery room (P), does increased room temperature, thermal mattress, or another intervention (I), compared with plastic wraps alone (C), reduce hypothermia (less than 36 °C) on admission to neonatal intensive care unit (NICU) (O)?	Daniele Trevisanuto, Maria Fernanda de Almeida
		NRP 605	Thumb versus 2-finger techniques for chest compression—intervention	In neonates receiving cardiac compressions (P), does the use of a 2-thumb technique (I), compared with a 2-finger technique (C), result in return of spontaneous circulation (ROSC), improved neurologic outcomes, improved survival, improved perfusion and gas exchange during CPR, and decreased compressor fatigue (O)?	Myra Wyckoff, Lindsay Mildenhall
		NRP 618	Laryngeal mask airway—intervention	In newborn infants at near term (greater than 34 weeks) or term who have indications for intermittent positive pressure for resuscitation (P), does use of a laryngeal mask as a primary or secondary device (I), compared with mask ventilation or endotracheal intubation (C), improve response to resuscitation or change outcome (O), including indicators of neonatal brain injury, achieving stable vital signs, increasing Apgar scores, long-term outcomes, reducing the need for subsequent intubation, or neonatal morbidity and mortality?	Edgardo Szyld, Enrique Udaeta
		NRP 734	Limited-resource–induced hypothermia—intervention	In term infants with moderate/severe hypoxic-ischemic encephalopathy managed in resource-limited countries (P), does therapeutic hypothermia to core temperature of approximately 33.5 °C for 72 h delivered by passive hypothermia and/or ice packs (I), versus standard therapy (C), improve the rates of death, neurodevelopmental impairments at 18 months to 2 years (O)?	Jeffrey Perlman
		NRP 738	Oxygen delivery during CPR (neonatal)—intervention	In neonates receiving cardiac compressions (P), does 100% O_2 as the ventilation gas (I), compared with lower concentrations of oxygen (C), increase survival rates, improve neurologic outcomes, decrease time to ROSC, or decrease oxidative injury (O)?	Myra Wyckoff, Lindsay Mildenhall
		NRP 787	Delayed cord clamping in preterm infants requiring resuscitation (intervention)	In preterm infants, including those who received resuscitation (P), does delayed cord clamping (greater than 30 s) (I), compared with immediate cord clamping (C), improve survival, long-term developmental outcome, cardiovascular stability, occurrence of intraventricular hemorrhage (IVH), necrotizing enterocolitis, temperature on admission to a newborn area, and hyperbilirubinemia (O)?	Masanori Tamura, Susan Niermeyer
		NRP 793	Maintaining infant temperature during delivery room resuscitation—intervention	In newborn infants (greater than 30 weeks of gestation) in low-resource settings during and/or after resuscitation/stabilization (P), does drying and skin-to-skin contact or covering with plastic (I), compared with drying and no skin-to-skin or use of radiant warmer or incubator (C), change body temperature (O)?	Sithembiso Velaphi, Hege Ersdal, Nalini Singhal
		NRP 804	Babies born to mothers who are hypothermic or hyperthermic in labor—prognosis	In newborn babies (P), does maternal hypothermia or hyperthermia in labor (I), versus normal maternal temperature (C), result in adverse neonatal effects (O)? Outcomes include mortality, neonatal seizures, and adverse neurologic states.	Henry Lee, Marilyn Escobedo
		NRP 805	Delivery room assessment for less than 25 weeks and prognostic score	In extremely preterm infants (less than 25 weeks) (P), does delivery room assessment with a prognostic score (I), compared with gestational age assessment alone (C), change survival to 18 to 22 months (O)?	Steven Ringer, Steve Byrne

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Part	Task force	PICO ID	Short title	PICO question	Evidence reviewers
		NRP 806	Newborn infants who receive PPV for resuscitation, and use of a device to assess respiratory function—diagnostic	In newborn infants who receive PPV for resuscitation (P), does use of a device to assess respiratory function with or without pressure monitoring (I), compared with no device (C), change survival to hospital discharge with good neurologic outcome, IVH, time to heart rate greater than 100/min, bronchopulmonary dysplasia, pneumothorax (O)?	Helen Liley, Vishal Kapadia
		NRP 809	Sustained inflations—intervention	In term and preterm newborn infants who do not establish spontaneous respiration at birth (P), does administration of 1 or more pressure-limited sustained lung inflations (I), compared with intermittent PPV with short inspiratory times (C), change Apgar score at 5 min, establishment of FRC, requirement for mechanical ventilation in first 72 h, time to heart rate greater than 100/min, rate of tracheal intubation, overall mortality (O)?	Jane McGowan, David Boyle
		NRP 849	Umbilical cord milking—intervention	In very preterm infants (28 weeks or less) (P), does umbilical cord milking (I), in comparison with immediate umbilical cord clamping (C), affect death, neurodevelopmental outcome at 2 to 3 years, cardiovascular stability, i.e., need for pressors, need for fluid bolus, initial mean blood pressure, IVH (any grade, severe grade), temperature on admission, hematologic indices (initial hemoglobin, need for transfusion), hyperbilirubinemia, need for phototherapy, or need for exchange transfusion (O)?	Marya Strand, Takahiro Sugiura
		NRP 858	Warming of hypothermic newborns—intervention	In newborns who are hypothermic (temperature less than 36.0 °C) on admission (P), does rapid rewarming (I), compared with slow rewarming (C), change mortality rate, short and long-term neurologic outcome, hemorrhage, episodes of apnea and hypoglycemia, or need for respiratory support (O)?	Cheo Yeo, Daniele Trevisanuto
		NRP 859	Resuscitation training frequency	For course participants including (a) trainees and (b) practitioners (P), does frequent training (I), compared with less frequent training (annual or biennial) (C), change all levels of education or practice, prevention of adverse outcomes, overall mortality, scenario performance, medical knowledge, psychomotor performance, provider confidence, course satisfaction (O)?	Chris Colby, Khalid Aziz
		NRP 860	Predicting death or disability of newborns of greater than 34 weeks based on Apgar and/or absence of breathing—prognosis	In newborn infants of greater than 34 weeks of gestation, receiving PPV at birth in settings where resources are limited (P), does presence of heart rate with no spontaneous breathing or Apgar scores of 1 to 3 at greater than 5 min predict mortality or morbidity or cerebral palsy (O)?	Sithembiso Velaphi, Nalini Singhal, Hege Ersdal
		NRP 862	Use of feedback CPR devices for neonatal Cardiac arrest—diagnostic	In asystolic/bradycardic neonates receiving cardiac compressions (P), does the use of feedback devices such as end-tidal carbon dioxide ($ETCO_2$) monitors, pulse oximeters, or automated compression feedback devices (I), compared with clinical assessments of compression efficacy (C), decrease hands-off time, decrease time to ROSC, improve perfusion, increase survival rates, or improve neurologic outcomes (O)?	Lindsay Mildenhall, Takahiro Sugiura
		NRP 864	Oxygen concentration for resuscitating premature newborns—intervention	Among preterm newborns (less than 37 weeks of gestation) who receive PPV in the delivery room (P), does the use of high O_2 (50–100%) as the ventilation gas (I), compared with low concentrations of O_2 (21–30%) (C), decrease mortality, decrease bronchopulmonary dysplasia, decrease retinopathy, decrease IVH (O)?	Gary Weiner, Douglas McMillan
		NRP 865	Intubation and tracheal suctioning in nonvigorous infants born though MSAF versus no intubation for tracheal suctioning—intervention	In nonvigorous infants at birth born through MSAF (P), does tracheal intubation for suctioning (I), compared with no tracheal intubation (C), reduce meconium syndrome or prevent death (O)?	Sithembiso Velaphi, Jeffrey Perlman
		NRP 867	Neonatal resuscitation instructors	In neonatal resuscitation instructors (P), does formal training on specific aspects of how to facilitate learning (I), compared with generic or nonspecific training (C), change clinical outcome, improve all levels of education or practice (O)?	Helen Liley, Louis Halamek
		NRP 870	T-piece resuscitator and self-inflating bag—intervention	In newborns (preterm and term) receiving ventilation (PPV) during resuscitation (P), does using a T-piece resuscitator with PEEP (I), compared with using a self-inflating bag without PEEP (C), achieve spontaneous breathing sooner and/or reduce the incidence of pneumothorax, bronchopulmonary dysplasia, and mortality (O)?	Yacov Rabi, Han Suk Kim

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Part	Task force	PICO ID	Short title	PICO question	Evidence reviewers
		NRP 895	Chest compression ratio—intervention	In neonates receiving cardiac compressions (P), do other ratios (5:1, 9:3, 15:2, synchronous, etc) (I), compared with 3:1 compressions to ventilations (C), increase survival rates, improve neurologic outcomes, improve perfusion and gas exchange during CPR, decrease time to ROSC, decrease tissue injury, or decrease compressor fatigue (O)?	Qi Feng, Myra Wyckoff
		NRP 896	Apgar score of 0 for 10 min or longer—prognosis	In infants with a gestational age of 36 weeks or greater and an Apgar score of 0 for 10 min or longer, despite ongoing resuscitation (P), what is the rate of survival to NICU admission and death or neurocognitive impairment at 18 to 22 months (O)?	Ruth Guinsburg, Jane McGowan
		NRP 897	Outcomes for PEEP versus No PEEP in the delivery room—intervention	In preterm/term newborn infants who do not establish respiration at birth (P), does the use of PEEP as part of the initial ventilation strategy (I), compared with no PEEP (C), improve Apgar score at 5 min, intubation in the delivery room, chest compressions in the delivery room, heart rate greater than 100 min^{-1} by 2 min of life, time for heart rate to rise above 100 min^{-1}, air leaks, oxygen saturation/oxygenation, FIO_2 in the delivery room, mechanical ventilation in the first 72 h, bronchopulmonary dysplasia, survival to discharge (O)?	Yacov Rabi, Colm O'Donnell
		NRP 898	ECG/EKG (I) in comparison to oximetry or auscultation for the detection of heart rate	In babies requiring resuscitation (P), does electrocardiography (ECG/EKG) (I), compared with oximetry or auscultation (C), measure heart rate faster and more accurately (O)?	Marya Strand, Hege Ersdal
Part 8	EIT	EIT 623	High-fidelity manikins in training	Among participants undertaking ALS training in an education setting (P), does the use of high-fidelity manikins (I), compared with the use of low-fidelity manikins (C), change patient outcomes, skill performance in actual resuscitations, skill performance at 1 year, skill performance at time between course conclusion and 1 year, skill performance at course conclusion, cognitive knowledge (O)?	Adam Cheng, Andy Lockey
		EIT 624	Cardiac arrest centers	Adults and children in OHCA (P), does transport to a specialist cardiac arrest center (I), compared with no directed transport (C), change neurologically intact survival at 30 days, survival to hospital discharge with good neurologic outcome, survival to hospital discharge, hospital admission, ROSC (O)?	Judith Finn, Dion Stub
		EIT 628	Timing for BLS retraining	Among students who are taking BLS courses (P), does any specific interval for update or retraining (I), compared with standard practice (i.e., 12 or 24 monthly) (C), change patient outcomes, skill performance in actual resuscitations, skill performance at 1 year, skill performance at course conclusion, cognitive knowledge (O)?	Taku Iwami, Theresa Olasveengen
		EIT 631	Team and leadership training	Among students who are taking ALS courses in an educational setting (P), does inclusion of specific leadership or team training (I), compared with no such specific training (C), change patient outcomes, bystander CPR performance, skill performance in actual resuscitations, skill performance at 1 year, skill performance at course conclusion, cognitive knowledge (O)?	Koen Monsieurs, Elaine Gilfoyle
		EIT 633	Timing for advanced resuscitation training	Among students who are taking ALS courses in an educational setting (P), does any specific interval for update or retraining (I), compared with standard practice (i.e., 12 or 24 monthly) (C), change/improve patient outcomes, skill performance in actual resuscitations, skill performance between course completion and 1 year; skill performance at 1 year, skill performance at course conclusion, cognitive knowledge (O)?	Matthew Ma, Chih-wei Yang, Farhan Bhanji
		EIT 634	Resource-limited settings	Among students who are taking BLS or ALS courses in a resource-limited educational setting (P), does any educational approach (I), compared with other approaches (C), change clinical outcome, skill performance in actual resuscitations, skill performance at 1 year, skill performance at time between course conclusion and 1 year, skill performance at course conclusion, cognitive knowledge (O)?	David Kloeck, Traci Wolbrink
		EIT 637	Precourse preparation for advanced life support courses	Among students who are taking ALS courses in an educational setting (P), does inclusion of specific precourse preparation (e.g., eLearning and pretesting) (I), compared with no such preparation (C), change survival rates, skill performance in actual resuscitations, cognitive knowledge, skill performance at course conclusion, skill performance at 1 year, skill performance at time between course conclusion and 1 year (O)?	Andy Lockey, Mary Mancini, John Billi
		EIT 638	Medical emergency teams for adults	Among adults who are at risk for cardiac or respiratory arrest in the hospital (P), does use of the Early Warning Score (EWS)/response teams/MET systems (I), compared with no such responses (C), change survival to hospital discharge, in-hospital incidence of cardiac/respiratory arrest, survival to hospital discharge with good neurologic outcome (O)?	Mary Mancini, Robert Frengley

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Part	Task force	PICO ID	Short title	PICO question	Evidence reviewers
		EIT 640	Measuring performance of resuscitation systems	Among resuscitation systems caring for patients in cardiac arrest in any setting (P), does a performance measurement system (I), compared with no system (C), change survival to hospital discharge, skill performance in actual resuscitations, survival to admission, system-level variables (O)?	Blair Bigham, Robert Schultz
		EIT 641	Implementation of guidelines in communities	Within organizations that provide care for patients in cardiac arrest in any setting (P), does implementation of resuscitation guidelines (I), compared with no such use (C), change survival to 180 days with good neurologic outcome, survival to hospital discharge, bystander CPR performance, ROSC (O)?	Jon Rittenberger, Theresa Olasveengen, Patrick Ko
		EIT 645	Debriefing of resuscitation performance	Among rescuers who are caring for patients in cardiac arrest in any setting (P), does briefing or debriefing (I), compared with no briefing or debriefing (C), change survival, skill performance in actual resuscitations, improve quality of resuscitation (e.g., reduce hands-off time), cognitive knowledge (O)?	Robert Greif, Dana Edelson
		EIT 647	CPR instruction methods (self-instruction versus traditional)	Among students who are taking BLS courses in an educational setting (P), does video or computer self-instructions (I), compared with traditional instructor-led courses (C), change survival, skill performance in actual resuscitations, skill performance at 1 year, skill performance at course conclusion, cognitive knowledge (O)?	Ming-Ju Hsieh, Matthew Ma, Judy Young
		EIT 648	CPR feedback devices in training	Among students who are taking BLS or ALS courses in an educational setting (P), does CPR feedback device use (I), compared with no use of CPR feedback devices (C), change improve patient outcomes, skill performance in actual resuscitations, skill performance at 1 year, skill performance at course conclusion, cognitive knowledge (O)?	Joyce Yeung, Mary Ann McNeil
		EIT 649	Basic life support training for high-risk populations	For people at high risk of OHCA (P), does focused training of likely rescuers (e.g., family or caregivers) (I) compared with no such targeting (C), change survival with favorable neurologic outcome at discharge, ROSC, bystander CPR performance, number of people trained in CPR, willingness to provide CPR (O)?	Janet Bray, Marion Leary
		EIT 651	AED training methods	Among students who are taking AED courses in an educational setting (P), does any specific training intervention (I), compared with traditional lecture/practice sessions (C), change clinical outcome, skill performance in actual resuscitations, skill performance at 1 year, skill performance at course conclusion, cognitive knowledge, use of AEDs (O)?	Jan Breckwoldt, Henrik Fischer
		EIT 878	Social media technologies	For OHCA (P), does having a citizen CPR responder notified of the event via technology or social media (I), compared with no such notification (C), change survival to hospital discharge with good neurologic outcome, survival to hospital discharge, hospital admission, ROSC, bystander CPR rates, time to first compressions (O)?	Zuzana Triska, Steven Brooks
		EIT 881	Compression-Only CPR Training	Among communities that are caring for patients in cardiac arrest in any setting (P), does teaching compression-only CPR (I), compared with conventional CPR (C), change survival rates, bystander CPR rates, willingness to provide CPR (O)?	Jonathan Duff, Aaron Donoghue
Part 9	First aid	FA 500	Second dose of epinephrine for anaphylaxis	Among adults and children experiencing severe anaphylaxis requiring the use of epinephrine (P), does administration of a second dose of epinephrine (I), compared with administration of only 1 dose (C), change resolution of symptoms, adverse effects, complications (O)?	Athanasios Chalkias, Barbara Caracci, Emmy De Buck
		FA 503	Straightening of an angulated fracture	Among adults and children who receive first aid for an angulated long bone fracture (P), does realignment of the fracture prior to splinting (I), compared with splinting as found (C), change neurologic injury, vascular injury, splinting, pain, time to medical transportation (O)?	Ryan Fringer, Catherine Patocka
		FA 517	Recovery position	Among adults who are breathing and unresponsive outside of a hospital (P), does positioning in a lateral, side-lying, recovery position (I), compared with supine position (C), change overall mortality, need for airway management, the incidence of aspiration, the likelihood of cervical spinal injury, complications, incidence of cardiac arrest (O)?	Janel Swain, S Seitz
		FA 519	Oxygen administration for first aid	Among adults and children who exhibit symptoms or signs of shortness of breath, difficulty breathing, or hypoxemia outside of a hospital (P), does administration of supplementary oxygen (I), compared with no administration of oxygen (C), change survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year; shortness of breath; time to resolution of symptoms; or therapeutic endpoints (e.g., oxygenation and ventilation) (O)?	Michael Nemeth, Chih-Hung Wang
		FA 520	Optimal position for shock	Among adults and children who receive first aid for shock (P), does positioning of the patient (I), compared with not positioning the patient (C), change overall mortality, complications, incidence of cardiac arrest, vital signs, hospital length of stay (O)?	Anthony Handley, Luis Lojero-Wheatley, Justin DeVoge

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Part	Task force	PICO ID	Short title	PICO question	Evidence reviewers
		FA 525	First aid treatment for an open chest wound	Among adults and children who are being treated for an open chest wound outside of a hospital (P), does occlusive bandage application or occlusive device (I), compared with a nonocclusive dressing (C), change or improve survival, respiratory arrest, oxygen saturation, vital signs, the rate of cardiac and respiratory arrests, improve therapeutic endpoints (oxygenation and ventilation) (O)?	Wei-tien Chang, Kyee Han
		FA 530	Control of bleeding	Among adults and children with bleeding (P), does application of localized cold therapy, elevation of extremity, and/or application of pressure over proximal pressure points (I), compared with direct pressure alone (C), change overall mortality, hemostasis, major bleeding, complications, hospital length of stay (O)?	Richard Bradley, Jae-Hyug Woo
		FA 534	Bronchodilator use for asthma with difficulty breathing	Among adults and children in the prehospital setting who have asthma and are experiencing difficulty in breathing (P), does bronchodilator administration (I), compared with no bronchodilator administration (C), change time to resolution of symptoms, time to resumption of usual activity, complications, harm to patient, therapeutic endpoints (e.g., oxygenation and ventilation), need for advanced medical care (O)?	Andrew MacPherson, Nathan Charlton, Ian Blanchard
		FA 540	Eye chemical injury: irrigation	Among adults and children who have a chemical or other unknown substance enter the conjunctival sac (P), does irrigation with isotonic saline, balanced salt solution, or other commercial eye irrigation solutions (I), compared with irrigation with water (C), change tissue healing, functional recovery, pain, complications, time to resumption of usual activity, restoration to the preexposure condition, time to resolution of symptoms (O)?	Ralph Shenefelt, L. Kristian Arnold, Janel Swain
		FA 584	Exertional dehydration and oral rehydration	Among adults and children with exertion-related dehydration (P), does drinking oral carbohydrate-electrolyte (CE) liquids (I), compared with drinking water (C), change volume/hydration status, vital signs, development of hyperthermia, development of hyponatremia, need for advanced medical care, blood glucose, patient satisfaction (O)?	Rita Herrington, Amy Kule, Jestin Carlson
		FA 586	Aspirin for chest pain (early vs. late)	Among adults who are experiencing chest pain outside of a hospital (P), does early administration of aspirin (I), compared with later administration of aspirin (C), change cardiovascular mortality, complications, incidence of cardiac arrest, cardiac functional outcome, infarct size, hospital length of stay, chest pain resolution (O)?	Janel Swain, Thomas Evans
		FA 768	Use of a tourniquet	Among adults and children with severe external limb bleeding (P), does the application of a tourniquet (I), compared with not applying a tourniquet (C), change hemostasis, overall mortality, vital signs, functional limb recovery, complications, blood loss, incidence of cardiac arrest (O)?	Jan Jensen, Michael Reilly
		FA 769	Hemostatic dressings	In patients with severe external bleeding (P), does the application of topical hemostatic dressings plus standard first aid (I), compared with standard first aid alone (C), change overall mortality, vital signs, hemostasis, complications, blood loss, major bleeding, incidence of cardiac arrest (O)?	Jan Jensen, Richard Bradley
		FA 770	Cooling of burns	Among adults and children with thermal injuries (P), does active cooling of burns (I), compared with passive cooling (C), change pain, complications, wound healing, need for advanced medical care, patient satisfaction, rates of fasciotomy, depth or breadth of burn (O)?	Natalie Hood, Nathan Charlton
		FA 771	Wet compared with dry burn dressings	Among adults and children with thermal injuries (P), does the use of a wet dressing (I), compared with dry dressing (C), change complications, pain, tissue healing, need for advanced medical care, patient satisfaction, rates of fasciotomy (O)?	Emmy De Buck, Ian Blanchard
		FA 772	Cervical spinal motion restriction	Among adults and children with suspected blunt traumatic cervical spinal injury (P), does cervical spinal motion restriction (I), compared with no cervical spinal motion restriction (C), change neurologic injury, complications, overall mortality, pain, patient comfort, movement of the spine, hospital length of stay (O)?	Tessa Dieltjens, Jeff Woodin
		FA 773	First aid training	Among adults and children receiving first aid (P), does care from a trained first aid provider (I), compared with care from an untrained person (C), change increase survival rates, recognition of acute injury or illness, prevent further illness or injury (i.e., harm), time to resolution of injury, the likelihood of harm (e.g., infection), time to resolution of symptoms (O)?	Jeffrey Pellegrino, Danita Koehler
		FA 794	Dental avulsion	Among adults and children with an avulsed permanent tooth (P), does storage of the tooth in any solution prior to replantation (I), compared with storage in whole milk or the patient's saliva (C), change success of reimplantation, tooth survival or viability, infection rate, pain, malfunction (eating, speech), color of the tooth (O)?	Nele Pauwels, Bryan Kitch
		FA 795	Hypoglycemia treatment	Among adults and children with symptomatic hypoglycemia (P), does administration of dietary forms of sugar (I), compared with standard dose (15–20 g) of glucose tablets (C), change time to resolution of symptoms, risk of complications (e.g., aspiration), blood glucose, hypoglycemia, hospital length of stay (O)?	Jestin Carlson, Susanne Schunder-Tatzber

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Part	Task force	PICO ID	Short title	PICO question	Evidence reviewers
		FA 799	Concussion	Among adults and children with suspected head injury without loss of consciousness (P), does use of a simple concussion scoring system (I), compared with standard first aid assessment without a scoring system (C), change time to recognition of the deteriorating patient, the likelihood of a poor neurologic outcome, survival to 30 days with good neurologic outcome, need for advanced medical care, time to medical transportation, or likelihood of differentiating between minor head contusion and more serious concussion (O)?	Richard Rusk, Christina Gruber
		FA 801	Stroke recognition	Among adults with suspected acute stroke (P), does the use of a rapid stroke scoring system or scale (I), compared with standard first aid assessment (C), change time to treatment (e.g., door to drug), recognition of acute injury or illness, discharge with favorable neurologic status, survival with favorable neurologic outcome, or increased public/layperson recognition of stroke signs (O)?	Pascal Cassan, Jeffrey Ferguson, Daniel Meyran
		FA 871	Aspirin for chest pain: administration	Among adults experiencing chest pain due to suspected MI (P), does administration of aspirin (I), compared with no administration of aspirin (C), change cardiovascular mortality, complications, adverse effects, incidence of cardiac arrest, cardiac functional outcome, infarct size, hospital length of stay (O)?	Thomas Evans, Janel Swain

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