Resuscitation
journal homepage: www.elsevier.com/locate/resuscitation

Executive Summary 2020 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations☆

Jerry P. Nolan, Ian Maconochie, Jasmeet Soar, Theresa M. Olasveengen, Robert Greif, Myra H. Wyckoff, Eunice M. Singletary, Richard Aickin, Katherine M. Berg, Mary E. Mancini, Farhan Bhanji, Jonathan Wyllie, David Zideman, Robert W. Neumar, Gavin D. Perkins, Maaret Castrén, Peter T. Morley, William H. Montgomery, Vinay M. Nadkarni, John E. Billi, Raina M. Merchant, Allan de Caen, Raffo Escalante-Kanashiro, David Kloeck, Tzong-Luen Wang, Mary Fran Hazinski

Keywords: AHA Scientific Statements, advanced life support, basic life support, cardiopulmonary resuscitation, first aid, neonatal life support, pediatric life support, resuscitation education

The International Liaison Committee on Resuscitation (ILCOR) was formed in 1992 as an international council of councils 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.[1] The ILCOR mission is to promote, disseminate, and advocate international implementation of evidence-informed resuscitation and first aid by using transparent evaluation and consensus summary of scientific data. Resuscitation includes all responses necessary to treat sudden life-threatening events affecting the cardiovascular and respiratory systems, with a focus on sudden cardiac arrest. As in 2015, this 2020 consensus publication also includes first aid topics as part of the international review and consensus recommendations.

There are 6 ILCOR Task Forces: (adult) Basic Life Support (BLS); (adult) Advanced Life Support (ALS); Pediatric (basic and advanced) Life Support (PLS); Neonatal Life Support (NLS); Education, Implementation, and Teams (EIT); and First Aid. This *2020 International Consensus on Cardiopulmonary Resuscitation* (CPR) *and Emergency Cardiovascular Care* (ECC) *Science With Treatment Recommendations* (CoSTR) includes a separate publication from each of the 6 task forces as well as this Executive Summary and a publication detailing the evidence evaluation process and management of potential conflicts of interest.

In this publication, the separate sections for each task force highlights the "hot" topics and the new CoSTRs developed. Not all relevant references are cited here; refer to each task force publication in this supplement for details of each of the reviews and task force deliberations. In addition, each task force publication summarizes additional reviews that are not highlighted in this Executive Summary.

Evidence Evaluation Process and Management of Potential Conflicts of Interest

Evidence Evaluation Process

ILCOR is committed to a rigorous and continuous review of scientific literature focused on resuscitation, cardiac arrest, relevant conditions

☆ This article has been co-published in Circulation.

https://doi.org/10.1016/j.resuscitation.2020.09.009
Available o

requiring first aid, related education and implementation strategies, and systems of care. After the publication of the *2015 International Consensus on CPR and ECC Science With Treatment Recommendations*, ILCOR also committed to sponsoring a continuous evidence-evaluation process, with topics prioritized for review by the task forces and with CoSTR updates published annually. For this 2020 CoSTR, the 6 ILCOR task forces performed structured reviews of 184 topics, completing the most ambitious evidence review that ILCOR has attempted to date.

The ILCOR systematic review process continues to be based on the methodological principles published by the National Academy of Health and Medicine (formerly the Institute of Medicine)[2]; Cochrane[3,4]; Grading of Recommendations Assessment, Development, and Evaluation (GRADE)[5]; and the reporting guidelines based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses recommendations.[6,7]

Three types of evidence evaluation provided the basis for this 2020 CoSTR: the systematic review, the scoping review, and the evidence update. Based on recommendations from the ILCOR Scientific Affairs Committee and agreement of the task forces, only systematic reviews could result in new or modified treatment recommendations.

Systematic Reviews

The systematic review (SysRev) represents the most structured and detailed of the reviews. It requires a rigorous process following strict methodology to answer a specific question, and each SysRev resulted in the generation of the task force CoSTR included in this publication. For this 2020 CoSTR process, ILCOR member councils agreed that treatment recommendations could be changed only as the result of a SysRev.

The SysRevs were performed by a knowledge synthesis unit (groups of well-respected researchers with methodological expertise in performing SysRevs), an expert systematic reviewer (an individual with methodological expertise and a track record of publications), or the task force. Many of the reviews resulted in separate published SysRevs.

To begin the SysRev, the task force and reviewers phrased the question to be answered in terms of the PICOST (population, intervention, comparator, outcome, study design, time) format. The literature searches were developed and conducted by information specialists who used, at a minimum, the MEDLINE, Embase, and the Cochrane Library databases. The clinical experts for the SysRev reviewed all identified studies and selected those that met inclusion criteria. The reviewers rated the risk of bias for each study, analysed the data, and performed meta-analyses as appropriate. The reviewers used the GRADE framework to rate the certainty/confidence in the estimates of the effect of an intervention or assessment across a body of evidence for each of the predefined outcomes; certainty, or confidence, was rated as high, moderate, low, or very low. Evidence from randomized controlled trials (RCTs) generally began the analysis as high-certainty evidence, and evidence from observational studies generally began the analysis as low-certainty evidence; examination of the evidence using the GRADE approach could result in either downgrading or upgrading the certainty of evidence. For additional information, refer to "2020 Evidence Evaluation Process and Management of Potential Conflicts of Interest" in this supplement.[8a,8b]

The data analysis was presented to the task force, and the task force drafted the summary consensus on science as well as the treatment recommendations. Each treatment recommendation indicates the strength of the recommendation (recommends = strong, suggests = weak) and the certainty of the evidence. The structured deliberations that the task force completed are highlighted in an evidence-to-decision table, with a table for each new, completed CoSTR included in Appendix A of each task force publication in this supplement.

Draft 2020 CoSTRs were posted on the ILCOR website[9] for a 2-week comment period. The task forces reviewed the comments and modified the CoSTR content as needed. Each task force publication in this supplement contains the final wording of the CoSTR statements as approved by the ILCOR task forces and by the ILCOR member councils.

Scoping Reviews

Scoping reviews (ScopRevs) are designed to identify the extent, range, and nature of evidence on a topic or a question. They follow a rigorous process but use a broader search strategy and were performed by topic experts in consultation with the task forces. The ScopRev produces a narrative summary of evidence, with tables presenting key data from the studies identified but with no risk of bias analysis for each study. The task force analysed the identified evidence and determined its value and implications for resuscitation practice or research. The rationale for each ScopRev, the summary of evidence, and task force insights are all highlighted in the body of each task force publication. If a ScopRev identified substantive evidence that may result in a future change in ILCOR treatment recommendations, the task force recommended that a new SysRev be performed. Draft ScopRevs were posted for a 2-week comment period on the ILCOR website, and the task forces revised text as needed in response to the public comments. All ScopRevs are included in their entirety in Appendix B of each task force publication in this supplement.

Evidence Updates

Evidence updates (EvUps) were performed to identify evidence published after the most recent ILCOR review of the topic. The EvUps were performed by volunteer members of the task forces or ILCOR member councils, who used the same search strategy that was used for the previous review. If the search strategy failed to identify new evidence, the search strategy was broadened to capture any relevant published studies. The task forces reviewed the EvUps to determine if sufficient evidence was identified to suggest the need for a new SysRev. All EvUps cited can be viewed in Appendix C of each task force publication in this supplement.

Potential Impact of Coronavirus Disease 2019 (COVID-19) on Resuscitation

The CoSTR reviews were all completed by early February 2020. As a result, this document does not address the topic of the potential influence of coronavirus disease 2019 (COVID-19) on resuscitation practice. An ILCOR writing group was assembled in the spring of 2020 to identify and evaluate the published evidence regarding risks of aerosol generation and infection transmission during attempted resuscitation of adults, children, and infants. This group developed a consensus on science with treatment recommendations and task force insights. This statement is published as a separate document.[10] As new evidence emerges, the ILCOR task forces will review and update this statement, so the reader is referred to the ILCOR website[9] for the most up-to-date recommendations.

Please cite this article in press as: J.P. Nolan, et al., Executive Summary 2020 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations, Resuscitation (2020), https://doi.org/10.1016/j.resuscitation.2020.09.009

Management of Potential Conflicts of Interest

ILCOR followed the rigorous conflict-of-interest (COI) policies that have been used successfully in previous years. Anyone involved in any part of the process was required to disclose all commercial relationships and other potential conflicts by using the standard AHA online COI disclosure process. Task force members as well as reviewers and collaborators all completed this online disclosure process before they were allowed to perform reviews and take part in discussions. Participants were asked to be sensitive to commercial conflicts as well as to any potential intellectual conflicts, such as having authored key studies related to a topic or being involved in ongoing studies related to a topic. AHA staff reviewed the disclosures before appointment to ensure that no disclosures were significant enough to preclude participation. Disclosure information for writing group members is listed in Appendix 1. Disclosure information for peer reviewers is listed in Appendix 2.

During in-person meetings, each participant was assigned a COI number, and a full list of disclosures was available to all participants throughout the meeting. Participants were required to state any relevant conflicts during in-person meetings as well as on webinars and conference calls and were required to abstain from voting on any wording of the consensus on science or treatment recommendations for any topics related to their potential conflicts. AHA staff members assisted the task force chairs in monitoring compliance. Any COI-related issues were brought to the attention of the task force chairs and the COI co-chairs. At each meeting, participants were notified of a toll-free telephone number to call to anonymously report any COI issues; no calls were received.

Basic Life Support

Hot Topics

CPR During Transport

The question of whether to transport a cardiac arrest victim to the hospital or complete CPR on the scene continues to be controversial. This topic has not been reviewed since 2005, and the BLS Task Force chose to undertake a ScopRev to determine if there was sufficient new evidence to warrant a SysRev. Eight nonrandomized studies reported that among patients with out-of-hospital cardiac arrest (OHCA) transported with CPR in progress, return of spontaneous circulation (ROSC) was achieved in the emergency department in approximately 9.5%, with 2.9% surviving to hospital discharge.

Manikin studies consistently document poorer CPR quality during transport while clinical studies evaluating the quality of CPR during transport report conflicting results. Three RCTs comparing manual CPR with mechanical CPR during transport showed no benefit from mechanical CPR with respect to ROSC or survival to discharge. Manikin studies indicate that mechanical CPR provided consistent CPR whereas the quality of manual CPR declined during transport. Nonrandomized studies showed that duration of transport with CPR and distance transported with CPR does not adversely impact patient outcomes. There are many facets to this question, and on the basis of the evidence identified, the task force concluded that there was a need for more than 1 SysRev.

Several questions remain unanswered, such as whether clinical outcomes are affected by the decision to transport with CPR in progress and when the decision to transport with ongoing CPR should be made. The use of feedback devices could improve the quality of CPR during transport. However, an important consideration is the risk of harm to personnel who perform manual CPR during transport—there is little evidence for this, but many anecdotal reports attest to the potential risk to unrestrained personnel in the back of a moving ambulance.

CPR Before Calling for Help for Adults With OHCA

The question of whether to first start CPR or call for help for adults with OHCA is likely to be influenced by the wide availability of mobile phones with a hands-free option, which makes it possible to call emergency medical services (EMS) and start CPR simultaneously. The SysRev identified just 1 cohort study including 17 461 adults with OHCA from a national registry of 925 288 cases.[11] Analysis was limited to cases in which lay rescuers witnessed the adult cardiac arrest and performed CPR without the need for dispatcher assistance. The groups differed in many respects, and despite adjustment, residual confounding was likely. The 3 groups (call and CPR first, call first, and CPR first) all had similar rates of survival with favourable outcome. The BLS Task Force chose to make a discordant recommendation (a strong recommendation despite very low-certainty evidence) that for an adult with OHCA, a lone bystander with a mobile phone should phone EMS, activate the speaker or other hands-free option on the mobile phone, and immediately begin CPR, with dispatcher assistance if required. If a lone rescuer must leave an adult victim to phone EMS, the priority should be prompt activation of EMS before returning to the victim to initiate CPR as soon as possible.

Resuscitation Care for Suspected Opioid-Associated Emergencies

Deaths from opioid overdose are increasing substantially, particularly in the United States. This topic was reviewed in 2015, but no treatment recommendation was made.[12a,12b] An updated SysRev on this topic was considered essential to inform best-practice guidelines for bystander resuscitation for suspected opioid-induced emergencies. No studies were identified that compared bystander-administered naloxone (intramuscular or intranasal) plus conventional CPR with conventional CPR only. As a response to the growing opioid epidemic, naloxone has been widely distributed by healthcare authorities to laypeople in various opioid-overdose prevention schemes. A recent SysRev identified 22 observational studies evaluating the effect of overdose education and naloxone distribution and found an association between implementation of these programs and decreased mortality rates.[13] On the basis of expert opinion, the BLS Task Force suggested that CPR be started without delay on any unresponsive person who is not breathing normally and that naloxone be used by lay rescuers in suspected opioid-related respiratory or circulatory arrest.

Feedback for CPR Quality

CPR feedback or prompt devices are intended to improve CPR quality, the probability of ROSC, and survival from cardiac arrest. Real-time CPR guidance devices can be categorized as (1) digital audiovisual feedback, including corrective audio prompts; (2) analogue audio and tactile clicker feedback for chest compression depth and release; and (3) metronome guidance for chest compression rate. Several additional studies were identified in this updated SysRev. This topic proved particularly controversial. Most higher-certainty data did not demonstrate a clinically or statistically significant association between real-time feedback and improved patient outcomes; furthermore, these devices require resources to purchase

Please cite this article in press as: J.P. Nolan, et al., Executive Summary 2020 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations, Resuscitation (2020), https://doi.org/10.1016/j.resuscitation.2020.09.009

and implement. On the other hand, several studies demonstrated clinically important improvements in outcomes associated with the use of feedback devices.

A permissive recommendation was considered appropriate because of the role that these devices play in CPR quality monitoring, benchmarking, and quality-improvement programs. The BLS Task Force agreed on a weak recommendation for healthcare systems to consider CPR feedback devices, given the evidence that they improve the quality of CPR and there was no signal of patient harm in the data reviewed. The task force highlighted that there was no consistent signal indicating that the real-time feedback function of these devices has a significant effect on individual cardiac arrest patient outcomes, suggesting that the devices should not be implemented for this reason alone outside of a comprehensive quality-assurance program.

Analysis of Rhythm During Chest Compressions

Artifact-filtering algorithms for the analysis of electrocardiographic rhythms during CPR have been proposed as a method to reduce pauses in chest compressions and thereby increase the quality of CPR. Most of the 14 studies included in this SysRev used previously collected electrocardiograms, electric impedance, and/or accelerometer signals recorded during CPR to evaluate the ability of algorithms or machine learning to detect shockable rhythms during chest compressions. None of these studies evaluated the effect of the artifact-filtering algorithms on any critical or important outcomes, but they provide insights into the potential benefits of this technology. The BLS Task Force prioritized avoiding the costs of introducing a new technology when its effects on patient outcomes and the risk of harm remain to be determined; thus, the task force suggested against the routine use of artifact-filtering algorithms for analysis of ECG rhythms during CPR. The task force made a weak recommendation for further research because (a) there is currently insufficient evidence to support a decision for or against routine use, (b) further research may reduce uncertainty about the effects, and (c) further research is thought to be of good value for the anticipated costs.

New Systematic Reviews

Dispatch Diagnosis of Cardiac Arrest

It is not known if there are specific call characteristics that impact the ability of emergency medical dispatchers to recognize cardiac arrest. This SysRev identified a wide variety of algorithms and criteria used by dispatch centres to identify cardiac arrest and other medical emergencies. There was great variability in the accuracy of these algorithms and the criteria for recognizing OHCA in adults. The BLS Task Force recognized that minimizing the frequency of missed cardiac arrest events may increase the frequency of false-positive cases.

Effect on treatment recommendations: The task force recommended that dispatch centres implement a standardized algorithm and/or standardized criteria to immediately determine if a patient is in cardiac arrest at the time of an emergency call. It was also recommended that dispatch centres monitor and track diagnostic capability.

Firm Surface for CPR

This topic was last reviewed by the BLS Task Force in 2010.[14a,14b] The evidence identified in this latest SysRev was grouped under the subheadings of mattress type, floor compared with bed, and backboard. The task force noted that effective manual compression depths can be achieved even on a soft surface if the CPR provider increases overall compression depth to compensate for mattress compression. Manikin studies indicate a marginal benefit to manual chest compression depth from the use of a backboard but use of these may cause significant interruption in chest compressions, and they have significant cost and training implications.

Effect on treatment recommendations: The treatment recommendations have been updated from 2010; they are all weak recommendations based on very low-certainty evidence. The BLS Task Force suggests performing manual chest compressions on a firm surface when possible; this includes activation of a bed's CPR mode if it has this feature. During in-hospital cardiac arrest, the task force suggests against moving a patient from a bed to the floor to improve chest compression depth. The task force was unable to make a recommendation about the use of backboards because the confidence in effect estimates was so low.

Starting CPR: Compressions-Airway-Breaths Versus Airway-Breaths-Compressions

Although most adult BLS guidelines recommend commencing chest compressions before giving rescue breaths, there is still considerable debate about this sequence. This SysRev did not identify any additional studies published after the 2015 ILCOR review.[12a,12b]

Effect on treatment recommendations: The treatment recommendation is unchanged from 2015.[12a,12b]

CPR Before Calling for Help for Adults With OHCA

This topic is discussed in more detail in the BLS Hot Topics section earlier in this publication. The SysRev identified just 1 cohort study on which to base the treatment recommendation.

Effect on treatment recommendations: Despite very low-certainty evidence, for adults with OHCA, the BLS Task Force made a strong recommendation that a lone bystander with a mobile phone should dial EMS, activate the speaker or other hands-free option on the mobile phone, and immediately begin CPR, with dispatcher assistance if required.

Timing of CPR Cycles (2 Minutes Versus Other)

This topic had not been updated since 2015[12a,12b] The current SysRev identified 2 older studies that included comparisons of groups with different CPR durations between rhythm checks, but both studies were designed to address the question of CPR first compared with defibrillation first. Consequently, the certainty of evidence supporting the optimal duration of CPR is low.

Effect on treatment recommendations: The treatment recommendation is unchanged from 2015.[12a,12b]

Hand Position During Compressions

This topic was last reviewed in 2015.[12a,12b] This latest SysRev did not identify any studies that evaluated the effect of any specific hand position on short-term or long-term survival after cardiac arrest. Physiological surrogate outcomes were reported in 3 very low-certainty studies.

Effect on treatment recommendations: The treatment recommendation is unchanged from 2015.[12a,12b]

Rhythm Check Timing

During CPR, rhythm checks cause pauses in chest compressions, and frequent pauses are associated with worse outcomes from cardiac arrest. This SysRev was undertaken to assess the evidence

Please cite this article in press as: J.P. Nolan, et al., Executive Summary 2020 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations, Resuscitation (2020), https://doi.org/10.1016/j.resuscitation.2020.09.009

for optimal timing for rhythm checks. Although only very low-certainty evidence addressing this question was identified, worse short-term and long-term outcomes have been reported with immediate rhythm check after shock delivery.

Effect on treatment recommendations: The treatment recommendation is unchanged from 2015.[12a,12b]

Feedback for CPR Quality

Feedback for CPR quality is discussed in more detail in the BLS Hot Topics section earlier in this publication. This topic was last reviewed in 2015, and several additional studies were identified in this updated SysRev.

Effect on treatment recommendations: The treatment recommendation is unchanged from 2015.[12a,12b]

Alternative Techniques (Cough CPR, Precordial Thump, Fist Pacing)

This topic was last reviewed in 2010.[14a,14b] Reports on social media continue to advocate cough CPR, and it may be perceived by the public as an effective way of preventing cardiac arrest. There is no evidence that cough CPR is effective in OHCA. Precordial thumping and fist pacing are techniques previously recommended to healthcare professionals.

Effect on treatment recommendations: Although the treatment recommendations remain essentially unchanged from 2010, the BLS Task Force has updated them to clarify the special circumstances when these alternative techniques might be appropriate. The strong recommendation against cough CPR, precordial thump, and fist pacing for cardiac arrest remains unchanged. The Task Force suggests that fist pacing may be considered only as a temporizing measure in the exceptional circumstance of a witnessed, monitored, in-hospital arrest (such as in a cardiac catheterization laboratory) with bradyasystole, if recognized promptly, before loss of consciousness.

Public-Access Automated External Defibrillator Programs

The impact on outcomes from cardiac arrest after implementation of a public-access automated external defibrillator (AED) program was last reviewed by ILCOR in 2015,[12a,12b] and SysRevs on the effects of public-access defibrillation on OHCA survival were published after 2015.[15,16] This updated ILCOR SysRev focused on comparing outcomes in systems with public-access AED programs with outcomes in systems with a traditional EMS response, and the review included 1 RCT and 30 observational studies.

Effect on treatment recommendations: The strong recommendation to implement public-access defibrillation programs for patients with OHCA is unchanged from 2015.[12a,12b]

Analysis of Rhythm During Chest Compressions

This topic is discussed in more detail in the BLS Hot Topics section earlier in this publication. Artifact-filtering algorithms for the analysis of electrocardiographic rhythm during CPR have been proposed as a method to reduce pauses in chest compressions and thereby increase the quality of CPR.

Effect on treatment recommendations: The weak recommendation against the routine use of artifact-filtering algorithms for the analysis of electrocardiographic rhythm during CPR is unchanged from 2015.[12a,12b] However, the previous weak suggestion that it would be reasonable for EMS systems that use integrated artifact-filtering algorithms in clinical practice to continue with their use has been changed to a weak recommendation that the usefulness of artifact-filtering algorithms for the analysis of electrocardiographic rhythm during CPR be assessed in clinical trials or research initiatives.

CPR Before Defibrillation

This topic was last reviewed by ILCOR in 2015.[12a,12b] Although previous treatment recommendations for CPR before defibrillation have been based on RCTs, the results from these trials are inconsistent, and the optimal timing of defibrillation remains uncertain. No new RCTs were identified.

Effect on treatment recommendations: The treatment recommendation is unchanged from 2015.[12a,12b]

Removal of Foreign Body Airway Obstruction

The topic of foreign body airway obstruction (FBAO) was last reviewed by ILCOR in 2010, and at that time, the principal treatment recommendation was that "chest thrusts, back blows, or abdominal thrusts are effective for relieving FBAO in conscious adults and children older than 1 year."[12a,12b] Recently, manual suction devices (airway clearance devices) that use a vacuum to remove foreign bodies have become commercially available. These devices have not previously been reviewed by ILCOR and were included in this SysRev. The data in the peer-reviewed literature assessing the efficacy of suction-based airway clearance devices comprised just 1 case series of 9 adults, which the task force deemed insufficient to support the implementation of a new technology with an associated financial and training cost.

Effect on treatment recommendations: The treatment recommendation has been substantially updated from 2010.[12a,12b] The BLS Task Force suggested that back slaps are used initially in adults and children with an FBAO and an ineffective cough and that abdominal thrusts are used where back slaps are ineffective (weak recommendation, very low-certainty evidence). Chest thrusts are suggested in unconscious adults and children with an FBAO. The task force suggested that rescuers consider the manual extraction of visible items in the mouth but should not perform blind finger sweeps in patients with an FBAO and that appropriately skilled healthcare providers use Magill forceps to remove an FBAO in patients with OHCA caused by FBAO. The task force suggested that suction-based airway clearance devices should not be used routinely.

Resuscitation Care for Suspected Opioid-Associated Emergencies

This topic is discussed in more detail in the BLS Hot Topics section earlier in this publication. In this updated SysRev, no studies were identified that compared bystander-administered naloxone (intramuscular or intranasal) plus conventional CPR with conventional CPR only.

Effect on treatment recommendations: No treatment recommendation was made in 2015, but given the scale of the opioid problem, on this occasion, on the basis of expert opinion, the BLS Task Force suggested that CPR be started without delay in any unresponsive person who is not breathing normally, and that naloxone be used by lay rescuers in suspected opioid-related respiratory or circulatory arrest.

Drowning

Prognostic factors that predict outcome after a drowning incident were last reviewed in 2015.[12a,12b] Attempting to rescue a submerged victim has substantial resource implications and may place rescuers at risk; thus, it was deemed important to update this SysRev for 2020. The

Please cite this article in press as: J.P. Nolan, et al., Executive Summary 2020 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations, Resuscitation (2020), https://doi.org/10.1016/j.resuscitation.2020.09.009

findings from the 6 new papers identified in this update are consistent with the 2015 treatment recommendation.

Effect on treatment recommendations: The treatment recommendation is unchanged from 2015.[12a,12b]

Harm From CPR to Victims Not in Cardiac Arrest

Lay rescuers may not begin CPR even when a victim is in cardiac arrest because of concern that delivering chest compressions to a person who is not in cardiac arrest could cause serious harm. Evidence that chest compressions are unlikely to cause harm in these circumstances may encourage more bystanders to commence CPR for cardiac arrest victims. This topic was last reviewed in 2015, and this updated SysRev did not find any studies.

Effect on treatment recommendations: The treatment recommendation is unchanged from 2015.[12a,12b]

Additional Reviews

The BLS Task Force also evaluated 3 other ScopRevs and 1 EvUp. These reviews, per ILCOR agreement, did not change treatment recommendations, but several resulted in the suggestion for new SysRevs.

Advanced Life Support

Hot Topics

Vasopressors During Cardiac Arrest

In 2019, the ILCOR ALS Task Force published a SysRev and meta-analysis[17] and a CoSTR[18,19] on this topic. The meta-analysis of 2 placebo-controlled trials showed that after OHCA, epinephrine increases ROSC, survival to discharge, and survival at 3 months but did not show an increase in survival to discharge with favourable neurological outcome.[17,20,21] The much larger and more recent trial (8000 patients)[20] found no difference in survival with favourable or unfavourable neurological outcome at 3 months; thus, the impact of epinephrine administration on neurological outcome for patients with OHCA remains uncertain.

Another meta-analysis of these 2 RCTs has shown that relative to placebo, the effects of adrenaline on ROSC are greater for patients with an initially nonshockable rhythm than for those with shockable rhythms.[22] Similar patterns are observed for longer-term survival outcomes, but the differences in effects are less pronounced.

The ALS Task Force recommends giving epinephrine as soon as feasible in cardiac arrest with nonshockable rhythms unless there is a clearly reversible cause that can be addressed rapidly. The optimal timing for epinephrine in patients with shockable rhythms is unknown. The task force suggests administering epinephrine after initial defibrillation attempts have been unsuccessful; however, the optimal timing or number of shocks after which epinephrine should be administered remains unclear.

There are few data to guide the specific dose and dose interval of epinephrine during cardiopulmonary resuscitation; however, the 2 OHCA RCTs comparing epinephrine with placebo used standard dose epinephrine (1 mg intravenous [IV] or intraosseous [IO] every 3 −5 minutes).

There is limited RCT evidence on the use of epinephrine for in-hospital cardiac arrest; therefore, on the basis of the evidence for OHCA, in 2019 the ILCOR ALS Task Force made the same recommendations for epinephrine administration for in-hospital and OHCA.

The use of vasopressin alone or in combination with epinephrine does not improve outcomes in comparison with epinephrine alone; thus, to reduce complexity, epinephrine alone is suggested.

Targeted Temperature Management

Targeted temperature management (TTM) has been the subject of considerable controversy for many years. A SysRev of TTM and treatment recommendations was included in the 2015 CoSTR.[23–26]

Several studies have been published after 2015, but the most important is HYPERION (Therapeutic Hypothermia After Cardiac Arrest in Non Shockable Rhythm), a French trial in which 581 adult, comatose patients with OHCA and in-hospital cardiac arrest (IHCA) and an initial nonshockable rhythm were randomized to either TTM with a target temperature of 33 °C or TTM with a temperature of 37 °C, both for 24 hours.[27] At 90 days, 10.2% in the 33 °C group were alive with a Cerebral Performance Category score of 1 or 2 (the primary outcome) compared with 5.7% in the normothermia group (risk difference, 4.5%; 95% CI, 0.1−8.9; $P = 0.04$). There was no difference in mortality at 90 days (81.3% versus 83.2%; risk difference, −1.9%; 95% CI, −8.0 to 4.3).

This trial reinforces the 2015 ILCOR treatment recommendations to consider TTM, targeting a constant temperature between 32 °C and 36 °C in patients who remain comatose after resuscitation from either IHCA or OHCA with an initial nonshockable rhythm.[25,26] This may be considered by some as controversial because, despite the result of the HYPERION trial, it remains a weak recommendation. However, the ALS Task Force chose to delay updating this SysRev until the completion and publication of the TTM-2 (Targeted Hypothermia Versus Targeted Normothermia After Out-of-Hospital Cardiac Arrest) RCT (NCT02908308). Instead, EvUps on this topic have been undertaken to assist in formulating regional guidelines.

Double Sequential Defibrillation

Patients in refractory ventricular fibrillation, comprising about 20% of patients with ventricular fibrillation/pulseless ventricular tachycardia, have significantly lower rates of survival than patients who respond to standard resuscitative treatments. Increasingly, these patients are being treated with double (dual) sequential defibrillation—the use of 2 defibrillators to deliver 2 overlapping shocks or 2 rapid sequential shocks—as a possible means of increasing ventricular fibrillation termination rates. The ALS Task Force's SysRev identified only observational studies that were at critical or serious risk of bias because of confounding, and the task force discussed the results of a small RCT comparing standard defibrillation with changing pad position or double sequential defibrillation.[28] Given this very low-certainty evidence, the task force suggested against the routine use of a double sequential defibrillation strategy to treat cardiac arrest with a shockable rhythm.

IV Versus IO Drug Delivery

The IO route is being used more frequently to deliver drugs during resuscitation. Although some EMS personnel are using the IO route in preference to the IV route for drug delivery in cardiac arrest, most commonly, the IO route is used only after failed attempts at IV cannulation or when IV cannulation is likely to be very difficult. Several observational studies have documented an association between IO drug delivery during resuscitation and a worse outcome in comparison with IV drug delivery. However, such studies are likely to include

Please cite this article in press as: J.P. Nolan, et al., Executive Summary 2020 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations, Resuscitation (2020), https://doi.org/10.1016/j.resuscitation.2020.09.009

considerable bias. Subgroup analyses from 2 recent RCTs showed no significant interaction between the IO and IV routes for the delivery of epinephrine or placebo[29] or amiodarone, lidocaine, or placebo,[30] although the point estimates generally favoured IV access. The ALS Task Force decided to suggest the IV route for the first attempt for drug delivery during adult cardiac arrest, but if IV attempts fail or IV access is not feasible, IO access is suggested. Prospective studies will be important to determine whether drug delivery first by IV or IO route impacts long-term outcomes in cardiac arrest.

Point of Care Echocardiography for Prognostication During CPR

In 2015, the ALS Task Force addressed the question of whether the use of cardiac ultrasound during CPR changed outcomes and suggested its use as an additional diagnostic tool to identify potentially reversible causes of arrest.[25,26] For 2020, the task force undertook a different SysRev that looked at the intra-arrest prognostic capabilities of point-of-care echocardiography. No RCTs were identified, and the 15 relevant observational studies included in the review were rated as very low-certainty evidence because of a high risk of bias. The bias related to inconsistent prognostic factor measurement, outcome measurement, lack of adjustment for other prognostic factors, and confounding from self-fulfilling prophecy. There was wide variation in classification of anatomy, type of cardiac motion, and timing of the intervention. The task force cautioned against the overinterpretation of right ventricular dilatation as a diagnostic indicator of massive pulmonary embolism because this finding is seen commonly in cardiac arrest from any cause. After careful consideration of the evidence, the task force suggested against the use of point-of-care echocardiography for prognostication during CPR. In the future, identifying a standardized definition of cardiac motion as seen during point-of-care echocardiography and minimizing other sources of bias will be essential to obtaining high-certainty evidence.

New Systematic Reviews

Double Sequential Defibrillation

This topic is discussed in more detail in the ALS Hot Topics section earlier in this publication. The task force's SysRev identified only observational studies that were at critical or serious risk of bias because of confounding and 1 recently published small pilot RCT.[31]

Effect on treatment recommendations: In this new recommendation, the ALS Task Force suggests against the routine use of a double sequential defibrillation strategy to treat cardiac arrest with a shockable rhythm.

IV Versus IO Drug Delivery

This topic is discussed in more detail in the ALS Hot Topics section earlier in this publication. A SysRev[32] provided the data supporting a new treatment recommendation.

Effect on treatment recommendations: This is a new treatment recommendation: the ALS Task Force suggests the IV route for the first attempt for drug delivery during adult cardiac arrest, but if IV attempts fail or IV access is not feasible, IO access is suggested.

Point of Care Echocardiography for Prognostication During CPR

The ALS Task Force undertook this new SysRev of the intra-arrest prognostic capabilities of point-of-care echocardiography. This topic is discussed in more detail in the ALS Hot Topics section earlier in this publication.

Effect on treatment recommendations: The task force suggested against the use of point-of-care echocardiography for prognostication during CPR.

Cardiac Arrest Associated With Pulmonary Embolism

The ALS Task Force updated a SysRev previously undertaken in 2015[25,26] that sought to identify whether any specific alteration in the ALS treatment algorithm compared with standard ALS care would result in better outcomes when treating an adult in cardiac arrest caused by pulmonary embolism or suspected pulmonary embolism. One additional observational study was identified that found no difference in outcome with or without fibrinolysis.[33]

Effect on treatment recommendations: The treatment recommendation is unchanged from 2015.[25,26]

Oxygen Dose After ROSC

Observational studies have shown that after ROSC, there is an association between both hypoxemia and hyperoxemia and worse outcome. A SysRev conducted to inform the 2020 CoSTR identified 6 RCTs that generally failed to show a benefit of a titrated (lower concentration of inspired oxygen) approach compared with standard care (higher concentration of inspired oxygen).[34] A subgroup analysis of patients with suspected hypoxic-ischaemic encephalopathy in 1 larger RCT documented better survival in patients for whom hyperoxemia was aggressively avoided.[35]

Effect on treatment recommendations: The treatment recommendation is unchanged from 2015.[25,26]

Ventilation Strategy After ROSC in Adults

Whether targeting a specific $Paco_2$ after ROSC in adults impacts outcomes was previously reviewed in 2015.[25,26] The ALS Task Force identified 2 small RCTs and 3 additional observational studies published since 2015. Unfortunately, differences in the $PaCO_2$ targets used in the arms of the 2 RCTs precluded meta-analysis.

Effect on treatment recommendations: The treatment recommendation was modified from 2015 and now states that there is insufficient evidence for or against targeting mild hypercapnia compared with normocapnia in adults with ROSC after cardiac arrest. The task force also suggests not routinely targeting hypocapnia in adults with ROSC after cardiac arrest.

Prophylactic Antibiotics After Cardiac Arrest

This new topic was prioritized by the ALS Task Force on the basis of the recent publication of a SysRev on the topic.[36] Pneumonia affects approximately 50% of intensive care unit patients after cardiac arrest. Meta-analyses of both randomized trials and observational studies showed no overall benefit in the use of prophylactic antibiotics during post–cardiac arrest care. One RCT documented a reduced incidence of early pneumonia in patients treated with prophylactic antibiotics but no effect on mortality.[37]

Effect on treatment recommendations: A new recommendation was provided that suggested not using prophylactic antibiotics in patients after ROSC.

Post-Cardiac Arrest Seizure Prophylaxis and Treatment

Clinical convulsions and epileptiform activity in the electroencephalogram (EEG) occur in 20% to 30% of comatose cardiac arrest survivors. Whether seizure prophylaxis and treatment in cardiac arrest survivors reduces the incidence of seizures and improves outcomes is unclear. This SysRev updated a review undertaken in 2015.[25,26]

Please cite this article in press as: J.P. Nolan, et al., Executive Summary 2020 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations, Resuscitation (2020), https://doi.org/10.1016/j.resuscitation.2020.09.009

Effect on treatment recommendations: This treatment recommendation has been updated from 2015. The ALS Task Force suggested that seizures be treated but suggested against post–cardiac arrest seizure prophylaxis in adults with ROSC. In 2015, there was a strong recommendation to treat seizures, and the weakening of this treatment recommendation takes into consideration the absence of direct evidence that seizure treatment improves critical outcomes in these patients.

Prognostication in Comatose Patients After Resuscitation From Cardiac Arrest

In many healthcare systems, life-sustaining treatment may be limited or withdrawn when unfavourable neurological outcomes are expected. Thus, timely and reliable prognostication is an important component of the treatment of patients who remain comatose after cardiac arrest. The 2015 ILCOR treatment recommendations on this topic distinguished between studies of prognostication among patients treated with or without hypothermia. The updated SysRevs and treatment recommendations for 2020 apply regardless of the temperature management strategy used. Many observational studies on this topic have been published since 2013, when the previous SysRev on neuroprognostication was undertaken. For 2020, separate SysRevs were undertaken for the 4 prognostication domains of clinical examination, neurophysiological tests, biomarkers, and imaging.

Effect on treatment recommendations: The treatment recommendations have been updated since 2015, the most important being a strong recommendation (albeit based on very low-certainty evidence) that neuroprognostication always be undertaken with the use of a multimodal approach because no single test has sufficient specificity to eliminate false positives.

Clinical Examination for Prognostication. The ALS Task Force suggests using the following components of clinical examination as part of a multimodal approach to predicting the neurological outcome of adults who are comatose after cardiac arrest (all based on very low-certainty evidence): pupillary light reflex, quantitative pupillometry, and bilateral absence of corneal reflex (all at 72 hours or more after ROSC) and the presence of myoclonus or status myoclonus within 7 days after ROSC. The task force also suggests recording EEG in the presence of myoclonic jerks to detect any associated epileptiform activity.

Neurophysiological Tests for Prognostication. The ALS Task Force suggests using the following neurophysiological tests as part of a multimodal approach to predicting the neurological outcome of adults who are comatose after cardiac arrest (all based on very low-certainty evidence): bilaterally absent N20 wave of somatosensory evoked potential, the presence of seizure activity on EEG, and burst suppression on EEG. The task force suggests not using the absence of EEG background reactivity alone to predict poor outcome in these patients.

Biomarkers for Prognostication. The ALS Task Force suggests using neuron-specific enolase within 72 hours as part of a multimodal approach to predicting neurological outcome of adults who are comatose after cardiac arrest. The task force suggests not using S-100B protein, glial fibrillary acidic protein, serum tau protein, or neurofilament light chain for predicting poor neurological outcome of adults who are comatose after cardiac arrest.

Imaging for Prognostication. The ALS Task Force suggests using the following imaging as part of a multimodal approach to predicting neurological outcome of adults who are comatose after cardiac arrest (all based on very low-certainty evidence): gray matter to white matter ratio on brain computed tomography, diffusion-weighted brain MRI, and apparent diffusion coefficient on brain MRI.

Additional Reviews

The ALS Task Force also evaluated 2 ScopRevs and 15 EvUps. These reviews, per ILCOR agreement, did not change treatment recommendations, but several resulted in the suggestion for new SysRevs.

Pediatric Life Support (Basic and Advanced)

Hot Topics

Fluid Administration Rate for Septic Shock and Management of Septic Shock

Although substantial progress has been made in reducing mortality and morbidity from septic shock in infants and children, recommendations for management are often based on a consensus of experts because available evidence is limited. A very detailed 2020 EvUp identified several relevant studies, and the PLS Task Force agreed that a SysRev is needed in the near future.

In early February 2020, as the PLS Task Force was finalizing the CoSTR publication, the Society of Critical Care Medicine published their "Surviving Sepsis Campaign International Guidelines for the Management of Septic Shock and Sepsis-Associated Organ Dysfunction in Children."[38] The task force cited recommendations from these guidelines in several of the septic shock topics in the PLS publication in this supplement and also agreed to request a SysRev about the general management of septic shock in infants and children.

Adrenaline/Epinephrine Initial Dose and Dose Intervals for Cardiac Arrest

Although epinephrine has been part of pediatric resuscitation for more than 50 years, there is little pediatric data about its effectiveness or the optimal initial dose or dose interval during resuscitation. The epinephrine SysRev identified evidence associating benefit with shorter time to initial epinephrine administration and improved outcomes in children with nonshockable rhythms and OHCA,[39–41] and a new treatment recommendation reflected this evidence. However, there remains insufficient evidence about the effect of time to initial epinephrine dose for OHCA with shockable rhythms. The 2 observational studies evaluating epinephrine dose intervals during IHCA yielded contradictory results, so evidence remains insufficient about the optimal dose interval for pediatric IHCA.[42,43] More data, ideally in the form of RCTs, is needed on this important topic.

Management of Traumatic Shock in Infants and Children

The 2020 CoSTR for PLS addresses the topic of graded volume resuscitation for infants and children with traumatic haemorrhagic shock as well as management of the child with cardiac arrest after trauma. The ScopRev on graded volume resuscitation identified a single observational study in the prehospital setting assessing the volume of fluid given to children with traumatic injuries,[44] with an

Please cite this article in press as: J.P. Nolan, et al., Executive Summary 2020 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations, Resuscitation (2020), https://doi.org/10.1016/j.resuscitation.2020.09.009

additional 4 studies comparing total crystalloid volume given over 24 hours[45–48] and 1 study evaluating the volume of crystalloids given to children who needed transfusion.[49] The task force agreed that the evidence was sufficient to consider a SysRev in the near future.

The task force discussions included the issue of the scope of the ILCOR PLS Task Force mandate and whether trauma should be included among topics that this task force evaluates, given that other organizations are addressing the topic. However, because trauma remains a leading cause of infant and child deaths worldwide, the task force agreed to continue to evaluate evidence addressing the management of seriously injured infants and children but agreed that traumatic cardiopulmonary arrest will, after 2020, remain in the purview of organizations such as the American College of Surgeons (eg, via the Advanced Trauma Life Support Course[50]).

Ventilation Rate With Advanced Airway During CPR

In 2010, the PLS Task Force identified insufficient pediatric evidence to identify any optimal minute ventilation during CPR with an advanced airway, and the treatment recommendations noted that it would be reasonable to provide a minute ventilation less-than-normal for age because cardiac output and pulmonary blood flow are much lower than normal during CPR.[51,52] This left the decision about ventilation rate up to individual council guidelines. For simplicity, some councils recommended the same ventilation rate used for adults. The 2020 EvUp search identified 1 small multicentre study in children with advanced airways during CPR, reporting an association between a ventilation rate of 30/min or greater for infants and 25/min or greater for children and improved outcomes.[53] These results raised the question of the need for a faster ventilation rate during CPR in children compared with adults. The task force agreed that more data are needed (eg, larger observational studies, RCTs) and agreed to request a SysRev when additional studies are published.

Use of Heamodynamic Monitoring When Available During CPR

CPR quality is essential to good resuscitation outcomes. Monitoring devices and systems available in critical care may provide valuable feedback and data about CPR quality. The task force requested a ScopRev to determine the evidence available to support the use of intra-arterial pressure monitoring if it is already in place during CPR. A single observational study reported an association between a mean diastolic (relaxation) blood pressure of 25 mmHg or higher in infants and 30 mmHg or higher in children and survival.[54] Although the task force agreed that identification of a threshold diastolic blood pressure associated with survival in children could be very helpful to guide resuscitation efforts, at this time, there is insufficient evidence to identify any such threshold.

New Systematic Reviews

Sequence of Compression and Ventilation

In 2015, there was inadequate evidence to support a PLS Task Force recommendation about the sequence of compressions and ventilation in infants and children.[55a,55b] In 2020, the PLS Task Force combined efforts with the BLS Task Force to perform a SysRev to identify evidence supporting a CPR sequence beginning with either compressions first or ventilation first. The search identified no studies in children. As a result, there is no change in the 2015 PLS treatment recommendation. To review the BLS summary, see "Starting CPR: Compressions-Airway-Breaths Versus Airway-Breaths-Compressions" (BLS 661: SysRev) in the 2020 CoSTR for BLS in this supplement.

Effect on treatment recommendation: no change from 2015; we are unable to make a recommendation.[55a,55b]

IO Versus IV Route of Drug Administration

The PLS Task Force joined with the NLS and ALS Task Forces in a SysRev to identify the evidence of superiority of either IO or IV routes of drug administration during CPR.[32] The search strategy included newborns, infants, children, and adults. Although evidence was identified in newborns and adults, the search yielded no studies that included infants (beyond newborns) or children. To review the neonatal evidence identified by the SysRev, see "Intraosseous Versus Umbilical Vein for Emergency Access" (NLS 616: SysRev) in the 2020 CoSTR for NLS in this supplement.

Effect on treatment recommendation: No change from 2010.[51,52]

Adrenaline/Epinephrine Time of Initial Dose and Dose Interval During CPR

The SysRev identified only observational (registry) data (including 1 large study reporting data from 26 755 children,[39] suggesting benefit associated with earlier rather than later initial epinephrine administration, especially for children with OHCA and nonshockable rhythms.[39–41] Because the 2 registry studies of epinephrine dose intervals in children with IHCA provided directly contradictory evidence,[42,43] the task force concluded that there was insufficient evidence to make a new recommendation about epinephrine dose interval.

Effect on treatment recommendations: New recommendations were provided suggesting that the initial dose of epinephrine be given as soon as possible for children with OHCA and nonshockable rhythm, but there was insufficient evidence to make a recommendation for initial epinephrine dose timing for OHCA with shockable rhythms and insufficient evidence to identify an optimal epinephrine dose interval.

Oxygen and Carbon Dioxide Targets in Pediatric Patients With ROSC

The PLS Task Force joined with the ALS Task Force to request a SysRev to identify evidence about optimal targets for Pa_{O_2} and Pa_{CO_2} after ROSC.[56a,56b] The PLS Task Force agreed to evaluate only the pediatric evidence. The search identified only observational studies about oxygen targets.[57–59] The SysRev also identified 2 observational studies that suggested potential harm (increased mortality) associated with both hypercapnia and hypocapnia (compared with normocapnia) after ROSC.[59,60]

Effect on treatment recommendations: The recommendations were modified from those published in 201555 targeting a Pa_{O_2} appropriate for the child's condition or normoxemia, adding that it might be reasonable to target an oxygen saturation of 94% to 99%. The treatment recommendations for targeting Pa_{CO_2} continue to suggest targeting normocapnia but now include examples of clinical problems where normocapnia would not be desirable.

Additional Reviews

In addition to the SysRevs, the PLS Task Force evaluated 10 ScopRevs and 37 EvUps. These reviews, per ILCOR agreement, did not change treatment recommendations, but several resulted in the suggestion for new SysRevs. All are available in Appendixes B and C of the PLS CoSTR.

Please cite this article in press as: J.P. Nolan, et al., Executive Summary 2020 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations, Resuscitation (2020), https://doi.org/10.1016/j.resuscitation.2020.09.009

Neonatal Life Support

Hot Topics

Tracheal Intubation and Suction of Nonvigorous Meconium-Stained Newborns

The 2015 recommendation about tracheal intubation and suctioning was based on 1 RCT and observational studies and GRADE reassessment of previously quoted evidence. In 2020, the NLS Task Force requested a SysRev to include studies published after 2015 to determine if any modification of the 2015 treatment recommendation was needed. None of the studies identified by the new SysRev[61] showed any benefit associated with the use of immediate laryngoscopy with or without suctioning for nonvigorous newborns delivered through meconium-stained amniotic fluid. As a result, the task force agreed to increase the certainty of the treatment recommendations against routine immediate direct laryngoscopy after delivery with or without suctioning for nonvigorous newborns delivered through meconium-stained amniotic fluid.

Adrenaline/Epinephrine for Neonatal Resuscitation

Before 2020, the NLS Task Force never performed a SysRev on the use, dose, and dose interval of epinephrine in newborn resuscitation. The 2020 SysRev identified only 2 small studies[62,63] including 97 infants from the same newborn intensive care unit (although in different epochs). The task force agreed that the 2010 treatment recommendations remain valid, with minor editorial revisions.

Initial Oxygen Concentration for Preterm Infants at Birth

During stabilization of the preterm newborn in the delivery room, medical practitioners must prevent or rapidly treat hypoxia while limiting exposure to excess oxygen that may cause complications. In 2019, the NLS Task Force requested a new SysRev after the publication of several relevant studies about the initial oxygen concentration to use in preterm newborn resuscitation.[64] In that review, pooled data from 2 observational studies of 1225 newborns showed an association between initiating resuscitation with lower oxygen concentration and significant benefit in reduction of long-term mortality for all preterm newborns 28 weeks of gestational age or less.[65,66] Although these results and associated treatment recommendations were published in the 2019 CoSTR[18,19] and not reevaluated in this 2020 CoSTR, the NLS Task Force agreed that initial oxygen concentration to use for resuscitation of the preterm newborn remains an important topic.

Impact of Duration of Intensive Resuscitation

Neonatal clinicians face a critical decision when intensive resuscitative efforts fail to result in ROSC. They must decide when to redirect care of the infant from resuscitation to providing comfort and contact with the parents. The timing of this decision is crucial—if made too early, it could deny the opportunity for the infant to survive with good neurodevelopmental outcome, but if made too late, it could result in very limited chance for survival without severe neurodevelopmental impairment. The NLS Task Force sought a SysRev to identify published evidence of any resuscitation exposure or duration that is associated with outcomes. The task force carefully weighed the very limited data and acknowledged that quality of resuscitative efforts will affect any study of resuscitation duration and outcomes. The new treatment recommendations suggest that discussion of discontinuing resuscitative efforts with the clinical team and the family might be appropriate after approximately 20 minutes after birth (see more information below).

New Systematic Reviews

Tracheal Intubation and Suction of Nonvigorous, Meconium-Stained Newborns

As previously noted, the evidence identified by the 2020 SysRev[61] added additional evidence of lack of benefit to immediate tracheal suctioning of nonvigorous newborns born through meconium-stained amniotic fluid.

Effect on treatment recommendations: The NLS Task Force strengthened the wording of the certainty of the evidence for the treatment recommendation, suggesting against routine immediate direct laryngoscopy after delivery of nonvigorous infants delivered through meconium-stained amniotic fluid. The recommendations acknowledged that meconium-stained amniotic fluid remains a risk factor for advanced resuscitation in the delivery room and noted that rarely an infant may require intubation and tracheal suctioning to relieve airway obstruction.

Sustained Inflation

If the newborn does not breathe spontaneously, providers must establish a functional residual capacity to replace lung fluid with air. However, published evidence has not identified the optimum method to accomplish this. In 2015, the NLS Task Force suggested against the routine use of sustained inflation[67–69]; in 2020, the task force sought a new SysRev to identify and analyse the results of several clinical trials published after 2015. The new SysRev[70] identified 10 RCTs enrolling 1502 preterm newborns.[71–80] Although the studies demonstrated no benefit or harm from initiating positive pressure ventilation with sustained inflation(s) in preterm infants, in the subset of very preterm infants (less than 28 + 0 weeks), 5 RCTs found potential harm from the use of sustained inflation(s).[71,72,75,76,79]

Effect on treatment recommendations: The task force strengthened the recommendation suggesting against the routine use of sustained inflation(s) of more than 5 seconds for preterm newborns. There is no evidence to support a recommendation about the use of any specific duration for initial inflations for term or late-preterm infants.

Adrenaline/Epinephrine for Neonatal Resuscitation

The 2019 SysRev about the effects of epinephrine dose and dose intervals[81] represents the first attempt to identify and analyse the evidence on this topic. Given the very limited evidence identified, the task force agreed that the 2010 treatment recommendations remained valid, suggesting epinephrine administration for a persistent heart rate of less than 60/min despite optimal ventilation and chest compressions.[67,68,82,83]

Effect on treatment recommendations: Only minor editorial changes were made to the 2010 recommendations.

IO Versus Umbilical Vein for Emergency Access

Although small case series and case reports suggest that fluids and medications can be delivered by the IO route during newborn resuscitation,[84,85] complications have also been reported.[84,86–90] In 2019, the NLS Task Force joined the ALS Task Force and the PLS Task Force to complete a joint SysRev with meta-analysis.[32] The

Please cite this article in press as: J.P. Nolan, et al., Executive Summary 2020 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations, Resuscitation (2020), https://doi.org/10.1016/j.resuscitation.2020.09.009

SysRev identified no published evidence addressing any of the preidentified outcomes in newborns.

Effect on treatment recommendations: The task force strengthened the recommendation for use of the umbilical venous route for fluid and drug administration during resuscitation in the delivery room but did allow use of the IO route if umbilical venous access is not feasible.

Impact of Duration of Intensive Resuscitation

During resuscitation of the newborn, clinicians and parents often ask how long resuscitative efforts can continue and still result in potential survival of the infant with good neurological outcome. In 2019, the NLS Task Force requested a SysRev to identify any evidence of an incremental time of resuscitation exposure from birth that was associated with very poor likelihood of survival. This SysRev identified 15 outcome studies of only 470 newborns.[91] The task force agreed that the limited number of infants in the studies and the heterogeneity of the studies provided very low-certainty evidence on which to base new 2020 treatment recommendations.

Effect on treatment recommendations: The task force noted that although there is no evidence that a specific duration of resuscitation consistently predicts mortality or moderate-to-severe neurodevelopmental impairment, the failure to achieve ROSC despite 10 to 20 minutes of intensive resuscitation is associated with high risk of mortality as well as severe neurodevelopmental impairment among survivors. The task force agreed that a reasonable time frame to suggest discussion of discontinuing resuscitative efforts is around 20 minutes after birth.

Additional Reviews

In addition to the SysRevs, the NLS Task Force performed 3 ScopRevs and 12 EvUps. All reviews are highlighted in the NLS publication, including appendixes in this supplement.

Education, Implementation, and Teams

Hot Topics

EMS Experience and Exposure

Resuscitation knowledge and skills are likely to degrade with time if not refreshed with regular use or training; however, a SysRev published in 2016[92a,92b] found very little evidence to support this concept. The EIT Task Force undertook a SysRev that identified 6 observational studies of very low-certainty evidence. Comparisons were divided into exposure to resuscitation by the team or individual, and years of career experience of individuals within the team. A critical risk of bias and a high degree of heterogeneity precluded meta-analyses. The task force made a weak recommendation that EMS systems should monitor exposure to resuscitation by clinical personnel and, where possible, implement strategies to address low exposure. This could include the rotation of EMS personnel through higher OHCA volume areas and the use of team simulation.

Community Initiatives to Promote BLS Implementation

This topic was last reviewed for the 2010 CoSTR,[93,94] although the role of communities in providing and promoting bystander CPR, a related topic, was reviewed for the 2015 CoSTR.[95,96] The EIT Task Force decided to search for evidence supporting the benefit of community initiatives (interventions aimed at increasing the engagement of the community in providing BLS with early defibrillation) in promoting BLS implementation. Studies evaluating the role of healthcare professionals or first responders with any duty to respond were excluded as were several specific interventions that are reviewed elsewhere in the 2020 CoSTR. Given the high heterogeneity among studies, a ScopRev was undertaken. Although only 40% of the 17 identified studies reported an increase in survival to hospital discharge, almost all showed a benefit with implementation of community initiatives, and this was greater in those evaluating bundled interventions. The task force suggests that a SysRev be undertaken, but in the meantime, the treatment recommendation from 2015 remains unchanged: "We recommend implementation of resuscitation guidelines within organizations that provide care for patients in cardiac arrest in any setting (strong recommendation, very low-quality evidence)."[95,96]

Opioid Overdose First Aid Education

The opioid overdose crisis is recognized as a major challenge, particularly in the United States. In 2015, the ALS Task Force made a strong recommendation for the use of naloxone for individuals in cardiac arrest caused by opioid toxicity.[25,26] At that time, the BLS Task Force made a weak recommendation to offer opioid overdose response education, with or without naloxone distribution, to persons at risk for opioid overdose.[12a,12b] The EIT Taskforce undertook a ScopRev of current opioid overdose response education programs to determine whether a new SysRev is required. Of 59 studies identified, only 8 used a comparator group and only 1 was a randomized controlled trial. Inconsistent reporting of educational interventions made it difficult to compare studies, and the EIT Task Force suggests that the use of the Guideline for Reporting Evidence-Based Practice Educational Interventions and Teaching checklist would improve standardization.[97] Another limitation in the evidence identified is that first aid and survival outcomes were generally self-reported by individuals refilling naloxone prescriptions and, therefore, are of questionable validity. The EIT Task Force found no evidence to change the current weak recommendation: "We suggest offering opioid overdose response education, with or without naloxone distribution, to persons at risk for opioid overdose in any setting."[12a,12b]

Willingness to Perform Bystander CPR

This topic was last reviewed by ILCOR in 2010.[93,94] Given the low incidence of bystander provision of CPR and use of AEDs, the EIT Task Force chose to undertake a ScopRev comparing factors that increase or decrease the willingness of bystanders to perform CPR for OHCA. The facilitators and barriers to performing CPR were categorized into personal factors, CPR knowledge, and procedural issues.[98] The 18 observational studies that were identified had significant heterogeneity among study populations and methodologies, definitions of factors associated with willingness to provide CPR, and outcomes reported. The task force agreed that there were insufficient data to warrant a SysRev. Although the treatment recommendation remains unchanged from 2010,[93,94] the EIT Task Force proposed that BLS training should include information to overcome potential barriers to CPR faced by lay rescuers. When

Please cite this article in press as: J.P. Nolan, et al., Executive Summary 2020 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations, Resuscitation (2020), https://doi.org/10.1016/j.resuscitation.2020.09.009

providing CPR instructions, EMS dispatchers should recognize the emotional barriers and physical factors that may make lay rescuers reluctant to perform CPR, and it will be important for dispatchers to support bystanders in starting and continuing CPR.

Out-of-Hospital CPR Training in Low-Resource Settings

To date, treatment recommendations with respect to CPR training have generally been made from the perspective of a well-resourced environment; these recommendations may not be applicable to lower-resource settings (per the World Bank definition by gross national income per capita). The EIT Task Force undertook a ScopRev to raise awareness of gaps in emergency care services around the world, to identify gaps in the literature, and to suggest future research priorities. Clinical outcomes were sought from studies of prehospital resuscitation among adults and children in low-resource settings. Of the 24 studies identified, none came from low-income countries, 4 came from lower-middle-income countries, and all others were from upper-middle-income economies. Longer-term outcomes, reported in 15 of the studies, were generally worse in the lower-middle-income countries.

The EIT Task Force encourages organizations responsible for emergency care in low-resource environments to collect data and document outcomes, ideally in the form of registries that comply with the Utstein-style reporting template.[99] In the future, experts and clinicians from low-resource environments should be involved in global initiatives such as ILCOR so that its recommendations can be made acceptable and applicable locally. Whether prehospital resuscitation is feasible, cost-effective, or even ethically justifiable in these regions has been questioned recently. Given the limited resources in low-income countries, the feasibility of full ALS and postresuscitation care is debatable. The priorities for healthcare systems should be determined locally. In the meantime, the weak recommendation made in 2015 stands: "We suggest that alternative instructional strategies would be reasonable for BLS or ALS teaching in low-income countries."[95,96]

New Systematic Reviews

EMS Experience and Exposure

This topic is discussed in more detail in the EIT Hot Topics section earlier in this publication. The EIT Task Force's SysRev identified only 6 observational studies, and because of the critical risk of bias and a high degree of heterogeneity, meta-analyses were not performed.[92a]

Effect on treatment recommendations: With this new treatment recommendation, the task force suggests that EMS systems monitor their clinical personnel's exposure to resuscitation and, where possible, implement strategies to address low exposure.

Patient Outcomes as a Result of a Member of the Resuscitation Team Attending an ALS Course

Whether resuscitation team member completion of an advanced cardiac life support course improves patient outcomes after cardiac arrest has long been debatable, not least because of the costs of these courses to participants and healthcare organizations. This EIT Task Force review is an adolopment of an existing SysRev and meta-analysis of 8 observational studies.[100] Although this was deemed very low-certainty evidence, it consistently favours advanced cardiac life support training.

Effect on treatment recommendations: The EIT Task Force made a weak recommendation for the provision of accredited adult advanced cardiac life support training for healthcare professionals.

Spaced Learning

A recent AHA scientific statement on education science describes spaced or distributed practice as the separation of training into several discrete sessions over a prolonged period with measurable intervals between training sessions (typically weeks to months).[101] The EIT Task Force undertook a SysRev of learners taking resuscitation courses and compared educational and clinical outcomes among those undergoing spaced learning with those undergoing massed learning (ie, training provided at a single time point). In all 17 of the studies identified, practical skills were assessed using manikins, so this was deemed only very low-certainty evidence to support spaced learning in resuscitation education.

Effect on treatment recommendations: In 2010, there was insufficient evidence to recommend any specific training intervention, compared with traditional lecture/practice sessions, to learning, retention, and use of ALS skills.[93,94] However, for 2020, the EIT Task Force suggests that spaced learning may be used instead of massed learning.

Opioid Overdose First Aid Education

This topic is discussed in more detail in the EIT Hot Topics section above. The EIT Task Force undertook a ScopRev of studies that compared education about response or care of an individual by first aid providers in an opioid overdose emergency with response by those with any other or no specialized education. Among the 8 identified studies with a comparator group, the task force found no evidence to change the current treatment recommendation.

Effect on treatment recommendations: The treatment recommendation is unchanged from 2015.[12a,12b]

Prehospital Termination of Resuscitation Rules

A recent SysRev identified 32 studies that addressed the use of termination of resuscitation rules that predict in-hospital outcomes among adults and children who do not achieve ROSC out-of-hospital.[102] The majority of these describe either the derivation and internal validation of individual termination of resuscitation rules or the external validation of previously published termination of resuscitation rules. Although the termination of resuscitation is commonly undertaken in many EMS systems, the identification of futile cases is challenging. The EIT Task Force advocates the adoption of termination of resuscitation guidelines that take into account the patient's prior wishes and/or expectations, consideration of patient preexisting comorbidities, and quality of life both before and after the cardiac arrest. However, a termination of resuscitation rule should not be the sole determinant of when to discontinue resuscitation. Global variation in cultural and legal issues must also be considered.

Effect on treatment recommendations: The 2010 CoSTR recommended the use of validated termination of resuscitation rules in adults.[93,94] For 2020, the EIT Task Force softened this to a conditional recommendation, taking into consideration the social acceptability of

Please cite this article in press as: J.P. Nolan, et al., Executive Summary 2020 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations, Resuscitation (2020), https://doi.org/10.1016/j.resuscitation.2020.09.009

excluding potential survivors from in-hospital treatment and the very limited clinical validation of such rules.

In-Hospital Termination of Resuscitation

Knowing when to stop a resuscitation attempt in-hospital is challenging. The EIT Task Force undertook a SysRev to determine whether the use of any clinical decision rule would predict a poor outcome with sufficient certainty to enable termination of the resuscitation attempt. Three studies used unwitnessed arrest, nonshockable rhythm, and 10 minutes of CPR without ROSC (the 3 variables of the so-called UN10 rule) to predict death before hospital discharge. These studies were based on historical cohorts and carry substantial risk of self-fulfilling prophecy bias. No single clinical factor or decision rule has been identified as sufficient to terminate resuscitation.

Effect on treatment recommendations: The EIT Task Force made a strong recommendation (based on very low-certainty evidence) against the use of the UN10 rule as a sole strategy to terminate in-hospital resuscitation. Clinicians should rely on clinical examination, their experience, and the patient's condition and wishes to inform their decision to terminate resuscitative efforts.

Additional Reviews

The EIT Task Force also evaluated 7 EvUps. The ScopRevs and EvUps, per ILCOR agreement, did not change treatment recommendations, but several resulted in the suggestion for new SysRevs.

First Aid

Hot Topics

Control of Life-Threatening External Bleeding

Trauma remains the leading cause of mortality and morbidity worldwide, and uncontrolled bleeding is the primary cause of death in up to 35% of patients who die from trauma.[103–105] The "Stop the Bleed" White House initiative[106] aims to bring battleground experience to the civilian world, with dissemination of education and equipment to recognize and control life-threatening bleeding. The combined SysRev for control of life-threatening bleeding used a common search strategy to evaluate evidence about direct manual pressure, tourniquets, haemostatic dressings, and haemostatic techniques.[107] The First Aid Task Force developed new recommendations about the use of tourniquets for life-threatening external extremity bleeding amenable to the use of a tourniquet. Additional recommendations include the use of direct manual pressure, with or without a haemostatic dressing, for life-threatening external bleeding not amenable to the use of a tourniquet.

Cooling of Heatstroke and Exertional Hyperthermia

Cooling for heatstroke and exertional hyperthermia was prioritized in light of the rising global risk of heat waves coupled with athletic events staged under these challenging conditions. The First Aid Task Force developed new treatment recommendations based on evidence suggesting that water immersion (between 1 °C and 26 °C, or between 33.8 °F and 78.8 °F) of the torso or whole body lowered the core body temperature faster than other active and passive cooling modalities.

Stroke Recognition

A new SysRev evaluated the available tools to assist the first aid provider in identifying potential stroke.[108] All tools were applied by trained EMS providers or nurses in the prehospital setting, so the evidence was only indirect when applied to the first aid setting; the ability of first aid providers to use the tools correctly remains an important question to be answered. The task force simplified previous recommendations[109,110] and continued to suggest that first aid providers use stroke assessment tools, noting an increased specificity (without loss of sensitivity) in tools that include measurement of blood glucose.

Dental Avulsion

When an injury causes tooth avulsion (ie, the tooth is pulled out with the root), the tooth must be stored in an appropriate medium to preserve viability until the tooth can be reimplanted. The First Aid Task Force sought a 2020 SysRev[111] to identify optimal media for temporary tooth storage, comparing the effects of many different media on periodontal ligament cell viability (surrogate for viability of the tooth for reimplantation). Although milk remains an effective medium, the task force concluded that other media as well as the use of clear cling film (ie, plastic wrap) were more effective in preserving viability.

New Systematic Reviews

Methods of Glucose Administration

The 2020 SysRev focused on methods and forms of glucose administration.[112] The review identified very limited evidence, and 2 of the 4 studies identified enrolled healthy volunteers (very indirect evidence).

Effect on treatment recommendations: The task force suggested oral swallowed sugar in preference to buccal administration of sugar. In a select group of children, sublingual administration of a wet paste of sugar improved resolution of hypoglycemia compared with oral swallowed glucose.

Heatstroke Cooling

The 2020 SysRev[113] focused on the potential for increased survival and reduced morbidity associated with heatstroke with the use of rapid core cooling. The task force evaluated limited evidence of 12 different active or passive cooling techniques in healthy adults with exertional hyperthermia (ie, indirect evidence about cooling for heatstroke). Evidence about cooling during heatstroke was based on observational studies and case series. Whole-body (neck-down) immersion in water with temperatures of 1 °C to 26 °C, or 33.8 °F to 78.8 °F (eg, in a small tub) produced the most rapid rate of cooling and was faster than other active-cooling techniques.

Effect on treatment recommendations: The new First Aid Task Force recommendation for adults with exertional hyperthermia or exertional heatstroke is immediate active cooling using whole-body (ie, neck-down) water immersion (1–26 °C, or 33.8–78.8 °F) until the core body temperature is less than 39 °C (102.2 °F). If water immersion is not possible, the task force recommends any other active-cooling methods.

Please cite this article in press as: J.P. Nolan, et al., Executive Summary 2020 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations, Resuscitation (2020), https://doi.org/10.1016/j.resuscitation.2020.09.009

Stroke Recognition

Because the prompt recognition of stroke is critical for effective treatment,[114] the First Aid Task Force requested a SysRev of stroke recognition tools appropriate for use in the first aid setting.[108] As noted previously, in all identified studies, the stroke scales or scoring tools were applied by trained EMS providers or nurses. As in the 2015 CoSTR, the 2020 First Aid Task Force recommended the use of stroke assessment scales or tools, based on the ability to perform point-of-care glucose measurement.

Effect on treatment recommendations: The treatment recommendations are essentially unchanged from 2015, although the specific stroke assessment tools cited vary slightly from those listed in 2015.[109,110]

Supplementary Oxygen in Acute Stroke

The 2020 SysRev focused exclusively on oxygen use for those with suspected stroke, rather than on general first aid oxygen use.[115] With few exceptions,[116] the studies reviewed reported no benefit associated with oxygen use (compared with room air) in those with suspected stroke, and 1 study[117] reported a higher rate of respiratory complications associated with oxygen use.

Effect on treatment recommendations: In a new recommendation focusing on the use of oxygen for those with suspected stroke, the task force suggested against the routine use of oxygen for those with suspected stroke.

First Aid Administration of Aspirin for Chest Pain: Early Compared With Late

The 2020 SysRev[118] evaluated the evidence about effects of early (prehospital or within 2 hours of symptom onset) compared with later, often in-hospital aspirin administration to anyone with nontraumatic chest pain. Two observational studies found an association of increased survival at 7 and 30 days[119,120] and 1 year[119] with early aspirin administration to those later diagnosed with acute myocardial infarction. However, increased survival at 35 days was not noted in a study administering enteric-coated aspirin.[121]

Effect on treatment recommendations: Early administration of aspirin is again suggested. However, the recommendation is no longer restricted to those with chest pain and suspected myocardial infarction but applies to all adults with nontraumatic chest pain.

Control of Life-Threatening Bleeding

A 2020 combined SysRev enabled the First Aid Task Force to evaluate the evidence for several methods to control life-threatening external bleeding, including direct pressure, pressure dressings, pressure points, tourniquets, haemostatic dressings, and haemostatic devices.[107] As noted previously, evidence from both military and civilian environments was identified. Key outcomes included mortality as well as time to cessation of bleeding. Direct manual pressure was demonstrated to be beneficial compared with compression devices, pressure dressings or bandages, or pressure points for severe life-threatening external bleeding. Tourniquet use was associated with a higher rate of bleeding cessation compared with direct pressure in military cohort studies[122,123] and lower all-cause mortality in 1 large prehospital cohort study.[124]

In-hospital RCTs performed in patients after endovascular procedures[125–137] demonstrated more rapid bleeding cessation with the use of haemostatic dressings plus direct manual pressure compared with direct manual pressure alone. Many patients in these studies also received anticoagulant medications.

Effect on treatment recommendations: The 2020 treatment recommendations now suggest the use of tourniquets for life-threatening external extremity bleeding that is amenable to the use of a tourniquet; direct pressure, with or without a haemostatic dressing is recommended for life-threatening external bleeding that is not amenable to tourniquet use.

Compression Wrap for Closed Extremity Joint Injury

First aid providers are often called to assist in the treatment of closed extremity joint injuries. The task force requested a SysRev to identify and analyse the evidence about treatment of these injuries.[138] The evidence, consisting of only in-hospital RCTs, found that compression wraps did not reduce pain[139,140] or swelling[139,141,142] or improve range of motion.[139–141,143,144] One small randomized trial found that a compression wrap did reduce recovery time and shorten time to return to sports.[141] The included studies may suffer from confounding related to the use of other standard therapy for acute joint injuries.

Effect on treatment recommendations: The recommendation is unchanged from 2010, when there was insufficient evidence to recommend for or against the application of a pressure bandage for an acute closed extremity joint injury.[145]

Dental Avulsion

The First Aid Task Force requested a 2020 SysRev of media used to store an avulsed tooth until it can be reimplanted.[111] Many RCTs found benefit from immersion of the tooth in Hanks' Balanced Salt Solution[146–157] as well as in oral rehydration salt solutions[154,155] or from wrapping the tooth in cling film (ie, plastic wrap)[158] as compared with immersion in milk. However, milk was better than many other media for storing a tooth until reimplantation.

Effect on treatment recommendations: The task force-recommended list of media and methods for storing an avulsed tooth is expanded and includes cling film (ie, plastic wrap); 2 solutions (coconut water and egg white) that were previously recommended are no longer included in the recommendations.

Additional Reviews

The First Aid Task Force also evaluated 8 ScopRevs and 2 EvUps.

Next Steps

The ILCOR councils, task forces, and members are committed to the process of continuous evidence evaluation. Through the ScopRevs and EvUps identified in this 2020 document, the task forces have identified many topics that require new SysRevs. The task forces will prioritize the next set of reviews, adding topics that result from the emerging evidence. The ILCOR leadership and task forces have set ambitious goals designed to analyse published studies and develop evidence-based treatment recommendations in a continuous, annual fashion to assist resuscitation councils in the creation and revision of their guidelines for CPR, ECC, education, and first aid.

Please cite this article in press as: J.P. Nolan, et al., Executive Summary 2020 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations, Resuscitation (2020), https://doi.org/10.1016/j.resuscitation.2020.09.009

Disclosures

Appendix 1 Writing Group Disclosures

Writing Group Member	Employment	Research Grant	Other Research Support	Speakers' Bureau/ Honoraria	Expert Witness	Ownership Interest	Consultant/ Advisory Board	Other
Jerry P. Nolan	Warwick Medical School (United Kingdom)	None	None	None	None	None	None	None
Richard Aickin	Starship Children's Hospital (New Zealand)	None	None	None	None	None	None	None
Katherine M. Berg	Beth Israel Deaconess Medical Center	NHLBI Grant K23 HL128814†	None	None	None	None	None	None
Farhan Bhanji	McGill University (Canada)	None	None	None	None	None	None	None
John E. Billi	University of Michigan	None	None	None	None	None	None	None
Maaret Castrén	Helsinki University Hospital (Finland)	None	None	None	None	None	None	None
Allan de Caen	University of Alberta (Canada)	None	None	None	None	None	None	None
Raffo Escalante-Kanashiro	Universidad Peruana de Ciencias Aplicadas (Peru)	None	None	None	None	None	None	None
Robert Greif	Bern University Hospital (Switzerland)	None	None	None	None	None	None	None
Mary Fran Hazinski	Vanderbilt University	None	None	None	None	None	None	None
David Kloeck	Resuscitation Council of Southern Africa (South Africa)	None	None	None	None	None	None	None
Ian Maconochie	Imperial College Healthcare Trust (United Kingdom)	None	None	None	None	None	None	None
Mary E. Mancini	University of Texas at Arlington	None	None	Stryker*	None	None	None	None
Raina M. Merchant	University of Pennsylvania	None	None	None	None	None	None	None
William H. Montgomery	Straub Clinic and Hospital	None	None	None	None	None	None	None
Peter T. Morley	University of Melbourne, Royal Melbourne Hospital (Australia)	None	None	None	None	None	None	None
Vinay M. Nadkarni	Children's Hospital Philadelphia	NIH (Unrestricted Research Grant to my Institution)*; AHRQ (Unrestricted Research Grant to my Institution)*; AHA-RQIP (Unrestricted Research Grant to my Institution)*; Nihon-Kohden (Unrestricted Research Grant to my Institution)*; Zoll Medical (Unrestricted Research Grant to my Institution)*	None	None	None	None	None	None
Robert W. Neumar	University of Michigan	NIH (R01 HL133129, K12 HL133304)†; AHA (19SFRN34760762)†	Stryker/PhysioControl (Equipment support for laboratory and clinical research)*	None	None	None	None	None
Theresa M. Olasveengen	Oslo University Hospital (Norway)	Zoll Foundation*; Laerdal Foundation*	None	None	None	None	None	None

(continued on next page)

Please cite this article in press as: J.P. Nolan, et al., Executive Summary 2020 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations, Resuscitation (2020), https://doi.org/10.1016/j.resuscitation.2020.09.009

Table *(continued)*

Writing Group Member	Employment	Research Grant	Other Research Support	Speakers' Bureau/ Honoraria	Expert Witness	Ownership Interest	Consultant/ Advisory Board	Other
Gavin D. Perkins	Warwick Medical School and University Hospitals NHS Foundation Trust (United Kingdom)	National Institute for Health Research (Institutional funding relating to cardiac arrest research)†; British Heart Foundation (Institutional funding relating to cardiac arrest research)†; Resuscitation Council UK (Institutional funding relating to cardiac arrest research)†	None	None	Her Majesty's Coroner*	None	None	None
Eunice M. Singletary	University of Virginia	None	None	None	None	None	American Red Cross Scientific Advisory Council (Volunteer Chairperson)*	None
Jasmeet Soar	Southmead Hospital North Bristol NHS Trust (United Kingdom)	None	None	None	None	None	None	None
Tzong-Luen Wang	Chang Bing Show Chwang Memorial Hospital (Taiwan)	None	None	None	None	None	None	None
Myra H. Wyckoff	UT Southwestern	None	None	None	None	None	None	None
Jonathan Wyllie	James Cook University Hospital (United Kingdom)	None	None	None	None	None	None	None
David Zideman	Thames Valley Air Ambulance Medical Directorate (United Kingdom)	None	None	None	None	None	None	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.

Appendix 2 Reviewer Disclosures

Reviewer	Employment	Research Grant	Other Research Support	Speakers' Bureau/ Honoraria	Expert Witness	Ownership Interest	Consultant/ Advisory Board	Other
Raúl J. Gazmuri	Rosalind Franklin University of Medicine and Science	Zoll Foundation (Myocardial Effects of Shock Burden During Defibrillation Attempts. Work conducted in a swine model)*; Zoll Foundation (Amplitude Spectral Area to Assess Hemodynamic and Metabolic Interventions during Cardiac Arrest. Work conducted in a swine model)*; Zoll Foundation (Does Erythropoietin Reduce Adverse Post-Resuscitation Myocardial and Cerebral Effects of Epinephrine Resulting in	None	None	None	None	None	None

Please cite this article in press as: J.P. Nolan, et al., Executive Summary 2020 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations, Resuscitation (2020), https://doi.org/10.1016/j.resuscitation.2020.09.009

Table *(continued)*

Reviewer	Employment	Research Grant	Other Research Support	Speakers' Bureau/ Honoraria	Expert Witness	Ownership Interest	Consultant/ Advisory Board	Other
		Improved Survival with Good Neurological Function? Work in a swine model)*						
Eddy Lang	University of Calgary (Canada)	None	None	None	None	None	None	None
Mary Ann McNeil	University of Minnesota	None	None	None	None	None	None	None
Vincent P. Reyes	Tuality Hospital	None	None	None	None	None	None	None
Taylor Sawyer	Seattle Children's Hospital/ University of Washington	None	None	None	None	None	None	None

This table represents the relationships of reviewers that may be perceived as actual or reasonably perceived conflicts of interest as reported on the Disclosure Questionnaire, which all reviewers 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.

REFERENCES

1. Perkins GD, Neumar R, Monsieurs KG, et al. The International Liaison Committee on Resuscitation-review of the last 25 years and vision for the future. Resuscitation 2017;121:104–16, doi:http://dx.doi.org/10.1016/j.resuscitation.2017.09.029.
2. Institute of Medicine (US) Committee of Standards for Systematic Reviews of Comparative Effectiveness Research. In: Eden J, Levit L, Berg A, Morton S, editors. Finding What Works in Health Care: Standards for Systematic Reviews. Washington, DC: The National Academies Press; 2011.
3. Cochrane Training. Introducing systematic reviews of prognosis studies to Cochrane: what and how? https://training.cochrane.org/resource/introducing-systematic-reviews-prognosis-studies-cochrane-what-and-how. Accessed March 17, 2020.
4. Cochrane Methods Screening and Diagnostic Tests. Handbook for DTA reviews. https://methods.cochrane.org/sdt/handbook-dta-reviews. Accessed March 17, 2020.
5. Schünemann H, Brożek J, Guyatt G, Oxman A. GRADE Handbook. 2013. . Accessed December 31, 2019 https://gdt.gradepro.org/app/handbook/handbook.html.
6. PRISMA. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) website. http://www.prisma-statement.org/. Accessed December 31, 2019.
7. Moher D, Liberati A, Tetzlaff J, Altman DG, PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. BMJ 2009;339:b2535, doi:http://dx.doi.org/10.1136/bmj.b2535.
8. (a) Morley PT, Atkins DL, Finn JC, et al. Evidence evaluation process and management of potential conflicts of interest: 2020 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. Circulation 2020;142(suppl 1):S28–40, doi:http://dx.doi.org/10.1161/CIR.0000000000000891.;
   (b) Morley P, Atkins DL, Finn JM, et al. Evidence evaluation process and management of potential conflicts of interest : 2020 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. Resuscitation 2020;156:A23–33.
9. International Liaison Committee on Resuscitation website. https://www.ilcor.org. Accessed August 3, 2020.
10. Perkins GD, Morley PT, Nolan JP, et al. International Liaison Committee on Resuscitation: COVID-19 consensus on science, treatment recommendations and task force insights. Resuscitation 2020;151:145–7, doi:http://dx.doi.org/10.1016/j.resuscitation.2020.04.035.
11. Kamikura T, Iwasaki H, Myojo Y, Sakagami S, Takei Y, Inaba H. Advantage of CPR-first over call-first actions for out-of-hospital cardiac arrests in nonelderly patients and of noncardiac aetiology. Resuscitation 2015;96:37–45, doi:http://dx.doi.org/10.1016/j.resuscitation.2015.06.027.
12. (a) Travers AH, Perkins GD, Berg RA, et al. Part 3: adult basic life support and automated external defibrillation: 2015 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. Circulation 2015;132(suppl 1):S51–83, doi:http://dx.doi.org/10.1161/CIR.0000000000000272.;
   (b) Perkins GD, Travers AH, Berg RA, et al. Basic Life Support Chapter Collaborators. Part 3: adult basic life support and automated external defibrillation: 2015 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. Resuscitation 2015;95:e43–69, doi:http://dx.doi.org/10.1016/j.resuscitation.2015.07.041.
13. McDonald R, Strang J. Are take-home naloxone programmes effective? Systematic review utilizing application of the Bradford Hill criteria. Addiction 2016;111:1177–87, doi:http://dx.doi.org/10.1111/add.13326.

Please cite this article in press as: J.P. Nolan, et al., Executive Summary 2020 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations, Resuscitation (2020), https://doi.org/10.1016/j.resuscitation.2020.09.009

14. (a) Sayre MR, Koster RW, Botha M, et al. Part 5: adult basic life support: 2010 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. Circulation 2010;122(suppl 2):S298–324, doi:http://dx.doi.org/10.1161/CIRCULATIONAHA.110.970996.;
(b) Koster RW, Sayre MR, Botha M, et al. Part 5: adult basic life support: 2010 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. Resuscitation 2010;81 (suppl 1):e48–70, doi:http://dx.doi.org/10.1016/j.resuscitation.2010.08.005.
15. Holmberg MJ, Vognsen M, Andersen MS, Donnino MW, Andersen LW. Bystander automated external defibrillator use and clinical outcomes after out-of-hospital cardiac arrest: A systematic review and meta-analysis. Resuscitation 2017;120:77–87, doi:http://dx.doi.org/10.1016/j.resuscitation.2017.09.003.
16. Bækgaard JS, Viereck S, Møller TP, Ersbøll AK, Lippert F, Folke F. The Effects of Public Access Defibrillation on Survival After Out-of-Hospital Cardiac Arrest: A Systematic Review of Observational Studies. Circulation 2017;136:954–65, doi:http://dx.doi.org/10.1161/CIRCULATIONAHA.117.029067.
17. Holmberg MJ, Issa MS, Moskowitz A, et al. Vasopressors during adult cardiac arrest: A systematic review and meta-analysis. Resuscitation 2019;139:106–21, doi:http://dx.doi.org/10.1016/j.resuscitation.2019.04.008.
18. Soar J, Maconochie I, Wyckoff MH, et al. 2019 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations: Summary From the Basic Life Support; Advanced Life Support; Pediatric Life Support; Neonatal Life Support; Education, Implementation, and Teams; and First Aid Task Forces. Circulation 2019;140:e826–80, doi:http://dx.doi.org/10.1161/CIR.0000000000000734.
19. Soar J, Maconochie I, Wyckoff MH, et al. 2019 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. Resuscitation 2019;145:95–150, doi:http://dx.doi.org/10.1016/j.resuscitation.2019.10.016.
20. Perkins GD, Ji C, Deakin CD, et al. A Randomized Trial of Epinephrine in Out-of-Hospital Cardiac Arrest. N Engl J Med. 2018;379:711–21, doi:http://dx.doi.org/10.1056/NEJMoa1806842.
21. Jacobs IG, Finn JC, Jelinek GA, Oxer HF, Thompson PL. Effect of adrenaline on survival in out-of-hospital cardiac arrest: a randomised double-blind placebo-controlled trial. Resuscitation 2011;82:1138–43, doi:http://dx.doi.org/10.1016/j.resuscitation.2011.06.029.
22. Perkins GD, Kenna C, Ji C, et al. The effects of adrenaline in out of hospital cardiac arrest with shockable and non-shockable rhythms: Findings from the PACA and PARAMEDIC-2 randomised controlled trials. Resuscitation 2019;140:55–63, doi:http://dx.doi.org/10.1016/j.resuscitation.2019.05.007.
23. Donnino MW, Andersen LW, Berg KM, et al. Temperature management after cardiac arrest: an advisory statement by the Advanced Life Support Task Force of the International Liaison Committee on Resuscitation and the American Heart Association Emergency Cardiovascular Care Committee and the Council on Cardiopulmonary, Critical Care, Perioperative and Resuscitation. Resuscitation 2016;98:97–104, doi:http://dx.doi.org/10.1016/j.resuscitation.2015.09.396.
24. Donnino MW, Andersen LW, Berg KM, et al. Temperature management after cardiac arrest: an advisory statement by the Advanced Life Support Task Force of the International Liaison Committee on Resuscitation and the American Heart Association Emergency Cardiovascular Care Committee and the Council on Cardiopulmonary, Critical Care, Perioperative and Resuscitation. Circulation 2015;132:2448–56, doi:http://dx.doi.org/10.1161/CIR.0000000000000313.
25. Callaway CW, Soar J, Aibiki M, et al. Part 4: advanced life support: 2015 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. Circulation 2015;132:S84–S145, doi:http://dx.doi.org/10.1161/CIR.0000000000000273.
26. Soar J, Callaway CW, Aibiki M, et al. Advanced Life Support Chapter Collaborators. Part 4: advanced life support: 2015 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. Resuscitation 2015;95:e71–e120, doi:http://dx.doi.org/10.1016/j.resuscitation.2015.07.042.
27. Lascarrou JB, Merdji H, Le Gouge A, et al. Targeted temperature management for cardiac arrest with nonshockable rhythm. N Engl J Med 2019;381:2327–37, doi:http://dx.doi.org/10.1056/NEJMoa1906661.
28. Cheskes S, Dorian P, Feldman M, et al. Double sequential external defibrillation for refractory ventricular fibrillation: the DOSE VF pilot randomized controlled trial. Resuscitation 2020;150:178–84, doi:http://dx.doi.org/10.1016/j.resuscitation.2020.02.010.
29. Nolan JP, Deakin CD, Ji C, et al. Intraosseous versus intravenous administration of adrenaline in patients with out-of-hospital cardiac arrest: a secondary analysis of the PARAMEDIC2 placebo-controlled trial. Intensive Care Med 2020;46:954–62, doi:http://dx.doi.org/10.1007/s00134-019-05920-7.
30. Daya MR, Leroux BG, Dorian P, et al. Survival after intravenous versus intraosseous amiodarone, lidocaine, or placebo in out-of-hospital shock-refractory cardiac arrest. Circulation 2020;141:188–98, doi:http://dx.doi.org/10.1161/CIRCULATIONAHA.119.042240.
31. Deakin CD, Morley P, Soar J, Drennan IR. Double (dual) sequential defibrillation for refractory ventricular fibrillation cardiac arrest: A systematic review. Resuscitation 2020;155:24–31.
32. Granfeldt A, Avis SR, Lind PC, et al. IV vs. IO administration of drugs during cardiac arrest (adult) (ALS): systematic review: consensus on science with treatment recommendations. 2020. . Updated February 20, 2020. Accessed March 18, 2020 https://costr.ilcor.org/document/iv-vs-io-administration-of-drugs-during-cardiac-arrest-systematic-review.
33. Javaudin F, Lascarrou JB, Le Bastard Q, et al. Thrombolysis during resuscitation for out-of-hospital cardiac arrest caused by pulmonary embolism increases 30-day survival: findings from the french national cardiac arrest registry. Chest 2019;156:1167–75, doi:http://dx.doi.org/10.1016/j.chest.2019.07.015.
34. Holmberg MJ, Nicholson T, Nolan JP, et al. Adult Pediatric Advanced Life Support Task Force at the International Liaison Committee on Resuscitation (ILCOR). Oxygenation and ventilation targets after cardiac arrest: a systematic review and meta-analysis. Resuscitation 2020;152:107–15, doi:http://dx.doi.org/10.1016/j.resuscitation.2020.04.031.
35. Mackle D, Bellomo R, Bailey M, et al. Conservative oxygen therapy during mechanical ventilation in the ICU. N Engl J Med 2020;382:989–98, doi:http://dx.doi.org/10.1056/NEJMoa1903297.
36. Couper K, Laloo R, Field R, Perkins GD, Thomas M, Yeung J. Prophylactic antibiotic use following cardiac arrest: a systematic review and meta-analysis. Resuscitation 2019;141:166–73, doi:http://dx.doi.org/10.1016/j.resuscitation.2019.04.047.
37. François B, Cariou A, Clere-Jehl R, et al. Prevention of early ventilator-associated pneumonia after cardiac arrest. N Engl J Med 2019;381:1831–42, doi:http://dx.doi.org/10.1056/NEJMoa1812379.
38. Weiss SL, Peters MJ, Alhazzani W, et al. Executive summary: surviving sepsis campaign international guidelines for the management of septic shock and sepsis-associated organ dysfunction in children. Intensive Care Med 2020;46:1–9, doi:http://dx.doi.org/10.1007/s00134-019-05877-7.
39. Hansen M, Schmicker RH, Newgard CD, et al. Time to epinephrine administration and survival from nonshockable out-of-hospital cardiac arrest among children and adults. Circulation 2018;137:2032

Please cite this article in press as: J.P. Nolan, et al., Executive Summary 2020 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations, Resuscitation (2020), https://doi.org/10.1016/j.resuscitation.2020.09.009

–40, doi:http://dx.doi.org/10.1161/CIRCULATIONAHA.117.033067.
40. Lin YR, Li CJ, Huang CC, et al. Early epinephrine improves the stabilization of initial post-resuscitation hemodynamics in children with non-shockable out-of-hospital cardiac arrest. Front Pediatr 2019;7:220, doi:http://dx.doi.org/10.3389/fped.2019.00220.
41. Fukuda T, Kondo Y, Hayashida K, Sekiguchi H, Kukita I. Time to epinephrine and survival after paediatric out-of-hospital cardiac arrest. Eur Heart J Cardiovasc Pharmacother 2018;4:144–51, doi:http://dx.doi.org/10.1093/ehjcvp/pvx023.
42. Meert K, Telford R, Holubkov R, et al. Paediatric in-hospital cardiac arrest: Factors associated with survival and neurobehavioural outcome one year later. Resuscitation 2018;124:96–105, doi:http://dx.doi.org/10.1016/j.resuscitation.2018.01.013.
43. Hoyme DB, Patel SS, Samson RA, et al. Epinephrine dosing interval and survival outcomes during pediatric in-hospital cardiac arrest. Resuscitation 2017;117:18–23, doi:http://dx.doi.org/10.1016/j.resuscitation.2017.05.023.
44. Hussmann B, Lefering R, Kauther MD, et al. Influence of prehospital volume replacement on outcome in polytraumatized children. Crit Care 2012;16:R201, doi:http://dx.doi.org/10.1186/cc11809.
45. Acker SN, Ross JT, Partrick DA, DeWitt P, Bensard DD. Injured children are resistant to the adverse effects of early high volume crystalloid resuscitation. J Pediatr Surg 2014;49:1852–5, doi:http://dx.doi.org/10.1016/j.jpedsurg.2014.09.034.
46. Coons BE, Tam S, Rubsam J, Stylianos S, Duron V. High volume crystalloid resuscitation adversely affects pediatric trauma patients. J Pediatr Surg 2018;53:2202–8, doi:http://dx.doi.org/10.1016/j.jpedsurg.2018.07.009.
47. Zhu CS, Cobb D, Jonas RB, et al. Shock index and pulse pressure as triggers for massive transfusion. J Trauma Acute Care Surg 2019;87(1S suppl 1):S159–64, doi:http://dx.doi.org/10.1097/TA.0000000000002333.
48. Elkbuli A, Zajd S, Ehrhardt Jr JD, McKenney M, Boneva D. Aggressive crystalloid resuscitation outcomes in low-severity pediatric trauma. J Surg Res 2020;247:350–5, doi:http://dx.doi.org/10.1016/j.jss.2019.10.009.
49. Edwards MJ, Lustik MB, Clark ME, Creamer KM, Tuggle D. The effects of balanced blood component resuscitation and crystalloid administration in pediatric trauma patients requiring transfusion in Afghanistan and Iraq 2002 to 2012. J Trauma Acute Care Surg 2015;78:330–5, doi:http://dx.doi.org/10.1097/TA.0000000000000469.
50. Henry S. ATLS Advanced Trauma Life Support. 10th edition Student Course Manual Chicago, IL: American College of Surgeons; 2018.
51. Kleinman ME, de Caen AR, Chameides L, et al. Part 10: pediatric basic and advanced life support: 2010 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. Circulation 2010;122(suppl 2):S466–515, doi:http://dx.doi.org/10.1161/CIRCULATIONAHA.110.971093.
52. de Caen AR, Kleinman ME, Chameides L, et al. Part 10: paediatric basic and advanced life support: 2010 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations. Resuscitation 2010;81:e213–59, doi:http://dx.doi.org/10.1016/j.resuscitation.2010.08.028.
53. Sutton RM, Reeder RW, Landis WP, et al. Ventilation rates and pediatric in-hospital cardiac arrest survival outcomes. Crit Care Med 2019;47:1627–36, doi:http://dx.doi.org/10.1097/CCM.0000000000003898.
54. Berg RA, Sutton RM, Reeder RW, et al. Association between diastolic blood pressure during pediatric in-hospital cardiopulmonary resuscitation and survival. Circulation 2018;137:1784–95, doi:http://dx.doi.org/10.1161/CIRCULATIONAHA.117.032270.
55. (a) de Caen AR, Maconochie IK, Aickin R, et al. Part 6: pediatric basic life support and pediatric advanced life support: 2015 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. Circulation 2015;132:S177–203, doi:http://dx.doi.org/10.1161/CIR.0000000000000275.;
(b) Maconochie IK, de Caen AR, Aickin R, et al. Pediatric Basic Life Support and Pediatric Advanced Life Support Chapter Collaborators. Part 6: pediatric basic life support and pediatric advanced life support: 2015 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. Resuscitation 2015;95:e147–68, doi:http://dx.doi.org/10.1016/j.resuscitation.2015.07.
56. Holmberg MJ, Nicholson T, Nolan JP, et al. Oxygenation and ventilation targets after cardiac arrest: a systematic review and meta-analysis. Resuscitation 2020, doi:http://dx.doi.org/10.1016/j.resuscitation.2020.04.031 Epub ahead of print.
57. Ferguson LP, Durward A, Tibby SM. Relationship between arterial partial oxygen pressure after resuscitation from cardiac arrest and mortality in children. Circulation 2012;126:335–42, doi:http://dx.doi.org/10.1161/CIRCULATIONAHA.111.085100.
58. van Zellem L, de Jonge R, van Rosmalen J, Reiss I, Tibboel D, Buysse C. High cumulative oxygen levels are associated with improved survival of children treated with mild therapeutic hypothermia after cardiac arrest. Resuscitation 2015;90:150–7, doi:http://dx.doi.org/10.1016/j.resuscitation.2014.12.013.
59. López-Herce J, del Castillo J, Matamoros M, et al. Post return of spontaneous circulation factors associated with mortality in pediatric in-hospital cardiac arrest: a prospective multicenter multinational observational study. Crit Care 2014;18:607, doi:http://dx.doi.org/10.1186/s13054-014-0607-9.
60. Del Castillo J, López-Herce J, Matamoros M, et al. Hyperoxia, hypocapnia and hypercapnia as outcome factors after cardiac arrest in children. Resuscitation 2012;83:1456–61, doi:http://dx.doi.org/10.1016/j.resuscitation.2012.07.019.
61. Trevisanuto D, Strand ML, Kawakami MD, et al. Tracheal suctioning of meconium at birth for non-vigorous infants: a systematic review and meta-analysis. Resuscitation 2020;149:117–26, doi:http://dx.doi.org/10.1016/j.resuscitation.2020.01.038.
62. Halling C, Sparks JE, Christie L, Wyckoff MH. Efficacy of intravenous and endotracheal epinephrine during neonatal cardiopulmonary resuscitation in the delivery room. J Pediatr 2017;185:232–6, doi:http://dx.doi.org/10.1016/j.jpeds.2017.02.024.
63. Barber CA, Wyckoff MH. Use and efficacy of endotracheal versus intravenous epinephrine during neonatal cardiopulmonary resuscitation in the delivery room. Pediatrics 2006;118:1028–34, doi:http://dx.doi.org/10.1542/peds.2006-0416.
64. Welsford M, Nishiyama C, Shortt C, et al. Initial oxygen use for preterm newborn resuscitation: a systematic review with meta-analysis. Pediatrics 2019143:, doi:http://dx.doi.org/10.1542/peds.2018-1828.
65. Soraisham AS, Rabi Y, Shah PS, et al. Neurodevelopmental outcomes of preterm infants resuscitated with different oxygen concentration at birth. J Perinatol 2017;37:1141–7, doi:http://dx.doi.org/10.1038/jp.2017.83.
66. Kapadia VS, Lal CV, Kakkilaya V, Heyne R, Savani RC, Wyckoff MH. Impact of the neonatal resuscitation program-recommended low oxygen strategy on outcomes of infants born preterm. J Pediatr 2017;191:35–41, doi:http://dx.doi.org/10.1016/j.jpeds.2017.08.074.
67. Perlman JM, Wyllie J, Kattwinkel J, et al. Part 7: neonatal resuscitation: 2015 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. Circulation 2015;132:S204–41, doi:http://dx.doi.org/10.1161/CIR.0000000000000276.
68. Wyllie J, Perlman JM, Kattwinkel J, et al. Part 7: neonatal resuscitation: 2015 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. Resuscitation 2015;95:e169–201, doi:http://dx.doi.org/10.1016/j.resuscitation.2015.07.045.

Please cite this article in press as: J.P. Nolan, et al., Executive Summary 2020 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations, Resuscitation (2020), https://doi.org/10.1016/j.resuscitation.2020.09.009

69. Perlman JM, Wyllie J, Kattwinkel J, et al. Part 7: neonatal resuscitation: 2015 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations (Reprint). Pediatrics 2015;136:S120–66, doi:http://dx.doi.org/10.1542/peds.2015-3373D.
70. Foglia EE, Te Pas AB, Kirpalani H, et al. Sustained inflation vs standard resuscitation for preterm infants: a systematic review and meta-analysis. JAMA Pediatr 2020;e195897, doi:http://dx.doi.org/10.1001/jamapediatrics.2019.5897.
71. Lindner W, Högel J, Pohlandt F. Sustained pressure-controlled inflation or intermittent mandatory ventilation in preterm infants in the delivery room? A randomized, controlled trial on initial respiratory support via nasopharyngeal tube. Acta Paediatr 2005;94:303–9, doi:http://dx.doi.org/10.1111/j.1651-2227.2005.tb18431.x.
72. Lista G, Boni L, Scopesi F, et al. Sustained lung inflation at birth for preterm infants: a randomized clinical trial. Pediatrics 2015;135:e457–64, doi:http://dx.doi.org/10.1542/peds.2014-1692.
73. Schwaberger B, Pichler G, Avian A, Binder-Heschl C, Baik N, Urlesberger B. Do sustained lung inflations during neonatal resuscitation affect cerebral blood volume in preterm infants? a randomized controlled pilot study. PLoS One 2015;10:e0138964, doi:http://dx.doi.org/10.1371/journal.pone.0138964.
74. Mercadante D, Colnaghi M, Polimeni V, et al. Sustained lung inflation in late preterm infants: a randomized controlled trial. J Perinatol 2016;36:443–7, doi:http://dx.doi.org/10.1038/jp.2015.222.
75. Jiravisitkul P, Rattanasiri S, Nuntnarumit P. Randomised controlled trial of sustained lung inflation for resuscitation of preterm infants in the delivery room. Resuscitation 2017;111:68–73, doi:http://dx.doi.org/10.1016/j.resuscitation.2016.12.003.
76. Ngan AY, Cheung PY, Hudson-Mason A, et al. Using exhaled CO_2 to guide initial respiratory support at birth: a randomised controlled trial. Arch Dis Child Fetal Neonatal Ed 2017;102:F525–31, doi:http://dx.doi.org/10.1136/archdischild-2016-312286.
77. El-Chimi MS, Awad HA, El-Gammasy TM, El-Farghali OG, Sallam MT, Shinkar DM. Sustained versus intermittent lung inflation for resuscitation of preterm infants: a randomized controlled trial. J Matern Fetal Neonatal Med 2017;30:1273–8, doi:http://dx.doi.org/10.1080/14767058.2016.1210598.
78. Abd El-Fattah N, Nasef N, Al-Harrass MF, Khashaba M. Sustained lung inflation at birth for preterm infants at risk of respiratory distress syndrome: the proper pressure and duration. J Neonatal Perinatal Med 2017;10:409–17, doi:http://dx.doi.org/10.3233/npm-171760.
79. Kirpalani H, Ratcliffe SJ, Keszler M, et al. Effect of sustained inflations vs intermittent positive pressure ventilation on bronchopulmonary dysplasia or death among extremely preterm infants: the SAIL Randomized Clinical Trial. JAMA 2019;321:1165–75, doi:http://dx.doi.org/10.1001/jama.2019.1660.
80. La Verde A, Franchini S, Lapergola G, et al. Effects of sustained inflation or positive pressure ventilation on the release of adrenomedullin in preterm infants with respiratory failure at birth. Am J Perinatol 2019;36:S110–4, doi:http://dx.doi.org/10.1055/s-0039-1692133.
81. Isayama T, Mildenhall M, Schmölzer GM, et al. On behalf of the International Liaison Committee on Resuscitation Newborn Life Support Task Force. The route, dose, and interval of epinephrine for neonatal resuscitation: a systematic review. Pediatrics 2020 in press.
82. Perlman JM, Wyllie J, Kattwinkel J, et al. Part 11: neonatal resuscitation: 2010 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. Circulation 2010;122:S516–38, doi:http://dx.doi.org/10.1161/CIRCULATIONAHA.110.971127.
83. Perlman JM, Wyllie J, Kattwinkel J, et al. Neonatal resuscitation: 2010 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations. Pediatrics 2010;126:e1319–44, doi:http://dx.doi.org/10.1542/peds.2010-2972B.
84. Ellemunter H, Simma B, Trawöger R, Maurer H. Intraosseous lines in preterm and full term neonates. Arch Dis Child Fetal Neonatal Ed 1999;80:F74–5, doi:http://dx.doi.org/10.1136/fn.80.1.f74.
85. Wagner M, Olischar M, O'Reilly M, et al. Review of routes to administer medication during prolonged neonatal resuscitation. Pediatr Crit Care Med 2018;19:332–8, doi:http://dx.doi.org/10.1097/PCC.0000000000001493.
86. Vidal R, Kissoon N, Gayle M. Compartment syndrome following intraosseous infusion. Pediatrics 1993;91:1201–2.
87. Katz DS, Wojtowycz AR. Tibial fracture: a complication of intraosseous infusion. Am J Emerg Med 1994;12:258–9, doi:http://dx.doi.org/10.1016/0735-6757(94)90261-5.
88. Carreras-González E, Brió-Sanagustín S, Guimerá I, Crespo C. Complication of the intraosseous route in a newborn infant [in Spanish]. Med Intensiva 2012;36:233–4, doi:http://dx.doi.org/10.1016/j.medin.2011.05.004.
89. Oesterlie GE, Petersen KK, Knudsen L, Henriksen TB. Crural amputation of a newborn as a consequence of intraosseous needle insertion and calcium infusion. Pediatr Emerg Care 2014;30:413–4, doi:http://dx.doi.org/10.1097/PEC.0000000000000150.
90. Suominen PK, Nurmi E, Lauerma K. Intraosseous access in neonates and infants: risk of severe complications — a case report. Acta Anaesthesiol Scand 2015;59:1389–93, doi:http://dx.doi.org/10.1111/aas.12602.
91. Foglia EE, Weiner GL, de Almeida MF, et al. Duration of resuscitation at birth, mortality and neurodevelopment: a systematic review. Pediatrics 2020;e20201449, doi:http://dx.doi.org/10.1542/peds.2020-1449.
92. (a) Dyson K, Bray J, Smith K, Bernard S, Finn J. A systematic review of the effect of emergency medical service practitioners' experience and exposure to out-of-hospital cardiac arrest on patient survival and procedural performance. Resuscitation 2014;85:1134–41, doi:http://dx.doi.org/10.1016/j.resuscitation.2014.05.020.;
(b) Bray J, Nehme Z, Andrew Nguyen A, et al. on behalf of the Education, Implementation and Teams Task Force of the International Liaison Committee on Resuscitation. A systematic review of the impact of emergency medical service practitioner experience and exposure to out of hospital cardiac arrest on patient outcomes. Resuscitation 2020;155:134–42, doi:http://dx.doi.org/10.1016/j.resuscitation.2020.07.025.
93. Mancini ME, Soar J, Bhanji F, et al. Part 12: education, implementation, and teams: 2010 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. Circulation 2010;122:S539–81, doi:http://dx.doi.org/10.1161/CIRCULATIONAHA.110.971143.
94. Soar J, Mancini ME, Bhanji F, et al. Part 12: education, implementation, and teams: 2010 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. Resuscitation 2010;81:e288–330, doi:http://dx.doi.org/10.1016/j.resuscitation.2010.08.030.
95. Finn JC, Bhanji F, Lockey A, et al. Part 8: education, implementation, and teams: 2015 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. Resuscitation 2015;95:e203–24, doi:http://dx.doi.org/10.1016/j.resuscitation.2015.07.046.
96. Bhanji F, Finn JC, Lockey A, et al. Part 8: education, implementation, and teams: 2015 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. Circulation 2015;132:S242–68, doi:http://dx.doi.org/10.1161/CIR.0000000000000277.
97. Phillips AC, Lewis LK, McEvoy MP, et al. Development and validation of the guideline for reporting evidence-based practice educational interventions and teaching (GREET). BMC Med Educ 2016;16:237, doi:http://dx.doi.org/10.1186/s12909-016-0759-1.
98. Case R, Cartledge S, Siedenburg J, et al. Identifying barriers to the provision of bystander cardiopulmonary resuscitation (CPR) in high-risk regions: a qualitative review of emergency calls. Resuscitation 2018;129:43–7, doi:http://dx.doi.org/10.1016/j.resuscitation.2018.06.001.

Please cite this article in press as: J.P. Nolan, et al., Executive Summary 2020 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations, Resuscitation (2020), https://doi.org/10.1016/j.resuscitation.2020.09.009

99. Perkins GD, Jacobs IG, Nadkarni VM, et al. Cardiac arrest and cardiopulmonary resuscitation outcome reports: update of the utstein resuscitation registry templates for out-of-hospital cardiac arrest: a statement for healthcare professionals from a Task Force of the International Liaison Committee on Resuscitation (American Heart Association, European Resuscitation Council, Australian and New Zealand Council on Resuscitation, Heart and Stroke Foundation of Canada, InterAmerican Heart Foundation, Resuscitation Council of Southern Africa, Resuscitation Council of Asia); and the American Heart Association Emergency Cardiovascular Care Committee and the Council on Cardiopulmonary, Critical Care, Perioperative and Resuscitation. Resuscitation 2015;96:328–40, doi:http://dx.doi.org/10.1016/j.resuscitation.2014.11.002.
100. Lockey A, Lin Y, Cheng A. Impact of adult advanced cardiac life support course participation on patient outcomes—a systematic review and meta-analysis. Resuscitation 2018;129:48–54, doi:http://dx.doi.org/10.1016/j.resuscitation.2018.05.034.
101. Cheng A, Nadkarni VM, Mancini MB, et al. Resuscitation education science: educational strategies to improve outcomes from cardiac arrest: a scientific statement from the American Heart Association. Circulation 2018;138:e82–e122, doi:http://dx.doi.org/10.1161/CIR.0000000000000583.
102. Smyth M., Clarke A., Perkins G. Characteristics and performance of termination of resuscitation rules in adults who are treated for out-of-hospital cardiac arrest: a systematic review and meta-analysis. https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42019131010. Updated January 17, 2020. Accessed April 8, 2020.
103. World Health Organization. Violence and injury prevention. 2008. . Accessed February 28, 2020 https://www.who.int/violence_injury_prevention/en/.
104. Jacobs L, Burns KJ. The Hartford Consensus to improve survivability in mass casualty events: Process to policy. Am J Disaster Med 2014;9:67–71, doi:http://dx.doi.org/10.5055/ajdm.2014.0143.
105. Kauvar DS, Lefering R, Wade CE. Impact of hemorrhage on trauma outcome: an overview of epidemiology, clinical presentations, and therapeutic considerations. J Trauma 2006;60(suppl):S3–S11, doi:http://dx.doi.org/10.1097/01.ta.0000199961.02677.19.
106. U.S. Department of Homeland Security. Stop the bleed. https://www.dhs.gov/stopthebleed. Accessed March 18, 2020.
107. Charlton NP, Swain JM, Brozek JL, et al. Control of severe, life-threatening external bleeding in the out-of-hospital setting: a systematic review. Prehosp Emerg Care 2020;1–33, doi:http://dx.doi.org/10.1080/10903127.2020.1743801.
108. Meyran D, Cassan P, Singletary E, Zideman D, on behalf of the International Liaison Committee on Resuscitation (ILCOR) First Aid Task Force. First aid stroke recognition: systematic review: Consensus on Science With Treatment Recommendations. 2020. . Updated January 10, 2020. Accessed April 8, 2020 https://costr.ilcor.org/document/first-aid-stroke-recognition-tfsr.
109. Singletary EM, Zideman DA, De Buck ED, et al. Part 9: first aid: 2015 International Consensus on First Aid Science With Treatment Recommendations. Circulation 2015;132:S269–311, doi:http://dx.doi.org/10.1161/CIR.0000000000000278.
110. Zideman DA, Singletary EM, De Buck ED, et al. Part 9: first aid: 2015 International Consensus on First Aid Science With Treatment Recommendations. Resuscitation 2015;95:e225–E261, doi:http://dx.doi.org/10.1016/j.resuscitation.2015.07.047.
111. De Brier N, O D, Borra V, et al. Storage of an avulsed tooth prior to replantation: a systematic review and meta-analysis. Dent Traumatol 2020, doi:http://dx.doi.org/10.1111/edt.12564 Epub ahead of print.
112. De Buck E, Borra V, Carlson JN, Zideman DA, Singletary EM, Djärv T. First aid glucose administration routes for symptomatic hypoglycaemia. Cochrane Database Syst Rev 2019;4:CD013283, doi:http://dx.doi.org/10.1002/14651858.CD013283.pub2.
113. Douma MJ, Aves T, Allan KS, et al. First aid cooling techniques for heat stroke and exertional hyperthermia: a systematic review and meta-analysis. Resuscitation 2020;148:173–90, doi:http://dx.doi.org/10.1016/j.resuscitation.2020.01.007.
114. Powers WJ, Rabinstein AA, Ackerson T, et al. 2018 guidelines for the early management of patients with acute ischemic stroke: a guideline for healthcare professionals from the American Heart Association/American Stroke Association. Stroke 2018;49:e46–e110, doi:http://dx.doi.org/10.1161/STR.0000000000000158.
115. Chang WT, Sakamoto T, Lee CC, et al. First aid supplementary oxygen for acute stroke: Consensus on Science With Treatment Recommendations: International Liaison Committee on Resuscitation (ILCOR) First Aid Task Force. 2020. . Updated January 24, 2020. Accessed April 14, 2020 https://costr.ilcor.org/document/first-aid-supplementary-oxygen-for-acute-stroke-tfsr.
116. Roffe C, Ali K, Warusevitane A, et al. The SOS pilot study: a RCT of routine oxygen supplementation early after acute stroke–effect on recovery of neurological function at one week. PLoS One 2011;6:e19113, doi:http://dx.doi.org/10.1371/journal.pone.0019113.
117. Dylla L, Adler DH, Abar B, et al. Prehospital supplemental oxygen for acute stroke: a retrospective analysis. Am J Emerg Med 2019;30741–7, doi:http://dx.doi.org/10.1016/j.ajem.2019.11.002.
118. Djarv T, Swain JM, Chang WT, Zideman DA, Singletary E. Early or first aid administration versus late or in-hospital administration of aspirin for non-traumatic adult chest pain: a systematic review. Cureus 2020;12:e6862, doi:http://dx.doi.org/10.7759/cureus.6862.
119. Freimark D, Matetzky S, Leor J, Boyko V, Barbash IM, Behar S, Hod H. Timing of aspirin administration as a determinant of survival of patients with acute myocardial infarction treated with thrombolysis. Am J Cardiol 2002;89:381–5, doi:http://dx.doi.org/10.1016/s0002-9149(01)02256-1.
120. Barbash I, Freimark D, Gottlieb S, et al. Outcome of myocardial infarction in patients treated with aspirin is enhanced by pre-hospital administration. Cardiology 2002;98:141–7, doi:http://dx.doi.org/10.1159/000066324.
121. ISIS-2 (Second International Study of Infarct Survival) Collaborative Group. Randomised trial of intravenous streptokinase, oral aspirin, both, or neither among 17,187 cases of suspected acute myocardial infarction: ISIS-2. Lancet 1988;2:349–60.
122. Beekley AC, Sebesta JA, Blackbourne LH, et al. Prehospital tourniquet use in Operation Iraqi Freedom: effect on hemorrhage control and outcomes. J Trauma 2008;64:S28–37, doi:http://dx.doi.org/10.1097/TA.0b013e318160937e discussion S37.
123. Mucciarone JJ, Llewellyn CH, Wightman JM. Tactical combat casualty care in the assault on Punta Paitilla Airfield. Mil Med 2006;171:687–90, doi:http://dx.doi.org/10.7205/milmed.171.8.687.
124. Teixeira PGR, Brown CVR, Emigh B, et al. Civilian prehospital tourniquet use is associated with improved survival in patients with peripheral vascular injury. J Am Coll Surg 2018;226:769–76, doi:http://dx.doi.org/10.1016/j.jamcollsurg.2018.01.047 e1.
125. Arbel J, Rozenbaum E, Reges O, et al. USage of chitosan for Femoral (USF) haemostasis after percutaneous procedures: a comparative open label study. Euro Intervention 2011;6:1104–9, doi:http://dx.doi.org/10.4244/EIJV6I9A192.
126. Balzer JO, Schwarz W, Thalhammer A, Eichler K, Schmitz-Rixen T, Vogl TJ. Postinterventional percutaneous closure of femoral artery access sites using the Clo-Sur PAD device: initial findings. Eur Radiol 2007;17:693–700, doi:http://dx.doi.org/10.1007/s00330-006-0279-1.
127. Behler RH, Scola MR, Nichols TC, et al. ARFI ultrasound for *in vivo* hemostasis assessment postcardiac catheterization, part II: pilot clinical results. Ultrason Imaging 2009;31:159–71, doi:http://dx.doi.org/10.1177/016173460903100302.
128. Kang SH, Han D, Kim S, et al. Hemostasis pad combined with compression device after transradial coronary procedures: a randomized controlled trial. PLoS One 2017;12:e0181099, doi:http://dx.doi.org/10.1371/journal.pone.0181099.
129. Kordestani SS, Noohi F, Azarnik H, et al. A randomized controlled trial on the hemostasis of femoral artery using topical hemostatic agent. Clin Appl Thromb Hemost 2012;18:501–5, doi:http://dx.doi.org/10.1177/1076029611432745.
130. McConnell MK, McDilda K, Bridges R, et al. Comparison of different methods for achieving hemostasis after arterial sheath removal. J

Cardiovasc Nurs 2012;27:E1–5, doi:http://dx.doi.org/10.1097/JCN.0b013e318223881b.
131. Mlekusch W, Dick P, Haumer M, Sabeti S, Minar E, Schillinger M. Arterial puncture site management after percutaneous transluminal procedures using a hemostatic wound dressing (Clo-Sur P.A.D.) versus conventional manual compression: a randomized controlled trial. J Endovasc Ther 2006;13:23–31, doi:http://dx.doi.org/10.1583/05-1679.1.
132. Narins CR, Zareba W, Rocco V, McNitt S. A prospective, randomized trial of topical hemostasis patch use following percutaneous coronary and peripheral intervention. J Invasive Cardiol 2008;20:579–84.
133. Nguyen N, Hasan S, Caufield L, Ling FS, Narins CR. Randomized controlled trial of topical hemostasis pad use for achieving vascular hemostasis following percutaneous coronary intervention. Catheter Cardiovasc Interv 2007;69:801–7, doi:http://dx.doi.org/10.1002/ccd.21024.
134. Sairaku A, Nakano Y, Oda N, et al. Rapid hemostasis at the femoral venous access site using a novel hemostatic pad containing kaolin after atrial fibrillation ablation. J Interv Card Electrophysiol 2011;31:157–64, doi:http://dx.doi.org/10.1007/s10840-011-9552-6.
135. Schwarz T, Rastan A, Pochert V, et al. Mechanical compression versus haemostatic wound dressing after femoral artery sheath removal: a prospective, randomized study. Vasa 2009;38:53–9, doi:http://dx.doi.org/10.1024/0301-1526.38.1.53.
136. Trabattoni D, Gatto P, Bartorelli AL. A new kaolin-based hemostatic bandage use after coronary diagnostic and interventional procedures. Int J Cardiol 2012;156:53–4, doi:http://dx.doi.org/10.1016/j.ijcard.2010.10.030.
137. Waragai T, Morgan G, Ralston T, Chaturvedi R, Lee KJ, Benson L. Vascular hemostasis bandage compared to standard manual compression after cardiac catheterization in children. Catheter Cardiovasc Interv 2011;78:262–6, doi:http://dx.doi.org/10.1002/ccd.23057.
138. Borra V, Berry D, Zideman D, Singletary E, De Buck E. Compression wrapping for acute closed extremity joint injuries: a systematic review. J Athl Train 2020, doi:http://dx.doi.org/10.4085/1062-6050-93-20 Epub ahead of print.
139. Boyce SH, Quigley MA, Campbell S. Management of ankle sprains: a randomised controlled trial of the treatment of inversion injuries using an elastic support bandage or an Aircast ankle brace. Br J Sports Med 2005;39:91–6, doi:http://dx.doi.org/10.1136/bjsm.2003.009233.
140. O'Connor G, Martin AJ. Acute ankle sprain: is there a best support? Eur J Emerg Med 2011;18:225–30, doi:http://dx.doi.org/10.1097/MEJ.0b013e3283440efd.
141. Bendahou M, Khiami F, Saïdi K, et al. Compression stockings in ankle sprain: a multicenter randomized study. Am J Emerg Med 2014;32:1005–10, doi:http://dx.doi.org/10.1016/j.ajem.2014.05.054.
142. Rucinkski TJ, Hooker DN, Prentice WE, Shields EW, Cote-Murray DJ. The effects of intermittent compression on edema in postacute ankle sprains. J Orthop Sports Phys Ther 1991;14:65–9, doi:http://dx.doi.org/10.2519/jospt.1991.14.2.65.
143. Leanderson J, Wredmark T. Treatment of acute ankle sprain. Comparison of a semi-rigid ankle brace and compression bandage in 73 patients. Acta Orthop Scand 1995;66:529–31, doi:http://dx.doi.org/10.3109/17453679509002308.
144. Beynnon BD, Renström PA, Haugh L, Uh BS, Barker H. A prospective, randomized clinical investigation of the treatment of first-time ankle sprains. Am J Sports Med 2006;34:1401–12, doi:http://dx.doi.org/10.1177/0363546506288676.
145. Markenson D, Ferguson JD, Chameides L, et al. Part 13: first aid: 2010 American Heart Association and American Red Cross International Consensus on First Aid Science With Treatment Recommendations. Circulation 2010;122:S582–605, doi:http://dx.doi.org/10.1161/CIRCULATIONAHA.110.971168.
146. Abraham BKP, Varma BR, Xavier AM, Kumar SJ. Comparative evaluation of the efficacy of aloe vera gel with milk and Hank's Balanced Salt Solution in maintaining the viability of PDL cells in avulsed teeth. J Clin Diagn Res 2019;13:ZC11–5, doi:http://dx.doi.org/10.7860/jcdr/2019/37876.12700.
147. Ahangari Z, Alborzi S, Yadegari Z, Dehghani F, Ahangari L, Naseri M. The effect of propolis as a biological storage media on periodontal ligament cell survival in an avulsed tooth: an *in vitro* study. Cell J 2013;15:244–9.
148. Chen H, Huang B. (-)-Epigallocatechin-3-gallate: a novel storage medium for avulsed teeth. Dent Traumatol 2012;28:158–60, doi:http://dx.doi.org/10.1111/j.1600-9657.2011.01066.x.
149. Doyle DL, Dumsha TC, Sydiskis RJ. Effect of soaking in Hank's balanced salt solution or milk on PDL cell viability of dry stored human teeth. Endod Dent Traumatol 1998;14:221–4, doi:http://dx.doi.org/10.1111/j.1600-9657.1998.tb00843.x.
150. Gopikrishna V, Thomas T, Kandaswamy D. A quantitative analysis of coconut water: a new storage media for avulsed teeth. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2008;105:e61–5, doi:http://dx.doi.org/10.1016/j.tripleo.2007.08.003.
151. Khademi AA, Saei S, Mohajeri MR, et al. A new storage medium for an avulsed tooth. J Contemp Dent Pract 2008;9:25–32.
152. Martin MP, Pileggi R. A quantitative analysis of Propolis: a promising new storage media following avulsion. Dent Traumatol 2004;20:85–9, doi:http://dx.doi.org/10.1111/j.1600-4469.2004.00233.x.
153. Prueksakorn A, Puasiri S, Ruangsri S, et al. The preservative effect of Thai propolis extract on the viability of human periodontal ligament cells. Dent Traumatol 2016;32:495–501, doi:http://dx.doi.org/10.1111/edt.12292.
154. Rajendran P, Varghese NO, Varughese JM, Murugaian E. Evaluation, using extracted human teeth, of Ricetral as a storage medium for avulsions–an *in vitro* study. Dent Traumatol 2011;27:217–20, doi:http://dx.doi.org/10.1111/j.1600-9657.2011.00988.x.
155. Subramaniam P, Girija P, Eswara U, Girish Babu KL. Oral rehydration salt-liquid as a storage medium for avulsed tooth. Dent Traumatol 2015;31:62–6, doi:http://dx.doi.org/10.1111/edt.12127.
156. Sunil OL, Devadathan A, Jacob J, Mathew J, Rex I. A comparative evaluation of post traumatic periodontal ligament cell viability using four different storage media—an in vitro study. Health Sci 2013;2:1–9, doi:http://dx.doi.org/10.4103/ejd.ejd_101_16.
157. Talebi M, Parisay I, Afshari JT, Shajiei A, Ghadim MS. Viability and reproducibility of periodontal ligament cells on avulsed teeth stored in Ham's F-10 solution. J Clin Pediatr Dent 2018;42:203–7, doi:http://dx.doi.org/10.17796/1053-4628-42.3.6.
158. Zeissler-Lajtman A, Connert T, Kühl S, Filippi A. Cling film as storage medium for avulsed teeth. An in vitro pilot study. Swiss Dent J 2017;127:954–9.

Please cite this article in press as: J.P. Nolan, et al., Executive Summary 2020 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations, Resuscitation (2020), https://doi.org/10.1016/j.resuscitation.2020.09.009