CoSTR

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

Methodology and Conflict of Interest Management

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"Quality in a service or product is not what you put into it. It is what the client or customer gets out of it." Peter Drucker

INTRODUCTION

The International Liaison Committee on Resuscitation (ILCOR) mission is to promote, disseminate, and advocate for international implementation of evidence-informed resuscitation and first aid by using transparent evaluation and consensus summary of scientific data. Six ILCOR task forces work to create the consensus on science with treatment recommendations (CoSTR): Advanced Life Support; Basic Life Support; Education, Implementation, and Teams; First Aid; Neonatal Life Support; and Pediatric Life Support. Each task force has 17 active members, with emeritus members frequently contributing to task force work; ILCOR accepts applications for task force membership yearly, and resuscitation and first aid experts from around the world apply. Applications are considered by the ILCOR board, the Scientific Advisory Committee, and current task force chairs and vice chairs. Terms are generally 3 years, with members eligible for a second 2-year term. Including task force members and external contributors, hundreds of volunteers from across the globe contribute to the prioritization of questions, the collection and interpretation of data, and the creation of guidance.

ILCOR publishes summaries of the evidence evaluation output each year (as it has since 2017).[1,2] This year, as was done in 2020, a more comprehensive update is provided, including the past year's work as well as key components of all reviews done in the preceding 4 years.[3-10]

ILCOR has continued to use 3 main approaches to support its guidance: the systematic review (SysRev), the scoping review (ScopRev), and evidence updates (EvUps). These are outlined in more detail later in this article. The processes undertaken by ILCOR to evaluate the evidence are based on the evolving recommendations of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)[11] and of Grading of Recommendations Assessment, Development, and Evaluation (GRADE). ILCOR uses the online project management tool ProofHub[12] to provide a framework for a consistent sequence

of steps for each type of review and to provide a repository for all documents. Instructional documents and presentations are provided for guidance, and checklists are created to ensure completion of key steps.[13]

The type of guidance given by ILCOR for each topic is also based on the published material from the GRADE working group and is in the form of either treatment recommendations (with strength of recommendation and certainty of the supporting evidence) or good practice statements.

THE EVIDENCE EVALUATION PROCESS

The steps undertaken during the exploration of the scientific literature and creation of new treatment recommendations are outlined in Table 1. Several of these steps, discussed in more detail in this section, relate mainly to performing a SysRev for questions addressing the impact of an intervention. Specific variations based on question type or other reviews (eg, ScopRevs) are also included.

Table 1. Outline of the ILCOR Systematic Review Process

Develop PICOST (including inclusion and exclusion criteria)
Confirm content expert team
Allocate level of importance to individual outcomes
Develop and fine-tune database-specific search strategies
Register review with PROSPERO
Conduct search in at least 3 databases
Screen articles identified according to inclusion and exclusion criteria
Compile final list of studies to include
Assess bias for individual studies
Extract data for creation of tables
Create GRADE evidence profile table
Complete evidence-to-decision framework
Draft CoSTRs
Revise draft of CoSTR
Create summary statement
Invite public to comment on draft CoSTRs
Create final CoSTR version for posting and publication

CoSTR indicates consensus on science with treatment recommendations; GRADE, Grading of Recommendations Assessment, Development, and Evaluation; PICOST, population, intervention, comparator, outcome, study design, and time frame; and PROSPERO, Prospective Register of Systematic Reviews.

Framing a Question

Which Questions?

An infinite number of topics could be explored, so ILCOR must prioritize the questions to ask. The ILCOR task forces seek input from task force members, ILCOR member organizations (guideline-writing organizations throughout the world), and independent input (via the internet or social media). Among factors taken into consideration when prioritizing questions are the impact on critical and important outcomes, the extent of controversy or uncertainty about effectiveness or cost-benefit of an intervention, and the emergence of science that has not previously been evaluated. Each task force maintains a master list of questions for which it aims to provide updated guidance, and ILCOR strives to update all topics at least once every 5 years.

What Is a PICOST?

The identified topics are translated into a template based on the standard PICO (population, intervention, comparator, outcome) format with 2 additional components (study design and time frame). Most questions, including diagnostic studies, can use this framework, but several other variations have been used. Alternatives used include population, exposure, comparator, outcome and population, concept, context.[14]

PICOST Template Review by Task Force

The task force reviews the individual components of the template created to facilitate the next steps in the review. This includes deciding what outcomes are prioritized as critical. The outcomes that are deemed critical can impact the certainty of evidence assigned to a treatment recommendation, because the certainty of evidence for a recommendation is defined by the certainty of evidence for the critical outcomes. For example, if there is high-certainty evidence for an important outcome but low-certainty evidence for the critical outcomes, a treatment recommendation will be described as supported by low-certainty evidence. Outcomes and their categorization as critical or important are specified *a priori*,

though occasionally the outcomes (and their allocated priorities) need to be revisited after the literature search has been completed. There is also discussion about whether any subgroup analyses should be prespecified and whether there are any key publications to help the development of the search strategies. A modified PICOST template is used to assist with other types of questions such as those relating to diagnostic test accuracy.

Content Experts

A team of content experts is nominated by the task force for each PICOST. This team comprises members of the task force, an ILCOR Scientific Advisory Committee representative, and other invited individuals sourced from international contacts. In some situations, the questions are within the scope of multiple task forces (eg, Basic Life Support and Pediatric Life Support; Education, Implementation, and Teams and Neonatal Life Support). In these nodal reviews, a task force will take the lead, and 1 or 2 content experts from contributing task forces will be part of the review team. The task force chairs are required to check the conflict-of-interest disclosures for the content expert team members and resolve any potential conflicts according to the ILCOR conflict of interest (COI) policy (*vide infra*).

Searching the Literature

Once the PICOST has been completed and the review team assembled, the search strategies for the required databases are finalized. In many situations, similar questions have already been created, so the search strategies may only need to be adapted and updated. Otherwise, new search strategies are created using the nuances of the specific PICOST. At a minimum, it is expected that Medline, Embase, and Cochrane databases are searched. Searches are also performed for ongoing or unpublished clinical trials by searching the International Clinical Trials Registry Platform[15] and US clinical trials registry.[16] These may also be identified by the search of the Cochrane CENTRAL database.[17] Additional databases and search strategies are added when deemed essential for the specific question being asked.

The search for some questions will focus on studies involving only human participants, but for other questions where most available or relevant evidence is from animal studies or manikin studies, different iterations of the search may be required to ensure that relevant studies are identified.

It is expected that all languages be included in the search, provided there is an English abstract to enable screening. When multilingual authors are engaged in the content expert teams or are brought in for help with translation, additional non-English abstracts can also be screened. Information specialists work with the content expert team to develop and modify these search strategies. The overarching philosophy is to create a sensitive search, so these searches often result in many thousands of studies to be screened.

Register the PICOST With PROSPERO

All SysRevs performed by ILCOR are expected to be registered in an international database of prospectively registered SysRevs (called *PROSPERO*).[18] This step should be performed before data extraction and is included for several reasons, including transparency of the process, avoidance of unnecessary duplication, and discouraging reporting bias.

[Screening the Studies

The content expert team allocates its members to ensure at least 2 independent authors screen the studies in alignment with prespecified inclusion and exclusion criteria. These criteria are based on whether the study addresses the prespecified population, intervention, and comparator, although for questions where little evidence is available, indirect evidence (eg, from animal or simulation studies) may also be considered. The initial screen is performed by using titles and abstracts (employing an online program, such as Covidence or Rayyan), followed by full text review of those papers included after the initial abstract screen. Many PICOSTs also specify criteria for the type of studies to be included: this is usually comparative studies (whether randomized or not), but sometimes they are more restrictive (eg, only randomized controlled trials if there are known to be a number of these

already published).[19] Discrepancies in decisions regarding inclusion are usually resolved by engaging an additional adjudicating reviewer or reviewers from within the content expert team. The full list of included studies is then reviewed by the task force to ensure critical omissions have not occurred. While ILCOR has not yet adopted the use of artificial intelligence for the screening and inclusion stage of reviews, this is a topic currently under discussion.

Bias Assessment

The individual studies are then assessed for risk of bias; ILCOR uses the revised Cochrane Risk of Bias 2 (RoB 2) tool[20] for randomized controlled trials and the Risk of Bias in Nonrandomized Studies of Interventions (ROBINS-I)[21] tool for nonrandomized studies. The RoB 2 tool assesses individual studies across 5 domains, with the overall result for each study being either low risk of bias, some concerns, or high risk of bias.[20] The ROBINS-I tool assesses studies across 7 domains, with the overall result for each study being either low risk of bias, moderate risk of bias, serious risk of bias, critical risk of bias, or no information.[21] The risk of bias may vary for different outcomes within a given study, and the content experts are expected to comment on this. Other risk-of-bias tools are used for studies involving assessment of diagnostic test accuracy or prognostication (eg, Quality in Prognosis Studies or Quality Assessment of Diagnostic Accuracy Studies 2 tool).[22] The risk of bias for included studies (both overall and, if there are wide differences, for specific outcomes) is then displayed in in a table.

Data Extraction

Relevant data from individual studies and their outcomes are extracted and used to populate summary tables and GRADE tables (such as evidence profile tables). The ILCOR content expert teams use GRADEPro[23] to input their data into relevant tables, which are included in the published SysRevs.

Combining Data Into GRADE Tables

The GRADE evidence profile tables enable an assessment of the totality of data across the identified published studies for a prioritized outcome (see example in Table 2).

Table 2. GRADE Evidence Profile Table for Intervention: Prehospital Critical Care Compared With Advanced Life Support for Patients With Out-of-Hospital Cardiac Arrest[24]

Certainty assessment							No. of patients		Effect		Certainty	Importance
Studies, n	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Prehospital critical care, n (%)	Advanced life support, n (%)	Relative (95% CI)	Absolute (95% CI)		
Survival to hospital admission/return of spontaneous circulation: nontrauma												
8	Nonrandomized studies	Serious*	Not serious	Not serious	Serious†	None	6035/31337 (19.3)	50789/608423 (8.3)	OR, 1.95 (1.35–2.82)	67 more per 1000 (from 26 more to 121 more)	Low	Critical

*ROBINS-I tool assessment.
†Some studies not reporting number of events or totals. Some studies imprecise effect estimates with wide confidence intervals.
GRADE indicates Grading of Recommendations Assessment, Development, and Evaluation; OR, odds ratio.

GRADE tables enable inclusion of key features of the extracted data from the identified studies that answer the question and report the outcome of interest. In addition to the importance of the outcome, and the number and type of studies included, the evidence profile table displays an overall assessment of risk of bias (across all included studies), inconsistency, indirectness, imprecision, and other potential influencing factors.[25,26] These tables also include absolute outcomes (with numerator and denominator) and, where data have been combined, a

relative and absolute comparison. Similar GRADE evidence profile tables are created when asking questions about diagnostic test accuracy (see example in Table 3).

Table 3. GRADE Evidence Profile Table for Diagnostic Test Accuracy: the Index Test of Bedside Sonographic Assessment During CPR in Adults in Cardiac Arrest in Any Setting[27]

Outcome	Studies (subjects), n	Certainty assessment						Subjects, n	Effect	Certainty
		Study design	Risk of bias	Indirectness	Inconsistency	Imprecision	Other considerations	Events /test (+) Events /test (−)	Sensitivity (95% CI) Specificity (95% CI)	
Myocardial infarction (index test: reduced contractility in a region of myocardium | reference standard: autopsy and/or clinical adjudication)										
True positive (subjects with myocardial infarction)	1 (13)	Cohort study	Very serious*†‡	Serious§	Serious‖	Serious¶	None	12/13	0.86 (0.57–0.98)	Very low
False negative (subjects incorrectly classified as not having myocardial infarction)										
True negative (subjects without myocardial infarction)	1 (18)	Cohort study	Very serious*†‡	Serious§	Serious‖	Serious¶	None	2/16	0.94 (0.71–0.99)	Very low
False positive (subjects incorrectly classified as having myocardial infarction)										

*Convenience sample with unknown proportion of eligible cardiac arrest subjects enrolled.
†Blinding to the index test is not specified.
‡Differential verification bias.
§Includes cardiac arrest subjects with spontaneous cardiac contractility with or without effective cardiac output (eg, pulseless electrical activity or "peri–return of spontaneous circulation" states).
‖Only one study available; indicative that the literature is not well established (Huguet A, et al. *Systematic Reviews* 2013).
¶Wide confidence intervals that render a range of clinical interpretation.
CPR indicates cardiopulmonary resuscitation; GRADE, Grading of Recommendations Assessment, Development, and Evaluation.

Some reviews use the GRADE summary table as an alternative way of describing the data (Table 4). The overall certainty of evidence for each specified outcome is quantified as high, moderate, low, or very low.[28] The strongest supportive evidence for an intervention is a collection of randomized controlled trials; this evidence would start at high certainty but may be downgraded according to the factors listed above (considered in the GRADE Evidence Profile tables).[28]

Table 4. GRADE Summary of Findings Table for Diagnostic Test Accuracy: the Index Test of Bedside Sonographic Assessment During CPR in Adults in Cardiac Arrest in Any Setting[27]

Outcome	Studies (subjects), n	Sensitivity (95% CI)	Specificity (95% CI)	Pretest probability of target condition	Posttest probability following a positive POCUS (95% CI)	Posttest probability following a negative POCUS (95% CI)
Myocardial infarction Index test: reduced contractility in a region of myocardium Reference standard: autopsy and/or clinical adjudication	1 (31)	0.86 (0.57–0.98)	0.94 (0.71–0.99)	0.25	0.83 (0.40–0.97)	0.05 (0.01–0.17)
				0.50	0.93 (0.66–0.99)	0.13 (0.02–0.38)
				0.75	0.98 (0.86–1.00)	0.31 (0.06–0.64)

CPR indicates cardiopulmonary resuscitation; GRADE, Grading of Recommendations Assessment, Development, and Evaluation; and POCUS, point-of-care ultrasound.

Meta-Analyses

The ILCOR review team evaluates the extracted data from the identified studies in several ways. Data from each study are ideally expressed in both relative and absolute terms, with 95% confidence intervals. If it is agreed that the population of interest, the intervention, the comparator, and the outcome being assessed do not differ in any substantive ways between the identified studies, a meta-analysis is considered. There are many subtle variations in published definitions (for example, survival outcomes at 30 days versus hospital discharge) and year of resuscitation (where cohorts of patients were exposed to different cardiopulmonary resuscitation protocols, including advanced life support interventions). If

data are included in a meta-analysis, it is expected that appropriate sensitivity analyses are performed to assess the impact of key variables (including magnitude of study bias).

GRADE Evidence-to-Decision Framework

The GRADE working group developed the evidence-to-decision framework to help evidence reviewers to develop clinical recommendations. It explicitly and transparently requests that evidence reviewers consider specific criteria, including priority of the problem, benefits and harms, certainty of the evidence, resource and equity implications, cost-benefit, acceptability, and feasibility.[29]

All ILCOR SysRevs are expected to have an accompanying evidence-to-decision table.[30] These are presented and discussed at task force meetings as they finalize their CoSTRs. The evidence-to-decision tables for the SysRevs are provided in Appendix A for each section.

Consensus on Science With Treatment Recommendations

Consensus on Science

The consensus on science is produced from the evidence identified by the SysRev and is a written representation of the GRADE Evidence Profile table. For each outcome of interest, the consensus on science describes the number and methodological type of studies, the number of patients involved, the overall certainty of evidence (including reasons for adjusting/downgrading), the direction of the evidence, and a description of both relative and absolute outcomes (either individually or combined). For example, the evidence for the effect of the intraosseous compared with the intravenous route for medications during cardiac arrest would be worded as follows: *For the critical outcome of survival at 30 days, we identified moderate-certainty evidence (downgraded for serious imprecision) from 3 randomized controlled trials enrolling 9272 adults with out-of-hospital cardiac arrest, which showed no benefit from the intraosseous route compared with the intravenous route (odds ratio 0.99, 95% confidence interval 0.84–1.17; absolute effect 1 fewer per 1000, 95% confidence*

interval 10 fewer to 11 more). These statements are valuable, but the formulaic style is not ideal for summarizing all types of evidence. The annual CoSTR summary generally uses plain English to convey the key points of each review. The GRADE working group has also proposed variations in wording to try to simplify the message, and ILCOR is working with these suggestions to determine their value.[31]

Treatment Recommendations

The goal of ILCOR's SysRevs, with the collaboration of the international content experts, is to produce treatment recommendations wherever possible. The wording of the recommendation represents the strength of the recommendation (which can be strong or weak): *we recommend* (strong recommendation) or *we suggest* (weak recommendation). The certainty of evidence to support the recommendation is also included (as listed above): *high*, *moderate*, *low*, or *very low*.[32] In some situations, this may be easy and obvious, based on the data identified. It is a reality that for most PICOSTs, there is either low-certainty or very low–certainty evidence for most outcomes. The evidence-to-decision framework considerations may also influence whether a general or universal treatment recommendation can be made (for example, if an intervention involves such substantial cost or complexity that it is unlikely to be accessible in all locations, or if benefit is only demonstrated for a specific subgroup). Therefore, weak recommendations can also include specific subtypes, such as *conditional* (depending on patient values, resources available, or setting), *discretionary* (based on opinion of patient or practitioner), or *qualified* (by an explanation regarding the issues that would lead to different decisions).[33]

Good Practice Statements

In the past, if a weak recommendation could not be made, the ILCOR task forces have often opted for a statement that includes the words *there is insufficient evidence to* or *the confidence in effect estimates is so low that the task force considers a recommendation is too speculative*. The concern has always been that if there is not clear evidence to point the task

force one way or the other, then the most transparent option is to say nothing at all. However, at times it is unhelpful if the collection of international minds is unable to give some guidance, even in the absence of a robust signal from the evidence reviewed.

The GRADE working group has given some guidance around criteria that they believe would support a statement that is not an evidence-based treatment recommendation. The ILCOR task forces use good practice statements when they believe the statements have met the prerequisite criteria, including a message that is necessary, clear, and actionable; rationale that is based on indirect evidence; and implementation that will result in a positive benefit.[34,35] The GRADE working group also recommends that the evidence-to-decision framework be used to guide a good practice statement, and the task forces have begun to implement this guidance.[35]

Public Comment

The ILCOR website is used for the posting of all draft CoSTRs from SysRevs, as well as draft ScopRevs. These documents are made available on the ILCOR CoSTR website,[30] and public comment is invited. The comments made are visible to all and are reviewed by members of the ILCOR task forces. The type of response to the public comments varies for each question and each task force, but any substantive scientific insights are considered and, where appropriate, adjustments are made to the CoSTR.

Guideline Development by Writing Groups

Resuscitation guideline writing groups around the globe are invited to use the published drafts on the ILCOR CoSTR website. These stay in draft form until they are formally published in the yearly summary documents. The summary CoSTR manuscripts submitted for publication are also made available as preprints on the ILCOR website several months before the final online publication.

Other ILCOR Reviews

The ILCOR task forces conduct several other types of reviews that are incorporated into the summary CoSTR publications. These include adolopment, ScopRevs, and EvUps. These were all available for use for the 2020 CoSTR publication.[36,37]

Adolopment

The GRADE working group introduced the concept of adolopment to facilitate the combination of adoption, adaptation, and de novo development of recommendations.[38] The ILCOR task forces may identify recently performed SysRevs and meta-analyses. ILCOR has developed a process to review the published manuscript and consider whether it is methodologically sufficiently similar (eg, search strategy and databases searched, inclusion/exclusion criteria, scientific rigor) to incorporate its findings. The additional requirements are usually to update the search and to complete an evidence-to-decision table. This enables the task force to conclude whether a consensus on science statement and, if appropriate, treatment recommendations can be made based on the evidence identified in the adoloped review.

Scoping Reviews

The first ScopRev by ILCOR was published in 2020,[39] and many ScopRevs have been or are currently being undertaken and published by the 6 task forces. A ScopRev enables the reviewer to explore (scope) the literature to determine what, if any, next steps may be indicated.[14] The priority of a ScopRev is to determine what populations, interventions, and outcomes have been investigated, and, therefore, it starts with a broad search. This usually includes unpublished manuscripts as well as other types of gray literature (protocols, reports, guidelines, etc). The information identified is then grouped into thematic areas. Data are extracted from the studies to facilitate broad comparisons, but, unlike a SysRev, there is no formal attempt to assess methodological quality of included studies and, therefore, no need

for any meta-analyses. The searches may identify many articles, and the workload is often greater than a focused SysRev.

The process that a ScopRev follows is otherwise similar to a SysRev, including creation of a PICOST and completion of a modified PRISMA template,[40] though the end-product is typically a narrative description of findings (including gaps) and a recommendation about whether any SysRevs should be completed. Given the limitations in methodology, there is no possibility of creating new treatment recommendations from a ScopRev, but the task force may at times consider a good practice statement. If that is the case, ILCOR is adopting the recommended practice of also completing an evidence-to-decision table.[35]

Evidence Updates

ILCOR's EvUps were created to help task forces determine if they need to formally revisit ScopRevs or SysRevs. Authors follow specific EvUp guidance and a worksheet template to document their findings. Rerunning the original search in at least one of the original datasets accessed in the existing SysRev enables identification of studies published since the prior review and an assessment of whether the GRADE tables, the evidence-to-decision table, and the CoSTR needed to be updated. Ideally, these searches would be run on a continuous basis, but pragmatically, the results of the searches are reviewed every 12 to 24 months, or less frequently if other methods of literature surveillance suggest that a longer interval is reasonable. This process enables the task forces to determine when a CoSTR needs to be updated, but treatment recommendations cannot be changed based on an EvUp alone. In some cases, task forces have conducted EvUps of topics with older treatment recommendations that were not based on SysRevs, as the ILCOR process has evolved to become more rigorous over the past several years. In some of these cases, existing treatment recommendations (often dating back to 2010 or before) were withdrawn or converted to good

practice statements if direct evidence to support them was not identified. The complete EvUp worksheets are provided in Appendix B for each section.

Management of Potential Conflicts of Interest Throughout the Process

To ensure the integrity of the evidence evaluation and consensus on science processes, ILCOR follows rigorous COI management policies at all times. A full description of these policies and their implementation can be found in the ILCOR Internal Rules.[41] Any person involved in any part of the process discloses all commercial relationships and other potential conflicts by using the ILCOR online COI disclosure process. All participants always have access to this full list of disclosures through the ILCOR website, including both during and between meetings.

Each year from 2020 to 2024, ILCOR processed between 100 and 400 COI declarations. In addition to disclosing commercial relationships, volunteers are asked to be sensitive to any potential intellectual conflicts, such as having authored key studies related to a topic or involvement in ongoing studies related to a topic. All disclosures are considered by the ILCOR Board in the selection of task force chairs, vice chairs, members, and other leadership roles. Relationships are screened for conflicts in assigning individual PICOST questions to task force members or content experts.

Participants, task force chairs, task force members, staff, and the COI chair and vice chair raise COI questions and issues throughout the process and refer them to the COI chair or vice chair if they cannot be resolved within the task force. The COI chair keeps a log of each COI-related issue and its resolution. None of the COI issues for the work in this 2025 CoSTR required serious intervention, such as replacement of anyone in a leadership role. When a commercial relationship or intellectual conflict was discovered for a specific PICOST question, that conflict was reviewed, roles within the team may have been adjusted, and at times the question was reassigned to a content expert without a potential conflict. During conferences, a full list of disclosures is available to all participants throughout the

meeting. Participants are asked to state any potential conflict when they participate in discussions, and they abstain from voting on any issue for which they had a conflict. COI committee representatives are available during conferences for anonymous reporting; no such reports were received from 2021 to 2025. In addition, all ILCOR Board and General Assembly meetings begin with a reminder of our COI policies.

Ongoing Challenges and Opportunities

The world of evidence evaluation continues to evolve. There are regular updates to guidance and recommendations including for PRISMA and GRADE. Many of the future processes may well become streamlined or even assisted with artificial intelligence software. Some of the key issues are discussed below.

Newer Analytic Approaches

The advances in computing and sophistication in statistical analyses have enabled several additional approaches to evaluating the literature. These have strong methodological support, but how they are integrated with the standard interpretation of evidence is still evolving.

Network Meta-Analysis

Network meta-analysis is a statistical tool that enables researchers to compare multiple treatments at once, even when treatments have not been directly compared with each other. Like all analyses, there are some specific assumptions that are made. These include transitivity (assuming that factors effecting outcomes are similarly distributed) and coherence (consistency between direct and indirect evidence). The GRADE working group has published some guidance when considering network meta-analyses.[42] These analyses are increasingly being adopted by resuscitation scientists.[43]

Bayesian Analysis

Bayesian analyses enable assessment of the likelihood of an outcome in the context of existing beliefs about the effects of interventions. This results in an estimate of probabilities

around the size of the effect (described as a 95% credible interval). Bayesian analyses are also becoming more common in the resuscitation literature[44,45] and can be combined with network meta-analyses.[46]

Artificial Intelligence

A detailed review of the science to support resuscitation can be labor intensive. Artificial intelligence in its many guises may well be able to assist in components of the evidence evaluation process. These include developing search strategies, conducting regular searches, screening identified studies, extracting data from included studies, summarizing the findings, and assisting in the development of treatment recommendations. Online software for many of these is already commercially available. While ILCOR has not yet incorporated the use of artificial intelligence into its processes, how this could enhance the ILCOR review process is being considered and discussed.

Summary

ILCOR's evidence evaluation process enables summaries of resuscitation science and facilitates the development of treatment recommendations and good practice statements. The rigor of the evidence evaluation process and its responsiveness to the needs of the international community are essential if ILCOR is to continue to achieve its vision of saving more lives globally through resuscitation.

REFERENCES

1. Olasveengen TM, de Caen AR, Mancini ME, Maconochie IK, Aickin R, Atkins DL, Berg RA, Bingham RM, Brooks SC, Castren M, et al. 2017 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations Summary. *Circulation*. 2017;136:e424-e440. doi: 10.1161/CIR.0000000000000541
2. Olasveengen TM, de Caen AR, Mancini ME, Maconochie IK, Aickin R, Atkins DL, Berg RA, Bingham RM, Brooks SC, Castren M, et al. 2017 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations Summary. *Resuscitation*. 2017;121:201-214. doi: 10.1016/j.resuscitation.2017.10.021
3. Wyckoff MH, Singletary EM, Soar J, Olasveengen TM, Greif R, Liley HG, Zideman D, Bhanji F, Andersen LW, Avis SR, et al. 2021 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. *Resuscitation*. 2021;169:229-311. doi: 10.1016/j.resuscitation.2021.10.040
4. Wyckoff MH, Greif R, Morley PT, Ng K-C, Olasveengen TM, Singletary EM, Soar J, Cheng A, Drennan IR, Liley HG, et al. 2022 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. *Resuscitation*. 2022;181:208 - 288. doi: https://doi.org/10.1016/j.resuscitation.2022.10.005
5. Wyckoff MH, Greif R, Morley PT, Ng KC, Olasveengen TM, Singletary EM, Soar J, Cheng A, Drennan IR, Liley HG, et al. 2022 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*. 2022;146:E483-E557. doi: 10.1161/cir.0000000000001095

6. Wyckoff MH, Singletary EM, Soar J, Olasveengen TM, Greif R, Liley HG, Zideman D, Bhanji F, Andersen LW, Avis SR, et al. 2021 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations: Summary From the Basic Life Support; Advanced Life Support; Neonatal Life Support; Education, Implementation, and Teams; First Aid Task Forces; and the COVID-19 Working Group. *Circulation*. 2022;145:e645-e721. doi: 10.1161/CIR.0000000000001017
7. Berg KM, Bray JE, Ng KC, Liley HG, Greif R, Carlson JN, Morley PT, Drennan IR, Smyth M, Scholefield BR, et al. 2023 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*. 2023;148:e187-e280. doi: 10.1161/CIR.0000000000001179
8. Berg KM, Bray JE, Ng KC, Liley HG, Greif R, Carlson JN, Morley PT, Drennan IR, Smyth M, Scholefield BR, et al. 2023 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. *Resuscitation*. 2023:109992. doi: 10.1016/j.resuscitation.2023.109992

9. Greif R, Bray JE, Djarv T, Drennan IR, Liley HG, Ng KC, Cheng A, Douma MJ, Scholefield BR, Smyth M, et al. 2024 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. *Resuscitation*. 2024:110414. doi: 10.1016/j.resuscitation.2024.110414

10. Greif R, Bray JE, Djarv T, Drennan IR, Liley HG, Ng KC, Cheng A, Douma MJ, Scholefield BR, Smyth M, et al. 2024 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*. 2024. doi: 10.1161/CIR.0000000000001288

11. Moher D, Liberati A, Tetzlaff J, Altman DG, PRISMA Group* t. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Annals of internal medicine*. 2009;151:264-269.

12. Itex P. ProofHub. https://www.proofhub.com/. Accessed February 26, 2025.

13. International Liaison Committee on Resuscitation. Science advisory committee guidance and templates. https://ilcor.org/documents/continuous-evidence-evaluation-guidance-and-templates. Accessed February 26, 2025.

14. Peters MD, Marnie C, Tricco AC, Pollock D, Munn Z, Alexander L, McInerney P, Godfrey CM, Khalil H. Updated methodological guidance for the conduct of scoping reviews. *JBI evidence synthesis*. 2020;18:2119-2126.

15. World Health Organization. International Clinical Trials Registry Platform (ICTRP) website. https://www.who.int/clinical-trials-registry-platform. Accessed February 26, 2025.

16. National Library of Medicine. ClinicalTrials.gov website. https://www.clinicaltrials.gov/. Accessed February 26, 2025.

17. Cochrane Library. Cochrane Central Register of Controlled Trials (CENTRAL) website. https://www.cochranelibrary.com/central/about-central. Accessed February 26, 2025.

18. National Institute for Health and Care Research. PROSPERO home page. https://www.crd.york.ac.uk/prospero/. Accessed February 26, 2025.

19. Couper K, Andersen LW, Drennan IR, Grunau BE, Kudenchuk PJ, Lall R, Lavonas EJ, Perkins GD, Vallentin MF, Granfeldt A. Intraosseous and intravenous vascular access during adult cardiac arrest: a systematic review and meta-analysis. *Resuscitation*. 2024:110481.

20. Sterne JA, Savović J, Page MJ, Elbers RG, Blencowe NS, Boutron I, Cates CJ, Cheng H-Y, Corbett MS, Eldridge SM. RoB 2: a revised tool for assessing risk of bias in randomised trials. *bmj*. 2019;366.

21. Sterne JA, Hernán MA, Reeves BC, Savović J, Berkman ND, Viswanathan M, Henry D, Altman DG, Ansari MT, Boutron I. ROBINS-I: a tool for assessing risk of bias in non-randomised studies of interventions. *bmj*. 2016;355.

22. Hayden JA, van der Windt DA, Cartwright JL, Côté P, Bombardier C. Assessing bias in studies of prognostic factors. *Annals of internal medicine*. 2013;158:280-286.

23. McMaster University, Evidence Prime Inc. GRADEPro GDT. https://gradepro.org. Accessed February 26, 2025.

24. Boulton AJ. Prehospital critical care compared to advanced life support for patients with out-of-hospital cardiac arrest.

https://costr.ilcor.org/assets/images/photos/GRADEPro-300624.pdf. Accessed February 27, 2025.

25. Guyatt GH, Oxman AD, Santesso N, Helfand M, Vist G, Kunz R, Brozek J, Norris S, Meerpohl J, Djulbegovic B. GRADE guidelines: 12. Preparing summary of findings tables—binary outcomes. *Journal of clinical epidemiology*. 2013;66:158-172.

26. Guyatt GH, Thorlund K, Oxman AD, Walter SD, Patrick D, Furukawa TA, Johnston BC, Karanicolas P, Akl EA, Vist G. GRADE guidelines: 13. Preparing summary of findings tables and evidence profiles—continuous outcomes. *Journal of clinical epidemiology*. 2013;66:173-183.

27. Reynolds JC, Nicholson TC, O'Neil BJ, Drennan I, Issa M, Welsford M; on behalf of the ILCOR Advanced Life Support Task Force. Diagnostic test accuracy with point-of-care ultrasound during cardiopulmonary resuscitation to indicate the etiology of cardiac arrest. https://costr.ilcor.org/document/diagnostic-test-accuracy-of-point-of-care-ultrasound-during-cardiopulmonary-resuscitation-to-indicate-the-etiology-of-cardiac-arrest. 2022. Accessed February 27, 2025.

28. Guyatt G, Oxman AD, Sultan S, Brozek J, Glasziou P, Alonso-Coello P, Atkins D, Kunz R, Montori V, Jaeschke R. GRADE guidelines: 11. Making an overall rating of confidence in effect estimates for a single outcome and for all outcomes. *Journal of clinical epidemiology*. 2013;66:151-157.

29. Alonso-Coello P, Schünemann HJ, Moberg J, Brignardello-Petersen R, Akl EA, Davoli M, Treweek S, Mustafa RA, Rada G, Rosenbaum S. GRADE Evidence to Decision (EtD) frameworks: a systematic and transparent approach to making well informed healthcare choices. 1: Introduction. *bmj*. 2016;353.

30. International Liaison Committee on Resuscitation. Consensus on Science With Treatment Recommendations (CoSTR). https://costr.ilcor.org/. Accessed February 27, 2025.

31. Santesso N, Glenton C, Dahm P, Garner P, Akl EA, Alper B, Brignardello-Petersen R, Carrasco-Labra A, De Beer H, Hultcrantz M. GRADE guidelines 26: informative statements to communicate the findings of systematic reviews of interventions. *Journal of clinical epidemiology*. 2020;119:126-135.

32. Andrews JC, Schünemann HJ, Oxman AD, Pottie K, Meerpohl JJ, Coello PA, Rind D, Montori VM, Brito JP, Norris S. GRADE guidelines: 15. Going from evidence to recommendation—determinants of a recommendation's direction and strength. *Journal of clinical epidemiology*. 2013;66:726-735.

33. Schünemann H, Brożek J, Guyatt G, Oxman A. 6.2 Factors determining direction and strength of recommendations. In: *GRADE Handbook*. 2013.

34. Guyatt GH, Alonso-Coello P, Schünemann HJ, Djulbegovic B, Nothacker M, Lange S, Murad MH, Akl EA. Guideline panels should seldom make good practice statements: guidance from the GRADE Working Group. *Journal of clinical epidemiology*. 2016;80:3-7.

35. Dewidar O, Lotfi T, Langendam MW, Parmelli E, Parkinson ZS, Solo K, Chu DK, Mathew JL, Akl EA, Brignardello-Petersen R. Good or best practice statements: proposal for the operationalisation and implementation of GRADE guidance. *BMJ evidence-based medicine*. 2023;28:189-196.

36. Morley PT, Atkins DL, Finn JC, Maconochie I, Nolan JP, Rabi Y, Singletary EM, Wang TL, Welsford M, Olasveengen TM, 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-A34. doi: 10.1016/j.resuscitation.2020.09.011

37. Morley PT, Atkins DL, Finn JC, Maconochie I, Nolan JP, Rabi Y, Singletary EM, Wang TL, Welsford M, Olasveengen TM, 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:S28-S40. doi: 10.1161/CIR.0000000000000891

38. Schünemann HJ, Wiercioch W, Brozek J, Etxeandia-Ikobaltzeta I, Mustafa RA, Manja V, Brignardello-Petersen R, Neumann I, Falavigna M, Alhazzani W. GRADE Evidence to Decision (EtD) frameworks for adoption, adaptation, and de novo development of trustworthy recommendations: GRADE-ADOLOPMENT. *Journal of clinical epidemiology*. 2017;81:101-110.
39. Considine J, Gazmuri RJ, Perkins GD, Kudenchuk PJ, Olasveengen TM, Vaillancourt C, Nishiyama C, Hatanaka T, Mancini ME, Chung SP, et al. Chest compression components (rate, depth, chest wall recoil and leaning): A scoping review. *Resuscitation*. 2020;146:188-202. doi: 10.1016/j.resuscitation.2019.08.042
40. Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, Moher D, Peters MD, Horsley T, Weeks L. PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. *Annals of internal medicine*. 2018;169:467-473.
41. International Liaison Committee on Resuscitation. Other documents. https://ilcor.org/documents/other-documents. Accessed February 27, 2025.
42. Izcovich A, Chu DK, Mustafa RA, Guyatt G, Brignardello-Petersen R. A guide and pragmatic considerations for applying GRADE to network meta-analysis. *bmj*. 2023;381.
43. Sotiropoulos JX, Oei JL, Schmölzer GM, Libesman S, Hunter KE, Williams JG, Webster AC, Vento M, Kapadia V, Rabi Y. Initial oxygen concentration for the resuscitation of infants born at less than 32 weeks' gestation: a systematic review and individual participant data network meta-analysis. *JAMA pediatrics*. 2024;178:774-783.

44. Aneman A, Frost S, Parr M, Skrifvars MB. Target temperature management following cardiac arrest: a systematic review and Bayesian meta-analysis. *Critical Care*. 2022;26:58.

45. Rob D, Komárek A, Šmalcová J, Bělohlávek J. Effect of intraarrest transport, extracorporeal cardiopulmonary resuscitation, and invasive treatment: a post hoc bayesian reanalysis of a randomized clinical trial. *Chest*. 2024;165:368-370.

46. Khan SU, Lone AN, Talluri S, Khan MZ, Khan MU, Kaluski E. Efficacy and safety of mechanical versus manual compression in cardiac arrest–A Bayesian network meta-analysis. *Resuscitation*. 2018;130:182-188.