

Consensus on Science with Treatment Recommendations (COSTR) Template for [www.ilcor.org](http://www.ilcor.org) posting

## In situ (workplace-based) simulation-based cardiopulmonary resuscitation training: EIT 6407 TF SR

*This CoSTR is a final version prepared by ILCOR and is labelled “draft” to allow for public comments and to comply with copyright rules of journals. The ‘draft label’ will be removed from this website once a summary article has been published in a scientific journal.*

## Conflict of Interest Declaration

The ILCOR Continuous Evidence Evaluation process is guided by a rigorous ILCOR Conflict of Interest policy. The following Task Force members and other authors were recused from the discussion as they declared a conflict of interest: none

The following Task Force members and other authors declared an intellectual conflict of interest and this was acknowledged and managed by the Task Force Chairs and Conflict of Interest committees: Joyce Yeung.

## CoSTR Citation

Cortegiani A, Abelairas-Gómez C, Nabecker S, Olaussen A, Lauridsen KG, Lin J, Ippolito M, Sawyer T, Lockey A, Cheng A, Greif R on behalf of the International Liaison Committee on Resuscitation Education, Implementation and Teams Task Force (EIT) Life Support Task Force. Consensus on Science with Treatment Recommendations. [Internet] Brussels, Belgium: International Liaison Committee on Resuscitation (ILCOR) Education, Implementation, and Team Task Force, 2023 Dec 01.  Available from: [http://ilcor.org](http://ilcor.org/)

**Methodological Preamble and Link to Published Systematic Review**

Previous Evidence updates (2020, 2021, 2022) did not find sufficient evidence to issue a treatment recommendation. Considering newly published evidence and the potential impact on the quality of training and the subsequent effect on patient outcomes, the EIT TF decided to perform a formal systematic review for the 2025 CoSTR cycle. At the PICOST definition stage, the Task Force decided to consider as eligible for inclusion only studies reporting information on the characteristics of training in the control group. This explains the differences between previous evidence updates and this systematic review.

## Systematic Review

Publication in progress

## PICOST

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| --- | --- |
| **PICOST** | **Description** *(with recommended text)* |
| **Population** | Healthcare providers |
| **Intervention** | In situ (workplace-based) simulation-based cardiopulmonary resuscitation (CPR) training |
| **Comparison** | Traditional training |
| **Outcomes** | Patient survival (critical),  CPR skill performance at course completion, CPR skill performance in actual resuscitation, CPR skill performance <1yr, CPR skill performance ≥ 1yr of course completion; CPR quality (at course completion <1yr and ≥ 1yr of course completion) (important)  teamwork competencies (at course completion <1yr and ≥ 1yr of course completion); resources (time, equipment, cost), clinical performance (adherence to guidelines, time to critical interventions, medication errors etc.) (important) |
| **Study Design** | Randomized controlled trials (RCTs) and non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies with control groups) were eligible for inclusion  Studies with self-assessment as the only outcome, reviews and abstracts without full article were excluded. Unpublished studies (e.g., conference abstracts, trial protocols) are excluded. All relevant publications in any language are included as long as there is an English abstract |
| **Timeframe** | From inception to 25 March 2024 |

PROSPERO Registration CRD42024521780

**Risk of bias**

Risk of bias was assessed per article rather than per outcome (Table 1a and 1b).

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| **Table 1a.** Risk of Bias for nonrandomized studies (ROBINS-I). | | | | | | | |  |
| First author; year | Confounding | Selection of participants | Classification of interventions | Deviations from intended interventions | Missing data | Measurement of outcomes | Selection of reported results | Overall |
| Clarke 2019 | Critical | Low | Low | Low | No information | Moderate | Low | Critical |
| Hammontree 2022 | Serious | Low | Low | Low | Moderate | Moderate | Low | Serious |
| Herbers 2016 | Critical | Low | Low | Low | Low | Moderate | Low | Critical |
| Knight 2013 | Serious | Low | Low | Low | Moderate | Moderate | Low | Serious |
| Xu 2023 | Critical | Low | Low | Low | Low | Low | Low | Critical |

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| --- | --- | --- | --- | --- | --- | --- |
| **Table 1b.** Risk of Bias for randomized studies (RoB 2). | | | | | | |
| First author; year | Randomization process | Deviation from intended interventions | Missing outcome data | Measurement of outcomes | Selection of reported results | Overall |
| Rubio-Gurung 2014 | Some concerns | Low | Some concerns | Low | Some concerns | High |
| Kurasawa 2014 | Low | Low | Low | Low | Some concerns | Some concerns |
| Mei 2023 | High | Low | Low | Some concerns | Some concerns | High |
| Sullivan 2015 | Some concerns | Low | Low | Some concerns | Some concerns | Some concerns |

## [Consensus on Science](#_heading=h.1fob9te)

A search in Medline, Embase, Cochrane Library on 25 March 2024 identified 1005 references (Figure 1). After de-duplication, 713 titles and abstracts were reviewed. Full-text review was conducted on 22 papers. Nine studies (1–9) were identified that addressed the PICOST question comparing in situ simulation-based cardiopulmonary resuscitation training to traditional training.

Figure : PRISMA diagram

**Identification of studies via databases and registers**

Records removed *before screening*:

Duplicate records removed (n = 292)

Records identified from:

PubMed (n = 283)

Embase (n = 637)

Cochrane Library (n = 85)

**Identification**

Records screened

(n = 713)

Records excluded

(n = 3498)

Reports sought for retrieval

(n = 22)

Reports not retrieved

(n = 0)

**Screening**

Reports assessed for eligibility

(n = 22)

Reports excluded: 13

Wrong comparator (n = 3)

Wrong outcomes (n = 3)

Wrong study design (n = 7)

Studies included in review

(n = 9)

Reports of included studies

(n = 9)

**Patient Survival**

For the critical outcome of patient survival we identified one non-randomised prospective observational study with historical controls (4) reporting an association between the in situ simulation period and higher odds of survival at hospital discharge in pediatric patients who experience cardiac arrest [50/124 (40.3%) pre-intervention period vs. 28/46 (60.9%) post-intervention period; OR, 2.06 (95% CI, 1.02-4.25)].

**Patient outcomes**

For the critical outcome of patient outcomes we found one non-randomised study (9) reporting in the post intervention (in situ simulation) vs. pre-intervention period a lower incidence of neonatal asphyxia [88 (0.64%) vs. 133 (0.84%), P=.045], severe asphyxia [8 (0.058%) vs. 22 (0.138%), p =.029], hypoxic-ischemic encephalopathy [2 (0.01%) vs. 16 (0.1%), p = 0.003], and meconium aspiration syndrome [12 (0.09%) vs. 31 (0.19%), p = 0.014] but no difference in the composite outcome of neonatal asphyxia or low apgar score [111 (0.8%) vs. 154 (0.97%), p = 0.128], and low Apgar score [23 (0.17%) vs. 21 (0.13%), p = 0.445]. This outcome was not present in the original PICOST but was considered to be included in this systematic review after the inclusion/exclusion process by EIT TF consensus due to its importance.

**Clinical performance in actual resuscitation**

For the critical outcome of clinical performance in actual resuscitation outcomes, we found three non-randomised studies. One non-randomised before-after study(4) reported no significant difference in neurologic morbidity from admission to discharge assessed by pediatric cerebral performance category in the intervention group (0.11 vs 0.27; p = 0.37), no significant improvement in the performance of chest compressions < 60 s from heart rate < 60 s [OR, 0.63 (95% CI, 0.29-1.35)], significant improvement in Performance of 2 min continuous chest compressions between rhythm checks [OR, 2.23 (95% CI, 1.18-4.22] and no significant difference in the performance of shock < 3 min from recognized ventricular fibrillation/pulseless ventricular tachycardia [OR, 1.51 (95% CI, 0.38-5.96)] between the in situ simulation period vs. control. One non-randomised before-after study(3) reported improved time for calling for help by 12% between baseline and final evaluation, improved time elapsed by initiation of chest compressions by 52% and improved time to initial defibrillation 37% between the in situ simulation period vs. control. One non-randomised before-after study(2) reported non-adherence to PALS guidelines for subsequent epinephrine timing decreased by 39% and non-significant difference behaviors of administering epinephrine every 3 to 5 min (p = 0.30).

**Teamwork competencies in actual resuscitation at course completion <1yr**

For the important outcome teamwork competencies in actual resuscitation at course completion <1yr we found one relevant non-randomised study. This study (4) reported higher adherence to resuscitation standard operating performance as a measure of pediatric code team performance in the in situ simulation period [38/183 (20.8%) (23/64 (35.9); OR 2.14 (95% CI, 1.15-3.99)].

**Clinical performance in simulation**

For the important outcome of clinical performance in simulation outcomes we found four RCTs and one non-randomised study. One RCT (5) reported improved skill performance measured by the clinical performance tool [6.2 (± 4.3) vs (± 2.9); p = 0.004]. One RCT (8) compared different intervention groups involving in situ simulation training sessions performed at different follow-ups compared to standard training. This RCT reported shorted time elapse to call for help and initiation of chest compression in the intervention groups vs. control (p< 0.001), time elapse to successful defibrillation (p < 0.001), and better score in the composite outcome of key priorities, compressions within 20 s defibrillation within 180 s and use of a backboard (p < 0.001). One RCT(7) reported better technical score assessing technical skills and adherence to guidelines in the two simulation scenarios in the in situ simulation group vs. control [Scenario I: 24.4 (18.7–26.6) vs. 17.4 (15.6–19.5), p= .01); Scenario II: 22.7 (21.3–25.0) vs. 17.5 (15.3–19.6), p=0.004], lower occurrence of hazardous events in the in situ simulation group vs. control [23 (8%) vs. 52 (21%), P=<0.001], higher percentage of scenarios in which the heart rate was considered as the result of efficient resuscitation at 3 minutes [14 (24%) vs. 2 (4%), =0.003] and 5 minutes [40 (68%) vs. 25 (47%), P= 0.06] in the in situ simulation group. vs. control. One RCT(6) reported better medical management test in the in situ simulation group vs. control [57.09 (±9.18) vs. 38.47 (±15.69), p < 0.001]. One non-randomised study(1) reported no difference through the course of in situ mock code training in time to first epinephrine dosing and time to first defibrillation).

**Teamwork competencies in simulation at course completion <1yr**

For the important outcome of teamwork competencies in simulation at course completion <1yr we found three relevant RCTs. One RCT(5) reported no difference in teamwork assessed by the Behavioral Assessment Score in the intervention group [2.8 (± 3.6) vs. 3.0 (± 4.0); p: 0.69]. One RCT(7) reported better team performance score in the in situ simulation group [31.1 (20.8–36.8) vs. 19.9 (13.3–25.0); p<0.001]. Another RCT(6) reported better teamwork in the in situ simulation group vs. control [10.84 (±3.26) vs 7.87 (±4.14), p < 0.001].

**CPR skill performance in simulation at course completion**

For the important outcome of CPR skill performance in simulation at course completion we found one non-randomised study(1). This study evaluated CPR fraction as measure of skill and found an improved overall trend of 1.8% per time interval of training (p = 0.02).

**Resources**

For the important outcome of resources, we found no studies.

**CPR skill performance in actual resuscitation**

For the important outcome of CPR skill performance in actual resuscitation, we found no studies.

**Treatment Recommendations**

We recommend that in-situ simulation may be considered as an option for cardiopulmonary resuscitation training where resources are readily available. (weak recommendation, very low certainty evidence).

## Justification and Evidence to Decision Framework Highlights

We found evidence from RCTs and non-randomised studies supporting the effectiveness of in-situ simulation for cardiopulmonary resuscitation towards critical outcomes of patient survival, patients’ clinical outcomes, clinical performance in actual resuscitation and teamwork competencies in actual resuscitation, as well as outcomes during simulation.

The certainty of evidence is very low for all evaluated outcomes due to risk of bias, inconsistency, and imprecision.

We included studies that evaluate in situ simulation-based training in the context of adult (four), pediatric (three), or neonatal (two) cardiopulmonary resuscitation training and there is evidence of effectiveness in all. Of note, the only studies addressing the critical outcomes of patient survival and patient outcomes were performed in the context of cardiopulmonary resuscitation training in the pediatric setting.

The balance between the benefit and the resources needed may be favorable, especially when critical outcomes are considered.

**Knowledge Gaps**

The following knowledge gaps were identified:

* Since we did not perform a meta-analysis due to very high heterogeneity in the interventions and outcome definitions, formal subgroup analysis according to the type of cardiopulmonary resuscitation training (i.e. BLS, ACLS, PALS, NLS) could not be done. Further research may identify training settings that benefit the most.
* The overall risk of bias for the outcomes ranged from serious to very serious. Further high-quality research should strengthen the certainty of the evidence (i.e. adequate control for confounding factors in non-randomised studies, adequate randomization process in RCTs).
* We found no data on the important outcome of resources that includes direct and indirect costs, workload, equipment needed to perform in situ simulation-based cardiopulmonary resuscitation training compared to traditional training.
* We found high heterogeneity in terms of the characteristics of the interventions. Further research should define the minimal standard for in situ simulation and explore characteristics of the training in the setting of cardiopulmonary resuscitation.
* Research is needed on resources and methods for implementation and maintenance of in-situ simulation programs for resuscitation teaching.
* Further studies should report data on feasibility in low and middle-income countries.

**ETD summary table**

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