Review

Teaching team competencies within resuscitation training: A systematic review

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Abstract

Objectives: To evaluate the effectiveness of life support training with specific emphasis on team competencies on clinical and educational outcomes.

Methods: This systematic review was prospectively registered (PROSPERO CRD42023473154) and followed the PICOST (population, intervention, comparison, outcome, study design, timeframe) format. All randomized controlled trials and non-randomized studies evaluating learners undertaking life support training with specific emphasis on team competencies in any setting (actual and simulated resuscitations) were included. Unpublished studies were excluded. Medline, Embase and Cochrane databases as well as trial registries were searched from inception to August 2023 (updated January 18, 2024). Two researchers performed title and abstract screening, full-text screening, data extraction, assessment of risk of bias (using RoB2 and ROBINS-I) and certainty of evidence (using GRADE). PRISMA reporting checklist was used to report the results. No funding was obtained to perform this systematic review.

Results: The literature search identified 5470 manuscripts. After the removal of 2073 duplicates, reviewing the remaining articles' titles and abstracts yielded 31 articles for full-text review. Of these, 17 studies were finally included. The studies involved the following training levels: basic life support, adult advanced life support, paediatric and neonatal resuscitations. Most studies (n = 16) evaluated outcomes in simulated, and only one study in actual resuscitations. Studies included in all training contexts showed either neutrality and/or benefits of life support training with specific emphasis on team competencies. Team competencies training improved CPR skill performance and CPR quality. Specific team competencies that improved included leadership, communication, decision-making and task management. No undesirable effects were observed. Meta-analysis was not possible due to significant methodological heterogeneity. Sub-group analysis was impossible due to lack of data. Risk of bias assessment ranged from some concerns to serious. Overall certainty of evidence was rated as low to very low due to risk of bias and imprecision.

Conclusion: This systematic review identified very low and low certainty evidence, almost entirely derived from simulation studies. The studies and their findings were heterogenous but suggest that teaching team competencies can improve resuscitation skills performance and CPR quality, as well as improve team competencies, specifically leadership, communication, decision-making, and task management. Further research is required to understand optimal configuration of team competencies training interventions and to understand the effect on clinical outcomes and cost-effectiveness.

Keywords: Team competencies, Cardiopulmonary resuscitation, Communication, Decision-making, Teamwork, Workload

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Introduction

Effective management of patients in cardiac arrest requires a combination of knowledge, technical skills and team competencies. Team competencies are the non-clinical skills required to support the collective efforts of team members to deliver optimal care within complex hospital settings.[1] In the context of resuscitation, team competencies include team-related communication, decision-making, and leadership including workload management.[2] Resuscitation councils worldwide recommend the incorporation of team competencies training in the teaching of advanced life support for healthcare professionals.[3,4] The International Liaison Committee on Resuscitation (ILCOR) recommended in their 2020 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations, the use of specific leadership training for resuscitation courses based on very-low certainty evidence.[5,6]

A systematic review of the effect of teaching non-technical skills in advanced life support concluded that team simulation training improved non-technical skills and reduced the time to complete a simulated cardiac arrest.[7] Non-technical skills included in the review were leadership, teamwork, communication, and situational awareness.[7] Another ILCOR systematic review evaluating the effect of team and leadership training of advanced life support providers on patient outcomes concluded that team and leadership training as part of advanced life support courses improved patient outcomes.[8]

Our review adds to the existing body of knowledge by extending consideration to all life-support training contexts (beyond Advanced Life Support (ALS)/Advanced Cardiac Life Support (ACLS) for adults) and isolating the specific effect of team competence training, including only studies with a comparison group. We evaluated whether specific training in team competencies improves patient outcomes, cardiopulmonary resuscitation (CPR) skill performance and CPR quality, as well as provider confidence and team competencies, which might impact patient survival, the organization of life support courses, and resuscitation services worldwide. Our aim was to evaluate the effectiveness of life support training with specific emphasis on team competencies on clinical and educational outcomes.

Methods

This systematic review was undertaken as part of the continuous evidence evaluation process of the International Liaison Committee on Resuscitation (ILCOR) Task Force on Education, Implementation, and Teams (EIT), and was prospectively registered in PROSPERO (CRD42023473154). Results are reported in line with the Preferred Reporting Items for a Systematic Review and Meta-Analysis (PRISMA) reporting checklist.[9]

The PICOST (Population, Intervention, Comparison, Outcome, Study design, Timeframe) frame specified the research question:

Population: Learners undertaking life support training in any setting;

Intervention: Life support training with a specific emphasis on team competencies training;

Comparators: Life support training without specific emphasis on team competencies training;

Outcomes: Patient survival (actual resuscitation), cardiopulmonary resuscitation (CPR) skill performance at course completion (simulation), CPR skill performance (in actual resuscitation and simulation) < 1 yr and ≥ 1 yr of course completion; CPR quality (simulation) (at course completion, <1yr and ≥ 1 yr of course completion); confidence (at course completion and < 1 yr and ≥ 1 yr of course completion), teamwork competencies (in actual resuscitation and simulation) (at course completion, <1yr and ≥ 1 yr of course completion); resources (time, equipment, cost);

Study Designs: Randomized controlled trials (RCTs) and non-randomized studies (non-RCT, interrupted time series, controlled before-and-after studies, cohort studies) were eligible for inclusion. Studies evaluating scoring systems (no relevant outcome), and studies with self-assessment as the only outcome were excluded, as well as reviews and unpublished studies (e.g., conference abstracts, trial protocols).

Timeframe: Literature was searched from inception to 30 Aug 2023, and updated January 18, 2024. All languages were included if there was an English abstract available.

In contrast to the PROSPERO registration, study screening had started at the time of registration (17 October 2023). Screening of articles commenced on 22 September 2023. There was a clerical error upon registration – the source document stated 'yes' for if the search had already begun, but it was not correctly entered on the PROSPERO website. Also, in contrast to the PROSPERO registration, we did not perform sub-group analyses due to lack of sufficient studies to do so.

Definitions

- Team competencies were defined as non-technical skills to work on a team including e.g. specifying goals, 'team-related' communication, structured handovers, situation awareness, coordinated behaviours, task allocation, sharing the mental model, performance monitoring etc.[10]
- Team leadership was defined as a specific teamwork competence requiring specific coordination activities such as distributing tasks, assigning work, and enforcing rules and procedures.[7]
- Teamwork was defined as a process that includes clarity of goal distribution, applicable team-related communication, and defined roles of the team members.[7]
- Critical outcomes included patient survival, CPR skill performance and quality beyond course completion, CPR skill performance and quality beyond one year.
- Important outcomes were CPR skill performance and quality at course completion, confidence at course completion and beyond, teamwork competencies at course completion and beyond.

Eligibility criteria

Studies were eligible for inclusion if they investigated training with a specific emphasis on team competencies compared to none, that reported on adult, paediatric, or neonatal resuscitation in-hospital or out-of-hospital in any training setting (basic and advanced life support).

Sources, search strategy, data extraction

The databases Medline, Embase and Cochrane were searched from inception to August 2023, and updated January 18, 2024. The International Clinical Trials Registry Platform (https://www.who.int/ictrp/en/); the US clinical trials registry (https://www.clinicaltrials.gov; Cochrane CENTRAL (https://www.cochranelibrary.com/about/central-landing-page.html) were searched and no additional studies

were identified. An information specialist hired by ILCOR developed the search strategy, performed it and updated the search later using the same search strategy (Appendix 1.).

Titles and abstracts were screened independently in pairs by 4 coauthors (AC & BF, JY & KG) using Rayyan (https://www.rayyan. ai).[11] Disagreements were discussed and resolved within the author team or with the advice of the ILCOR EIT taskforce. The remaining full texts were screened independently in pairs by 4 coauthors (AC & BF, JY & KG). Data from included studies was then extracted into a standard data extraction form by 4 coauthors (AC, BF, JY, KG).

Risk of bias assessment and synthesis method

Working in pairs, two coauthors (AC & BF, JY & KG) independently performed the risk of bias assessment using the 'Risk of Bias 2 (RoB 2)' tool[12] for randomized controlled trials and the 'Risk of Bias in Non-randomized studies of interventions (ROBINS-I)' tool[13] for non-randomized studies. Disagreement was discussed and resolved within the coauthor team and/or with assistance of the ILCOR EIT taskforce.

The Grading of Recommendations Assessment, Development and Evaluation (GRADE) methodology was used to assess certainty of evidence.[14] We did not identify two or more studies of similar design on the same intervention and assessing the same outcome and therefore a *meta*-analysis could not be performed. Therefore, we followed the Synthesis Without Meta-Analysis (SwiM) reporting guidelines to summarize the evidence.[15]

Results

Study characteristics

The primary literature search (including the updated search) identified 5470 articles, after de-duplication, the titles and abstracts of 3397 articles were screened. Thirty-one articles entered the full-text assessment, and 14 articles were excluded due to either wrong study design, not a study involving cardiopulmonary resuscitation, no control group or were conference abstracts, leaving 17 studies for the final analysis (flow chart Fig. 1; PRISMA Checklist Appendix 2.).

Appendix 3 depicts the included studies' characteristics, designs, and main outcomes. Table 1 displays an overview of the study characteristics, training contexts and interventions for team competencies training. Nine studies were performed in Europe,[16–24] seven in North America[25–31] and one in South America.[32] Only one study included patient outcomes.[27]

Risk of bias assessment and certainty of evidence

Risk of bias for the included studies ranged from some concerns to serious (Appendix 4.). The studies varied considerably in methodology used, training intervention applied, and training context (details in Tables 1. and 2.). Certainty of evidence was rated as low to very low due to risk of bias and imprecision (Appendix 5.).

Study outcomes (Appendix 3., RoB tables Appendix 4.)

Patient survival

For the critical outcome of patient survival, one RCT[27] reported descriptive data on patient outcomes, reporting 11% of patients died in the intervention group, and 13% of patients died in the control group. No information was provided about the timeframe of patient survival. The study was not powered to make inferences about survival.

CPR skill performance in real resuscitations

One RCT[27] reported CPR performance scores, using a checklist based upon standards of Advanced Trauma Life Support and other care checklists which was normalised to create a score that could be compared across different resuscitation events, and found no significant difference between the intervention and control groups.

Team competencies in real resuscitations

One RCT[27] reported more leadership behaviour in the intervention group than control group.

CPR skill performance at course completion and beyond (simulations)

We found 10 studies, 9 RCT,[16,18,21,22,24,25,27–29,31] and one before and after study[32] for CPR skill performance at course completion. Six studies[16,21,25,28,29,32] reported time to varying key resuscitation behaviours, four[16,21,29,32] of them found no significant difference between the intervention and control groups. One of the RCTs[28] reported significantly shorter time to chest compressions out of five behaviours; another study[25] reported shorter times for eight of nine behaviours. Seven[16,22,24,27–29,31,32] studies reported CPR performance scores using varying measures. Six[16,22,24,27–29,31] found no significant difference between the intervention and control groups. One non-randomised study[32] reported higher median scores in a checklist of expected CPR acts in the intervention (95%) vs. the control group (85%).

One RCT[21] reported no difference in the rate of correct arm and shoulder positioning between intervention and control groups. Another RCT[18] reported adherence to European Resuscitation Council advanced life support guidelines, finding greater adherence in the intervention versus the control group.

CPR skill performance beyond course completion was reported in four RCTs[16,21,22,24] Two[22,24] found no significant difference in performance scores at four months[24] and six months[22] after course completion. One RCT[16] reported significantly higher technical CPR skill scores (calculated from compression depth and rate; detection of shockable rhythm; ventilation efficiency; and time to CPR initiation) in the intervention (70%) vs. the control (62%) group at follow-up (time unspecified), despite no difference at course completion. Another RCT[21] reported significantly shorter time to first meaningful resuscitation measure in the intervention group at four months after course completion.

Evidence relating to CPR skill performance beyond one year was not identified.

CPR quality at course completion and beyond (simulations)

For CPR quality at course completion, we found four RCTs.[17,18,20,21] Two[17,18] measured no-flow time, one measuring the amount of time one of four team members provided chest compressions reported[17] significantly shorter no-flow time in the intervention group while the other[18] (measuring the percentage of the scenario time frame minus the time with chest compressions performed by any team member) found no significant differences between groups. One RCT[21] measured hands-on time and compression rate and found no difference between groups. Another RCT[20] found no difference in chest compression quality or in chest compression pauses between groups.

We found one RCT for CPR quality beyond course completion.[21] Four months after the intervention, hands-on time was higher in the intervention group when compared to the control group with higher

PRISMA Flow Chart - Teaching team competencies within resuscitation training: a systematic review
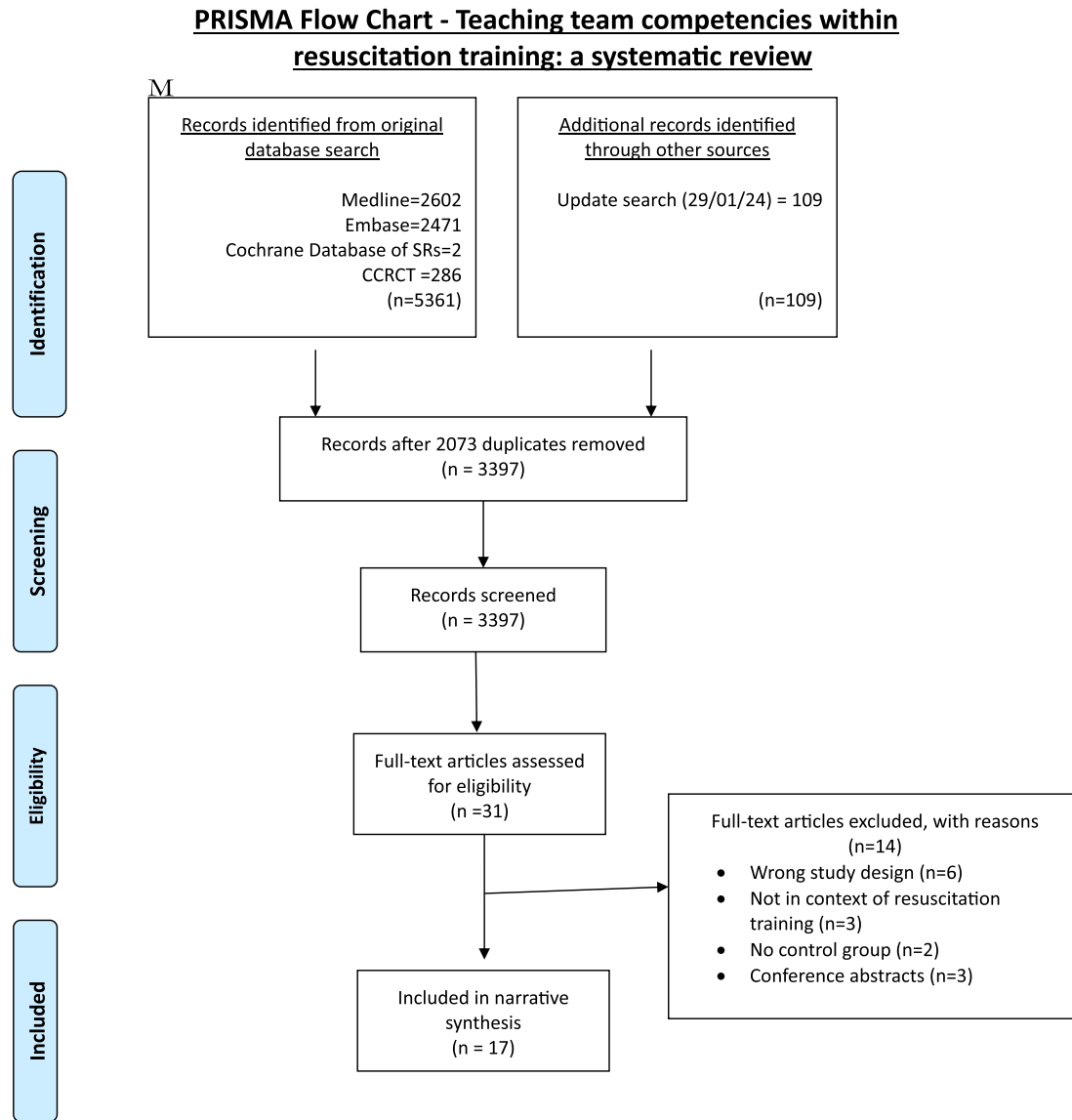

Fig. 1 – PRISMA Flow Chart – Teaching team competencies within resuscitation training: a systematic review.

rates of guideline-compliant compressions as recommended and more compressions per minute.

Evidence relating to CPR quality beyond one year was not identified.

Confidence at course completion and beyond (simulations)
For confidence at course completion, we identified one RCT[16] which found no significant difference between groups. For confidence beyond course completion, one RCT[16] found no significant difference between groups at follow-up. Evidence relating to confidence beyond one year was not identified.

Teamwork competencies at course completion and beyond (simulations)
For teamwork competencies at course completion we identified 14 studies, 12 RCTs,[16,17,19–21,24–26,28–31] and 2[23,32] non-RCTs.

Communication: Two RCTs[20,30] reported a significantly greater proportion of leadership statements (measured differently) in the

intervention group compared to control. Three RCTs[26,29,30] identified significantly increased directed team communication with the intervention. One RCT[29] also reported increased completed closed-loop communications and follower-initiated communications in the intervention group. One RCT[17] measured 'teamwork verbalisations' and found a significantly higher number of verbalisations in the intervention group, like directed orders, task assignments, undirected orders, and planning. In contrast, one RCT[21] identified more leading utterances in the control group.

Decision-making and leadership behaviour: One RCTs[19,27] reported more leadership behaviour in the intervention group. One[21] also reported significantly increased corrections of improper chest compressions in the intervention group. Another RCT[20] reported increased decision-making in the intervention group. One non-randomised study[23] reported no significant difference in leadership behaviour between intervention and control groups.

Teamwork: One RCT[16] reported significantly higher team-level efficacy in the intervention group. One non-randomised study[32]

Table 1 – Teaching team competencies within resuscitation training: a systematic review: Overview of study characteristics.

Years of publication	2007–2023
Countries of studies	Europe (3 Germany,[17–19] 2 Switzerland,[20,21] 2 Finland,[22,23] 1 France,[24] 1 Belgium[16]) North America (6 USA[26–31], 1 Canada[25]) South America (1 Brazil[32])
Training context	Advanced Life Support: 9[17,18,22,24–27,29,32] Immediate Life Support: 1[20] Basic Life Support: 1[21] Paediatric resuscitation: 4[18,19,26,32] Neonatal resuscitation: 4[23,28,30,31] Not stated: 1[16]
Training interventions	- Short Crisis Resource Management training (<1 h): 4[16,19,23,25] - Long Crisis Resource Management raining > 1 h: 1[18] - Crisis Resource Management training of unspecified length: 1[17] - 2-hour TeamSTEPPS 2.0 training: 1[26] - 4-hour leadership training: 1[27] - 2-hour team training: 1[31] - 30-min task-oriented role assignment training: 1[28] - 10-min leadership training specifically for female learners: 1[20] - Teamwork and human error training of unspecified length: 1[30] - TeamSTEPPS training of unspecified length: 1[32] - Instructions focused on leadership and communication to enhance team coordination of unspecified length: 1[21] - Pit crew model: 1[22] - Team leaders blindfolded during practice: 1[29] - Practice in interrupted scenarios: 1[24]

reported more teamwork intervention events in the intervention group. Two RCTs[24,31] and one non-randomised study[23] found no significant difference in measures of teamwork between groups.

Non-technical skills: Two RCTs[25,28] reported significantly higher non-technical skill performance[25] (measured differently) and total behavioural skills scores[28] in the intervention group.

Workload management: Two RCTs[30,31] reported significantly improved workload management (measured differently) in the intervention group.

For teamwork competencies beyond course completion we identified three RCT.[16,21,24] One RCT[21] reported more leadership utterances, task assignments, commands, and decisions about what to do in the intervention group four months after the course. Another RCT[16] reported significantly higher self-reported teamwork in the intervention group at follow-up. An RCT[24] reported no significant difference between groups in 'TEAM scores' at three months after course completion. Evidence relating to team competencies beyond one year was not identified.

Discussion

Resuscitation councils worldwide include training of team competencies in their advanced life support courses with the aim to improve team performance, improve adherence to guidelines, reduce errors, and ultimately improve patient care.[3,6] The effectiveness of non-technical skills training to improve team performance in advanced life support,[7] and the effectiveness of team and leadership training in advanced life support course providers to improve patient outcomes[8] has been demonstrated. In this systematic review, we broadened the review question including the teaching context related to all levels of courses (from basic to advanced life support courses, in adult, pae-

diatric, and neonatal resuscitations), and expanded the included team competencies to a variety of described team competence interventions. We identified 17 studies in all training contexts with a wide variety of different team competence training interventions. Interventions included Crisis Resource Management training below and above one hour, or of unspecified length, TeamSTEPPS training, leadership training, team training, task-oriented role assignment training, human error training, Pit crew model training, team leader blindfolding, and practice in interrupted scenarios (for details compare Table 1).

In this systematic review, we have found very low certainty evidence that teaching team competencies improves the performance of resuscitation teams. Almost all of the evidence is derived from simulation studies rather than real-life resuscitations, limiting the inferences that can be drawn. However, no negative effects of training with emphasis on team competencies were identified, and therefore we suggest that team competencies be included in all life support courses despite the low certainty of effects on patient outcomes. The specific team competencies being trained should likely be tailored to the type of resuscitation course, aiming to train contextualised skills (technical and non-technical). Also, to address the lack of knowledge, well designed studies ideally reflecting patient outcomes are necessary.[33,34]

Only one RCT[27] reported higher patient survival in a descriptive way with such training. However, this study was not powered to evaluate survival, therefore any inference of that result has to be taken with caution. Interestingly, another review on teaching team competencies identified improved patient outcomes of providers who had attended advanced life support courses.[8]

Several included studies reported that team competencies training improved CPR skill performance,[16,18,21,25,28,32] and some aspects of teamwork competencies, including communication,

Table 2 – Teaching team competencies within resuscitation training: a systematic review: Types of outcomes, overall findings, risk of bias assessments.

Types of Outcome	Training context	Number of studies	Neutral	In favour of training with no emphasis on teamwork competencies	In favour of training with emphasis on teamwork competencies	Risk of Bias of single studies
Survival	ALS[27]	1[27]	–	–	1[27]	Some concerns[27]
CPR skill performance beyond course completion	ALS[22,24] BLS[21] Not stated[16]	4[16,21,22,24]	2[22,24]		2[16,21]	Some concerns[16,21,22,24]
CPR quality beyond course completion	BLS[21]	1[21]	–	–	1[21]	Some concerns[21]
CPR skill performance at course completion: Time to key resuscitation behaviours	ALS[25,29,32] BLS[21] Paediatric[32] Neonatal[28] Not stated[16]	6[16,21,25,28,29,32]	4[16,21,29,32]	–	2[25,28]	Serious[32] Some concerns[16,21,25,28,29]
CPR skill performance at course completion: CPR performance scores	ALS[22,24,27,29,32] Paediatric[32] Neonatal[28,31] Not stated[16]	8[16,22,24,27–29,31,32]	7[16,22,24,27–29,31]	–	1[32]	Serious[32] Some concerns[16,22,24,27–29,31]
CPR skill performance at course completion: rate of correct arm and shoulder positioning	BLS[21]	1[21]	1[21]	–	–	Some concerns[21]
CPR skill performance at course completion: adherence to ALS guidelines	ALS[18] BLS[18]	1[18]	–	–	1[18]	High[18]
CPR quality at course completion	ALS[17,18] ILS[20] BLS[18,21]	4[17,18,20,21]	3[18,20,21]	–	1[17]	Some concerns[17,21] High[18,20]
Confidence at course completion	Not stated[16]	1[16]	1[16]	–	–	Some concerns[16]
Confidence beyond course completion	Not stated[16]	1[16]	1[16]	–	–	Some concerns[16]
Teamwork competencies at course completion: communication	ALS[17,26,29] BLS[21] ILS[20] Paediatric[26] Neonatal[30]	6[17,20,21,26,29,30]	–	1[21]	5[17,20,26,29,30]	High[20,30] Some concerns[17,21,26,29]
Teamwork competencies at course completion: decision-making and leadership behaviour	ALS[27] ILS[20] BLS[19] Neonatal[23]	4[19,20,23,27]	1[23]	–	3[19,20,27]	Serious[23] High[20] Some concerns[19,27]
Teamwork competencies at course completion: teamwork	ALS[24,32] Paediatric[32] Neonatal[23,31] Not stated[16]	5[16,23,24,31,32]	3[23,24,31]	–	2[16,32]	Serious[23,32] Some concerns[16,24,31]
Teamwork competencies at course completion: Non-Technical Skills	ALS[25] Neonatal[28]	2[25,28]	–	–	2[25,28]	Some concerns[25,28]
Teamwork competencies at course completion: workload management	Neonatal[30,31]	2[30,31]	–	–	2[30,31]	High[30] Some concerns[31]
Teamwork competencies beyond course completion	ALS[24] BLS[21] Not stated[16]	3[16,21,24]	1[24]	–	2[16,21]	Some concerns[16,21,24]

ALS = Advanced Life Support, CPR = cardiopulmonary resuscitation, BLS = Basic Life Support, ILS = Immediate Life Support.

decision-making and leadership behaviour, teamwork, non-technical skills, and workload management.[16,17,19–21,25–32] Two studies even reported better CPR skill performance beyond course completion.[16,21] We did not find any report of harmful effects of team competence training in either context of training or course format.

Results about the overall concept of teamwork competencies varied. Some studies showed improvement with specific training of team competencies at course completion. Five studies[17,20,26,29,30] reported improved communication with such training, three studies[19,20,27] found improved decision-making and leadership skills. These results imply that specific training in communication skills might be especially beneficial to achieve improvements in teamwork during resuscitations. However, all these studies were in a simulated setting. We lack data about whether results from resuscitation training can be translated into better communication during real cardiac arrests.

Included studies covered a variety of different teaching interventions for teamwork competencies but due to the high heterogeneity we could not compare the effect of these different teaching methods. Thus, potential superiority in the effectiveness of training intervention methods remains to be determined.

Only two RCT[16,21] showed improvement of teamwork competencies beyond course completion, which might be important to improve patient outcomes over time. Since limited data beyond course completion and no data for outcomes beyond one year after course completion is available, future studies are necessary to evaluate retention of teamwork competencies and the effect on patients' outcomes.

Resuscitation councils worldwide use teamwork competencies training in their resuscitation courses, therefore training in teamwork competencies seems widely accepted. However, we did not find any evidence on the cost-effectiveness of such teaching that supports this current teaching practice.

All but one included studies were performed in Europe and North America in high-resource countries. Only one study was performed in Brazil.[32] We therefore cannot comment if the conclusion of this review would change if studies from low-income settings or different parts of the world were available.

Limitations, knowledge gaps, and future research

The limitation of this systematic review is that only one study which reported descriptively improved patient survival, is underpowered for this outcome (leading to imprecision). The effects of team competencies training on clinical resuscitation performance and patient outcomes remain unclear. Future adequately powered studies are necessary to close this knowledge gap.

The ideal educational intervention, duration, and mode of delivery for teamwork competencies teaching remains unclear. Because of the heterogeneity and a wide variety of educational interventions reported and of measures used, a comparison between the teaching approaches was not possible. Future studies should compare different teaching interventions for team competencies training. Despite studies showing improved communication, decision-making, and leadership behaviours, it remains unclear whether training of particular competencies is more important than others. It is also unclear whether there is a difference between the teaching context and the group of learners. We did not find any evidence for the cost-effectiveness of the team competencies training, or any evidence from low-resource settings. Future studies should focus on these two important aspects. This systematic review was registered on PROSPERO, some changes were made after registration (which have been detailed in the methods section). PROSPERO allows changes in outcomes and measurements as some are not obvious a priori but can be found in the retrieved papers.

Conclusion

This systematic review assessed life support training with specific emphasis on team competencies compared to training without this emphasis. We identified very low and low certainty evidence, almost entirely derived from simulation studies. The studies and their findings were heterogenous but suggest that teaching team competencies can improve resuscitation skills performance and CPR quality, as well as improve team competencies, specifically leadership, communication, decision-making, and task management. Further research is required to understand optimal configuration of team competencies training interventions and to understand the effect on clinical outcomes and cost-effectiveness.

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Declaration of competing interest

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.resplu.2024.100687.

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