1. Cardiac Arrest Centers (EIT 6301 - SysRev)

QUESTION

Should cardiac arrest centers (CAC) vs. non-CAC be used for patients with out of hospital cardiac arrests?	
POPULATION:	Adults and children with attempted resuscitation after non-traumatic in-hospital or out-of-hospital cardiac arrest
INTERVENTION:	Care at a specialized cardiac arrest center CAC
COMPARISON:	Care in an institute not designated as a specialized cardiac arrest center
MAIN OUTCOMES:	Survival at 30 days with favorable neurological outcome (CRITICAL), Survival at hospital discharge with favorable neurological outcome (CRITICAL), Survival at 30 days (CRITICAL) and Survival at hospital discharge (CRITICAL), Return of spontaneous circulation (ROSC) post hospital admission for patients with ongoing CPR (IMPORTANT)
SETTING:	OUT OF HOSPITAL CARDIAC ARREST
PERSPECTIVE:	There is wide variability in survival among hospitals caring for patients after resuscitation from out of hospital cardiac arrest (OHCA). OHCA is common yet survival outcomes are poor both regional and international variation. Survival from OHCA ranges from 8-16.1%. Measures to maximise favourable neurological outcomes are a research priority to both patients and clinicians. Post-resuscitation care, including percutaneous coronary intervention (PCI) and targeted temperature measurement (TTM), is an important component to achieve good neurological outcome.
BACKGROUND:	In most countries, post resuscitation care is not regionalized to specialised hospitals and there is wide variation among hospitals in the availability and type of post-resuscitation care, as well as clinical outcomes. Other time-sensitive illness (e.g. trauma, acute myocardial infarction and stroke services) use regional triage systems to direct patients according to clinical needs to specialist centres which offer concentration of services and greater provider experience. Centralising specialised services to improve provision of targeted post-resuscitation care and patient outcome in cardiac arrest may offer similar benefits. The International Liaison Committee on Resuscitation (ILCOR) last considered the evidence on this topic in 2015 and concluded that specialist cardiac arrest centres (CAC) may be effective despite a lack of high quality data to support its implementation. Previous observational studies have reported an association between transport to CAC and survival to hospital discharge, but there is inconsistency in the hospital factors that are most related to patient outcome. Whilst most experts agree that CAC should have access to 24/7 cardiac catheterisation laboratory, targeted temperature management, and neurological services that offer electrophysiological modalities for monitoring and prognostication, discrepancies remains in the definition of services that constitute a specialist CAC.
CONFLICT OF INTERESTS:	The following Task Force member were recused from the discussion as he declared a conflict of interest (author of one of the studies): Matsuyama

ASSESSMENT

Problem
Is the problem a priority?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ No ○ Probably no ○ Probably yes ● Yes ○ Varies ○ Don't know	Out-of hospital cardiac arrest is common and survival outcomes remain poor and can vary regionally. • In 2020, primary-cause age-adjusted annual rate was 106.0 (95% CI,105.6–106.3) SCDs per 100 000 population.(1) • In the US, survival to hospital discharge after EMS-treated OHCA was 9.1% and survival to hospital discharge with good functional status was 7.1% (on the basis of 143 018 adult cases, CARES Registry 2021) (1) • In Europe, out-of-hospital cardiac arrest incidence for patients considered for resuscitation by emergency medical services has been reported as 84 per 100,000 population per year. (2) • Pan Asian network reported 66,780 OHCA cases were submitted to their registry over 2.5 years. (3) • Australian Resuscitation Outcomes Consortium registry reported an overall crude incidence of 102.5 cases per 100,000 population (range: 51.0–107.7 per 100,000 population (4) • Measures to maximise favourable neurological outcomes is research priority to patients and clinicians.	• Considered high priority for EIT TF • Several large registry-based studies and one RCT published since last review • Evidence to demonstrate benefit in regionalised trauma, stroke, acute MI/STEMI centers • Cardiac arrest centers differ between health systems, emergency care response systems and countries. • Cardiac arrest centers are part of co-ordinated system of emergency medical response • May act as a guide for developing regionalised care for OHCA

Desirable Effects
How substantial are the desirable anticipated effects?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ Trivial ○ Small ○ Moderate ○ Large ○ Varies ● Don't know	Observational studies have reported higher survival to 30 days and hospital discharge with favorable outcomes as well as survival to 30 days and hospital discharge. However, a randomised controlled trial did not find any difference in survival when patients with non-STEMI OHCA and prehospital ROSC was transferred to CAC.(5)	• Patients who are admitted to cardiac arrest centers do not always receive optimal protocolised post cardiac arrest care. Reasons behind this is likely multifactorial • Even small improvements in outcomes are likely to be favoured by patients and clinicians • Potential to maximise favourable neurological outcomes post-cardiac arrest. • Potential to focus resources with co-ordinated transfer system to maximise value for patients • Reduce treatment times due to secondary transfers.

Undesirable Effects

How substantial are the undesirable anticipated effects?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
○ Trivial ○ Small ○ Moderate ○ Large ○ Varies ● Don't know	• Lack of reporting of adverse effects e.g. rearrest • No subgroup analysis of transport times and secondary transfers can be performed within review. • One study used logistic regression model to examine transport times and concluded that over 14.0 minutes of transport time was sufficient to offset potential benefit of being transported to PCI center.(6) • Limited evidence from 2 studies (Denmark and Canada) that longer transports do not appear to be associated with worse survival outcomes. Kragholm 2017 (included in review) looked at direct transport to closest PCI (median 8.5min drive), bypassing nearest non-PCI hospital to go to PCI hospital (median 14min drive) and direct to non-PCI hospital (median 11min drive). Compared with patients taken to non-PCI hospitals, odds of survival were higher for patients taken to the nearest hospital with PCI center status (OR, 3.07; 95% CI, 1.90–4.97) and for patients bypassing closer hospitals to PCI centers (OR, 3.02; 95% CI, 2.01–4.53). Adjusted survival remained significantly better across transport times of 1 to 5, 6 to 10, 11 to 20, 21 to 30, and >30 minutes. (7) A second study found no association between transport interval and survival in either the study group (odds ratio 1.01; 95% CI 0.99 to 1.05) or the return of spontaneous circulation subgroup (odds ratio 1.04; 95% CI 0.99, 1.08).(8) • Lack of evidence evaluating the potential social impact for families or patients due to longer distance to travel	• High resource costs to set up new cardiac arrest centers and support system especially in rural areas or low-density population. • In healthcare systems where intensive care and interventional cardiology services are already well established, there is a potential that resources may be reallocated • This solution should be balanced however by understanding the risk of potentially diverting vital resources from other patients and the potential impact on sustainability of other services • Unnecessary transfer if patients are not going to survive • Potential social impact for patients and families

Certainty of evidence

What is the overall certainty of the evidence of effects?

JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
● Very low ○ Low ○ Moderate ○ High ○ No included studies	• Non-randomised study design; registry based cohort studies • Downgraded due to high heterogeneity, inconsistency and imprecision • One RCT published did not demonstrate any difference in patient outcomes between those transported to CAC compared to those who were not.	

Values

Is there important uncertainty about or variability in how much people value the main outcomes?

JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
○ Important uncertainty or variability ○ Possibly important uncertainty or	No studies address uncertainty or variability included in review	There may be variation in cultural views towards the priority of outcome of survival and survival with

variability ○ Probably no important uncertainty or variability ● No important uncertainty or variability	Previous study supported the critical importance of the outcomes of survival and survival with favourable neurological outcome.	favourable neurological outcomes in different countries.

Balance of effects

Does the balance between desirable and undesirable effects favor the intervention or the comparison?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ Favors the comparison ○ Probably favors the comparison ○ Does not favor either the intervention or the comparison ● Probably favors the intervention ○ Favors the intervention ○ Varies ○ Don't know	Little direct evidence to suggest longer transfer time to get to PCI hospital will lead to significant harm. As survival with favourable outcomes is of critical importance to patients, the balance between desirable and undesirable effects favor the intervention.	• High resource costs to set up new cardiac arrest centers and support system especially in rural areas or low-density population. • In healthcare systems where intensive care and interventional cardiology services are already well established, there is a potential that resources may be reallocated • This solution should be balanced however by understanding the risk of potentially diverting vital resources from other patients and the potential impact on sustainability of other services • Potential to facilitate the organisation of organ donation

Resources required

How large are the resource requirements (costs)?"

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ Large costs ○ Moderate costs ○ Negligible costs and savings ○ Moderate savings ○ Large savings ● Varies ○ Don't know	• No studies examined resource use of costs for cardiac arrest centers • A study in Toronto estimated that median total cost was only $690 per patient, this ranged from $290 for patients who were pronounced dead on scene to almost $40,000 per patient who was still alive at day-30 but they were unable to ascertain costs based on specific type of hospital.(9) • Indirect evidence from study of Primary Stroke center (PSC) in New York reported that admission to a PSC resulted in a gain of 0.22 years of life (95% CR, 0.12–0.33) and 0.15 quality-adjusted life years (95% CR, 0.08–0.23) per patient, at a cost of $3600 (95% CR, $2400–$5000) per patient, compared with admission to a nonPSC hospital. The incremental cost/quality-adjusted life year gained was $24 000.(10) • Indirect evidence from study that examined the cost effectiveness of STEMI center in Spain concluded that STEMI network was cost effective.(11)	• Resources are similar to those implemented for trauma, stroke, STEMI centers. • Some countries already have regionalised care in place and have established PCI and ICU service. • Team work and co-ordination between EMS, EDs, cardiology, radiology, neurology and ICU are necessary • Registries may be necessary to monitor and evaluate. • Implementation may be an issue in very remote regions and regions with less developed transport or emergency systems.

Certainty of evidence of required resources

What is the certainty of the evidence of resource requirements (costs)?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ Very low ○ Low ○ Moderate ○ High ● No included studies	No studies examined resource use of CAC and its demand on emergency medical system	

Cost effectiveness

Does the cost-effectiveness of the intervention favor the intervention or the comparison?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ Favors the comparison ○ Probably favors the comparison ○ Does not favor either the intervention or the comparison ○ Probably favors the intervention ○ Favors the intervention ○ Varies ● No included studies	No studies examined resource use of CAC and its demand on emergency medical system	

Equity

What would be the impact on health equity?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ Reduced ○ Probably reduced ○ Probably no impact ● Probably increased ○ Increased ○ Varies ○ Don't know	No studies examined equity of CAC	• Likely to reduce regional variation in care but may come at a cost to other areas of health care systems (e.g. impact of removing emergency services during patient transports; diversion of funds from other areas). • Potential to reduce difference in outcomes between primary and secondary transfer to cardiac arrest centers • May not benefit countries where no infrastructure or resources are in place to support cardiac arrest centers • The impact of regionalisation of care on health care providers is likely to vary widely. In some health care settings, regionalisation of care generally may threaten the viability of

		bypassed hospitals. Whereas in other settings, dedicated centres may allow resources in bypassed hospitals to be used elsewhere.

Acceptability

Is the intervention acceptable to key stakeholders?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ No ○ Probably no ● Probably yes ○ Yes ○ Varies ○ Don't know	No studies examined acceptability of CACs	• CAC and CAC hubs have been recommended in international guidelines • Some countries already have cardiac arrest centers, regionalised emergency transport system and registry. • The establishment of cardiac arrest center and emergency transport system needs to fit in with local health priorities and needs • Further evidence may persuade others to fund and support cardiac arrest centers

Feasibility

Is the intervention feasible to implement?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ No ○ Probably no ○ Probably yes ○ Yes ● Varies ○ Don't know	No studies examined feasibility of CAC	• Feasible in regions with advanced emergency systems • Similar systems in trauma, stroke and AMI are now standard practice. • Feasibility maybe an issue in rural areas or low density population

SUMMARY OF JUDGEMENTS

	JUDGEMENT						
PROBLEM	No	Probably no	Probably yes	**Yes**		Varies	Don't know
DESIRABLE EFFECTS	Trivial	Small	Moderate	Large		Varies	**Don't know**
UNDESIRABLE EFFECTS	Trivial	Small	Moderate	Large		Varies	**Don't know**
CERTAINTY OF EVIDENCE	**Very low**	Low	Moderate	High			No included studies

	JUDGEMENT						
VALUES	Important uncertainty or variability	Possibly important uncertainty or variability	Probably no important uncertainty or variability	**No important uncertainty or variability**			
BALANCE OF EFFECTS	Favors the comparison	Probably favors the comparison	Does not favor either the intervention or the comparison	**Probably favors the intervention**	Favors the intervention	Varies	Don't know
RESOURCES REQUIRED	Large costs	Moderate costs	Negligible costs and savings	Moderate savings	Large savings	**Varies**	Don't know
CERTAINTY OF EVIDENCE OF REQUIRED RESOURCES	Very low	Low	Moderate	High			**No included studies**
COST EFFECTIVENESS	Favors the comparison	Probably favors the comparison	Does not favor either the intervention or the comparison	Probably favors the intervention	Favors the intervention	Varies	**No included studies**
EQUITY	Reduced	Probably reduced	Probably no impact	**Probably increased**	Increased	Varies	Don't know
ACCEPTABILITY	No	Probably no	**Probably yes**	Yes		Varies	Don't know
FEASIBILITY	No	Probably no	Probably yes	Yes		**Varies**	Don't know

TYPE OF RECOMMENDATION

Strong recommendation against the intervention	Conditional recommendation against the intervention	Conditional recommendation for either the intervention or the comparison	**Conditional recommendation for the intervention**	Strong recommendation for the intervention
○	○	○	●	○

CONCLUSIONS

Recommendation

We suggest adults with OHCA should be cared for in cardiac arrest centers (weak recommendation, low quality evidence).

Justification

In making this suggestion, the EIT taskforce considered the following:

- This topic was prioritized by the EIT Task Force based on ongoing interest in improving patient outcomes following OHCA.
- We defined a cardiac arrest centers as specialized institutions offering two or more recommended treatment options for patients with OHCA, including access to a coronary angiography laboratory with 24/7 PCI capability, TTM, extracorporeal membrane oxygenation, mechanical ventilation, and neurological prognosticationcardiac arrest centre as those providing target temperature management and cardiac invention.
- Expedited transfer to a cardiac arrest centre for non-ST-elevation out-of-hospital cardiac arrest (ARREST) trial was published in 2023.(5) The results did not show any benefits in patients transferred to CAC. However, the taskforce is mindful that based on inclusion criteria of the study, the results were applicable only to patients with non-STEMI and prehospital ROSC in urban setting. Based on one RCT, we cannot recommend transfer to CAC for OHCA adults with presumed cardiac cause presenting with non-STEMI with prehospital ROSC in an urban city setting. Given the lack of generalisability, we included published data from non-randomised studies in our review.

Subgroup considerations

- There was insufficient data for subgroup analyses to make any recommendations about specific subgroups including age group, presenting rhythm, primary versus secondary transfer.
- We did not identify any studies on pediatric patients or in-hospital cardiac arrest in this review.

Implementation considerations

- We considered the successful implementation of regionalized care for trauma, stroke and STEMI.
- We reflected on the high level of resources required, particularly in regions with no regionalized emergency transport in place for other conditions (e.g. trauma, stroke, STEMI) and concluded that the benefits potentially outweigh issues associated with implementation.
- We recognised that implementing this recommendation may be resource and cost intensive, and whilst it has been successfully implemented in some countries, it may not be feasible in all regions.

Monitoring and evaluation

- Registries remain an effective method for monitoring the use and effectiveness of regionalised care.

Research priorities

- There were no studies identified that evaluated this question in the paediatric/in-hospital setting.
- Most studies only reported short term outcomes until hospital discharge, future studies should document long term neurological intact survival.
- There was a lack of studies that evaluated the long-term benefits and the impact on patient reported outcomes (12)
- There were insufficient data to allow for evaluating the effect of care at CAC in specific subgroups (e.g. age, cardiac etiology, shockable or no-shockable rhythm)
- There were no studies that reported on the cost-effectiveness of transferring and or caring for patients at cardiac arrest centers
- There were no studies that evaluated any negative outcomes associated with bypassing nearest hospitals (e.g. de-skilling in post-arrest management) and transferring patients to cardiac arrest centers
- There is insufficient evidence to evaluate what is a safe distance or time for transport
- There were no studies that examined the impact on families, particularly those from remote regions.
- There were no studies that evaluated the potential impact on organ donation

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2 . Cognitive aids during resuscitation education (EIT 6400 - SysRev)

Question

"Use of Cognitive Aids in Resuscitation"	
Population:	Adults, children and neonates in any setting (in-hospital or out-of-hospital) requiring resuscitation or laypersons and health care providers providing resuscitation or learning to provide resuscitation.
Intervention:	The use of cognitive aids or checklists during resuscitation or resuscitation training
Comparison:	Compared to no use of a cognitive aid or checklist
Main outcomes:	Survival to hospital discharge with good neurological outcome and survival to hospital discharge were ranked as critical outcomes. Quality of performance in actual resuscitations, skill performance 1 year after course conclusion, skill performance between course conclusion and 1 year, skill performance at course conclusion, knowledge at course conclusion were included as important outcomes. Measures of effect outcomes included adherence to resuscitation guidelines, CPR quality and test scores were also included as important outcomes.
Background:	Cognitive aids have been widely adopted in non-critical clinical situations. These aids, often in the form of checklists, flowcharts, or digital applications, provide a structured framework to provide guidance through complex and dynamic processes.

	The 2020 CoSTR from ILCOR recommended: We recommend against the use of cognitive aids for the purposes of lay providers initiating CPR (weak recommendation, low certainty of evidence). We suggest the use of cognitive aids for health care providers during trauma resuscitation (weak recommendation, very low certainty of evidence). In the absence of studies on cardiopulmonary resuscitation no evidence-based recommendation can be issued. There is insufficient data to suggest for or against the use of cognitive aids in lay provider training. We suggest the use of cognitive aids for training of health care providers in resuscitation (weak recommendation, very low certainty of evidence). The 2021 EvUp published in the CoSTR 2021 revealed a number of new studies published in last 2 years to trigger this Systematic Review
Conflict of interests:	Kevin Nation is the Chief Executive of the New Zealand and Australian Resuscitation Councils – both Councils produce resuscitation guidelines that may include algorithms, flowcharts and infographics.

Assessment

Problem Is the problem a priority?		
Judgement	Research evidence	Additional considerations
○ No ○ Probably no ○ Probably yes ● Yes	The management of cardiac arrest and other medical emergencies can be complex. Cognitive aids have been widely adopted in non-critical situations to guide adherence to guidelines, improve performance and reduce errors. Improvement in the design and use of	Resuscitation councils worldwide are using cognitive aids during training and clinical practice in form of algorithms, flow charts, posters, interactive apps and other formats.

○ Varies ○ Don't know	published algorithms and other cognitive aids and their use in education and resuscitation events may improve performance and patient outcomes.	Evidence on the effect of such cognitive aids might strengthen its use and enhance development of more used tailored approaches
Desirable Effects How substantial are the desirable anticipated effects?		
Judgement	Research evidence	Additional considerations
○ Trivial ○ Small ● Moderate ○ Large ○ Varies ○ Don't know	Health Care Providers Managing Resuscitation in Neonates We found 5 studies (30, 31, 1, 14, 22) investigating the effects of cognitive aids used during simulated neonatal resuscitation. Non interactive aids were used in 3 studies (30, 22, 1), a poster (22), an instruction card with images and captions (30) or a tablet with auditory and visual prompts (1). Interactive aids were used in 2 studies (14, 31), an audio voice guidance App (14), or an augmented reality decision support tool (31). For the important outcome of errors in preparing medication, we identified moderate certainty evidence (downgraded for serios indirectness) from one randomised trial (30) with 50 participants and investigating a printed cognitive aid to assist dose preparation. The use of the cognitive aid significantly	No critical outcomes regarding patient outcome or skill performance in real situations were investigated in any study. All studies involved an individual or teams using a cognitive aid in simulated clinical situations. There is significant heterogeneity in the types of cognitive aids studied. The most analysed outcome was "Adherence to a protocol or process". Cognitive aids may improve performance and patient outcome by providing real-time decision support and guidance and:

	reduced errors, 50% without aid versus 24% with aid RR 0.48 (0.27 to 0.83). For the important outcome of errors in choosing correct medication concentration, the same study found moderate certainty evidence that the printed cognitive aid decreased errors in selection of the correct medication concentration, 44% without aid versus 12% with aid RR 0.27 (0.12 to 0.59). For the important outcome of adherence to a protocol or process, we identified very low certainty evidence (downgraded for serious indirectness and serious impression) from 4 studies (14, 1, 22, 31) with a total of 89 participants in the intervention groups and 84 participants in the control groups. one study (31), investigating an electronic decision support tool, demonstrated improvement in performance score. one study (1) investigating an audio visual prompt device, demonstrated fewer deviations from a resuscitation algorithm. one study (14) investigating an audio visual guidance tool, demonstrated improved adherence to a resuscitation algorithm and performance to a guideline. one study (22) investigating a poster of an algorithm demonstrated no difference in performance.	● decreasing cognitive load of individuals or team collectively (35). Limitations to working memory, systems 1 cognitive processes and the impact of stress and distraction in resuscitation may impair rapid, accurate decision-making (36) which can be improved by cognitive aids. ● standardizing communication among resuscitation team members (37). ● allow for better situation awareness/ shared mental model among team members (38).

	Healthcare Providers Managing Paediatric Resuscitation We found 6 studies (24, 4, 3, 2, 25, 26) investigating the effects of cognitive aids used during simulated paediatric resuscitation. Non interactive aids were used in 2 studies (26, 25), a CPR checklist (26), or an electronic decision support tool (25). Interactive aids were used in 4 studies (24, 4, 3, 2), a Tablet App (24, 4), a Personal Digital Assistant App (3), or a Smartphone App (2).For the important outcome of errors in medication dosage, we identified very low quality evidence (downgraded for very serious risk of bias and serious indirectness) from 2 randomised trials (2, 3). one study reported less medication errors using a mobile App compared with conventional method (2). in the another study all the participants (n=17) dosed epinephrine appropriately using computer-based resuscitation tool compared with only 1 participant in the control group (n=17) (3). For the important outcome time to medication preparation and administration, we identified moderate quality evidence (downgraded for serious indirectness) from 1 randomised trial (2), demonstrating significant decrease in time to drug preparation and drug delivery with the use of the cognitive aids (mobile App). For the important outcome of CPR quality we found low quality evidence from 2 randomised trials (26, 4).	

	One study investigating the use of a checklist by 16 individuals in the intervention and control groups found no difference in CPR performance (26). One study investigating a decision support App with 32 teams in the intervention group and 75 teams in the two control arms also showed no difference in CPR quality metrics (4) For the important outcome of adherence to a protocol or process we found very low quality evidence (downgraded for very serious risk of bias and serious indirectness) from 2 randomised trials (3, 4). one study investigating a computer based resuscitation tool used by an individual with 19 participants in the intervention group examined the use of a computer based resuscitation tool by an individual, found improvement in the number of tasks completed with the tool compared to the19 participants in the control group. Other time relevant interventions showed no benefit (3). one study investigating a decision support App with 32 teams in the intervention group and 75 teams in the two control arms found significantly less deviations from guideline recommendations in the intervention groups (4). For the important outcome of non-technical team performance (assessed using TEAM and BAR scores) we found very low quality evidence (downgrade for very	

	serious risk of bias and serious indirectness) from one randomised trial (25). Negligible effect on non-technical performance were estimated in TEAM and BAR scores for all 35 teams used a non-interactive electronic decision support tool with non-technical skill prompts, 35 teams in the control group using memory alone and 35 teams using a combined technical and non-technical skills tool. For the less important outcome of user workload (assessed with NASA task load index score) we found very low quality evidence (downgraded for serious indirectness and very serious impression) from one observational study(24). 33 individual participants using a tablet App in the intervention arm had no significant difference in workload from the 15 participants in the control group. Healthcare Providers Managing Adult Advanced Life Support We found 8 studies (15, 16, 17, 6, 18, 5, 19, 20) investigating the effects of cognitive aids used during adult advanced life support simulated resuscitation. All the studies used interactive aids, a Smartphone App (15, 18, 19), a Tablet App (17, 6, 5), or a computer based clinical decision display system (16, 20).For the important outcome adherence to a protocol or process, we identified very low quality evidence (downgraded for very serious risk of bias and serious indirectness and very serious imprecision) from 8 randomised trials (15, 20, 19, 5, 18, 6, 17, 16).	

	Four studies (15, 17, 18, 19) investigated the use of interactive telephone Apps. Two studies reported improved performance scores (15, 19). Two studies (17, 18) demonstrated significantly improved adherence to correct sequences and reduce errors of commission. One study using an interactive computer prompt device demonstrated little difference in performance between the intervention group and control group in managing familiar algorithms but improved performance in the intervention group when managing less familiar protocols (20). Another study using an interactive large scree clinical decision display system seen by the team demonstrated a number of interventions performed closer to ACLS recommendations (16). Two studies (5, 6) with 40 teams participating in the intervention groups and 39 teams in the control groups investigated the use of interactive table Apps. One study (6) showed improved performance scores in the intervention group. One study (5) showed variable results between the intervention and control group. For the less important outcome of user workload (assessed with NASA task load index score) we found very low quality evidence (downgraded for very serios risk of bias and serious indirectness) from one randomised trial (6). 32 teams using an interactive tablet App in the	

	intervention group indicated significantly lower mental demand, physical demand and effort. Healthcare Providers Managing Other Emergencies We found 6 studies (7, 28, 29, 21, 23, 27) investigating the effects of cognitive aids used by healthcare providers managing other emergencies in simulated events. All of the studies used non interactive aids, checklists (29, 21, 28, 7, 23), or a Resuscitation Situation Display (27).For the important outcome adherence to a protocol or process, we identified very low quality evidence (downgraded for very serious risk of bias and serious imprecision) from 3 randomised trials (7, 28, 29). two studies (29, 28) with a total of 79 participants in each of the intervention and control groups demonstrated highly significant increases in average performance scores (28) and reduced failure to adhere to critical steps (29). two studies with 607 participants in 85 teams in the intervention and 95 teams in control groups demonstrated that using a medical emergency checklist resulted in 9% absolute and 15% relative risk reduction of failure to adhere to guideline-adherent critical process steps. All teams had a lower failure rate for adherence to key processes with the intervention (7) . With a checklist the intervention groups had significantly shorter time to adequate administration of glucose in the hypoglycaemic coma scenario (median times 632s with checklist, 756s without checklist, p=0.03) but did not shorten time to	

	performance of the other nine emergency interventions. Access to crisis checklists had no impact on whether emergency interventions were carried out or not (21) For the important outcome CPR performance and retention, we identified very low quality evidence (downgraded for very serious risk of bias, serious indirectness and serious imprecision) from 1 randomised trial (23) indicating long check lists superior to short checklist or no checklist for overall performance on procedural variables but not for CPR quality. For the important outcome Teamwork, simulation study (assessed with: Clinical Teamwork scale (CTS), we identified low quality evidence (downgraded for serious risk of bias and serious indirectness) from 1 observational trial (27) involving 3 teams in the intervention and control groups. The study found using a non-interactive situation display, resuscitation teamwork, as measured by the CTS, was overall better in the intervention group. For the less important outcome of situational awareness (assessed with Situational Awareness Global Assessment Technique, SAGAT) we found low quality evidence (downgraded for serious risk of bias and serious indirectness) from one observation study (27) involving 3 teams in the intervention and control group. The study found no difference with using a non-interactive situation display in either group.	

	Laypersons Delivering Resuscitation We found 9 studies, 7 randomised trials (32, 9, 10, 33, 13, 12, 34) and 2 observational studies (8, 11), investigating the effects of cognitive aids used by lay rescuers during simulated resuscitation. Non interactive aids were used in 4 studies (32, 33, 13, 34), Smartphone Apps (32, 33), a flowchart (13), or an instruction card (34). Interactive aids were used in 5 studies (8, 9, 10, 11, 12), Smartphone Apps (9, 12), Personal Digital Assistant Apps (8, 10), or a Chatbot (11). For the important outcome of adherence to a protocol or process assessed by a performance score, we identified very low quality evidence (downgraded for very serious risk of bias, serious inconsistency and very serious impression) from 5 randomised trials (32, 9, 33, 12, 34) with a total of 171 participants in the intervention groups and 190 participants in the control groups. three studies (32, 9, 33) investigating the use of mobile phone applications, demonstrated improved adherence to a process measured using a checklist or performance score. One study (12) investigating a mobile phone application using yes/no questions found no significant improvement. one study investigating the use of an instruction card by individuals found improved adherence to the sequence of AED use and improved time to shock (34).	

	For the important outcome of adherence to a protocol or process assessed with an Objective Structured Clinical Examination (OSCE) score, we found low quality evidence (downgraded for very serious indirectness) from one observational study (8). Investigating the use of speech recognition software on a personal digital assistant device, with 49 participants in the intervention group and 56 participants in the control group, the study demonstrated improved OSCE points scores. For the important outcome of quality of CPR we identified very low quality evidence (downgraded for very serious risk of bias, serious inconsistency and serious indirectness) from 2 randomised trials (10, 13) with 58 participants in intervention groups and 56 participants in the control groups. one study (10) investigating the use of a voice activated visual and auditory assisted decision device, demonstrated improved adherence to a 30:2 CPR ratio. one study (13) investigating the use of a flowchart demonstrated reduced hands off time during CPR. We also identified moderate quality evidence (downgraded for serious indirectness) from one observational study (11)with 21 participants investigating the feasibility of Chatbot guidance which demonstrated thirty-three percent of participants achieved high-quality CPR, 86% achieved quality chest release, 38% did so in depth of compressions and only 5% in compression rate.	

	24% achieved a mean depth between 50 and 60 mm and 62% achieved a mean rate between 100 and 120 c/min.	
Undesirable Effects How substantial are the undesirable anticipated effects?		
Judgement	Research evidence	Additional considerations
○ Trivial ○ Small ● Moderate ○ Large ○ Varies ○ Don't know	Laypersons Delivering Resuscitation We found very low quality evidence from 3 studies (10, 33, 13) with a total of 255 participants that demonstrated potentially undesirable effects. Two studies (10, 13) identified significant increase in time to commencing chest compressions. One study (33) found delays in calling emergency services and delays in commencing chest compressions.	In laypersons, the use of cognitive aids may ● promote fixation errors and groupthink(39) ● impair communication among team members(40) ● be distracting especially when not developed well (flow, colour, how easy to read, confusing to follow etc) and may worsen performance/patient outcome
Certainty of evidence What is the overall certainty of the evidence of effects?		
Judgement	Research evidence	Additional considerations

○ Very low ● Low ○ Moderate ○ High ○ No included studies	Health Care Providers Managing Resuscitation in Neonates The certainly of evidence was moderate for medication error outcomes and very low for adherence to protocol or process outcome Downgrades for serious indirectness and very serious imprecision Healthcare Providers Managing Paediatric Resuscitation The certainly of evidence was very low or low for most outcomes. For one outcome (medication timing) the certainty of evidence was moderate RCT downgrades for serious to very serious risk of bias and serious indirectness Non RCT downgrades for serious indirectness and very serious imprecision Healthcare Providers Managing Adult Advanced Life Support The certainty of evidence was very low Downgrades occurred for very serious risk of bias, serious indirectness and very serious imprecision Healthcare Providers Managing Other Emergencies The certainly of evidence was very low in two four outcomes and low in the other two	

	RCT downgrades for very serious risk of bias serious indirectness and serious imprecision Non RCT downgrades for serious risk of bias and serious indirectness Laypersons Delivering or Learning to Deliver Resuscitation The certainty of evidence was low or very low for three of four outcomes. One outcome (quality of CPR) was moderate RCT downgrades for very serious risk of bias, serious inconsistency, serious indirectness and very serious imprecision Non RCT downgrades for serious and very serious indirectness	
Values Is there important uncertainty about or variability in how much people value the main outcomes?		
Judgement	Research evidence	Additional considerations
○ Important uncertainty or variability ○ Possibly important uncertainty or variability ● Probably no important uncertainty or variability	We found no evidence for the use of cognitive aids by trained health care providers during actual resuscitation events. Good neurological function is a valued patient outcome however we found no studies evaluating this.	Despite all outcomes being assessed in simulated resuscitation, the main outcomes may be valued as surrogate for actual resuscitation performance in patients with cardiac arrest.

○ No important uncertainty or variability		
Balance of effects Does the balance between desirable and undesirable effects favor the intervention or the comparison?		
Judgement	Research evidence	Additional considerations
○ Favors the comparison ○ Probably favors the comparison ○ Does not favor either the intervention or the comparison ● Probably favors the intervention ○ Favors the intervention ○ Varies ○ Don't know	See listed outcomes under desirable and undesirable effects.	In contrast to the last systematic review in 2019 more randomized controlled trials in simulated resuscitation, indicate evidence for the desirable outcomes.
Resources required How large are the resource requirements (costs)?"		
Judgement	Research evidence	Additional considerations

○ Large costs ○ Moderate costs ○ Negligible costs and savings ○ Moderate savings ○ Large savings ○ Varies ● Don't know	No studies analysed costs of the development and implementation/resources. Displayed aids might be more difficult to implement than handheld cognitive aids.	Costs of development, dissemination and implementation of cognitive aids needs to be considered and investigated. These may vary from moderate costs for checklists or providers downloading an app onto their personal phone to higher costs for wearable applications. There may also be cost implications related training to use the cognitive aid
Certainty of evidence of required resources What is the certainty of the evidence of resource requirements (costs)?		
Judgement	Research evidence	Additional considerations
○ Very low ○ Low ○ Moderate ○ High ● No included studies	No studies analysed costs of resources.	
Cost effectiveness Does the cost-effectiveness of the intervention favor the intervention or the comparison?		

Judgement	Research evidence	Additional considerations
○ Favors the comparison ● Probably favors the comparison ○ Does not favor either the intervention or the comparison ○ Probably favors the intervention ○ Favors the intervention ○ Varies ○ No included studies	No studies analysed cost effectiveness	Despite no evidence being found, the use of cognitive aids may be cost effective for health care providers as it may potentially favour an improved outcome for resuscitation.
Equity What would be the impact on health equity?		
Judgement	Research evidence	Additional considerations
○ Reduced ○ Probably reduced ○ Probably no impact ○ Probably increased ○ Increased ○ Varies ● Don't know	There is no perceived impact on health equity.	Despite no evidence being found, we do not believe that the use of cognitive aids would have a negative effect on equity and may be cost effective for health care providers as it may potentially favour an improved outcome for resuscitation.
Acceptability		

Is the intervention acceptable to key stakeholders?		
Judgement	Research evidence	Additional considerations
○ No ○ Probably no ● Probably yes ○ Yes ○ Varies ○ Don't know	No studies assessed that category.	Cognitive aids, such as checklists, are widely used in medicine the task force argues that such cognitive aids are accepted by resuscitation providers.
Feasibility Is the intervention feasible to implement?		
Judgement	Research evidence	Additional considerations
○ No ○ Probably no ● Probably yes ○ Yes ○ Varies ○ Don't know	None of the studies investigated offered evidence regarding implementation issues, such as training or resource-related considerations. Nonetheless, it seems reasonable to supply cognitive tools for resuscitation practitioners to use during both training and real-life resuscitation.	Implementing the use of cognitive aids seems to be feasible although there are costs associated with training and installing and maintenance of the necessary software in case of digital cognitive aids.

Summary of judgements

	Judgement						
Problem	No	Probably no	Probably yes	Yes		Varies	Don't know

	Judgement						
Desirable Effects	Trivial	Small	Moderate	Large		Varies	Don't know
Undesirable Effects	Trivial	Small	Moderate	Large		Varies	Don't know
Certainty of evidence	Very low	Low	Moderate	High			No included studies
Values	Important uncertainty or variability	Possibly important uncertainty or variability	Probably no important uncertainty or variability	No important uncertainty or variability			
Balance of effects	Favors the comparison	Probably favors the comparison	Does not favor either the intervention or the comparison	Probably favors the intervention	Favors the intervention	Varies	Don't know
Resources required	Large costs	Moderate costs	Negligible costs and savings	Moderate savings	Large savings	Varies	Don't know
Certainty of evidence of	Very low	Low	Moderate	High			No included studies

	Judgement						
required resources							
Cost effectiveness	Favors the comparison	Probably favors the comparison	Does not favor either the intervention or the comparison	Probably favors the intervention	Favors the intervention	Varies	No included studies
Equity	Reduced	Probably reduced	Probably no impact	Probably increased	Increased	Varies	Don't know
Acceptability	No	Probably no	Probably yes	Yes		Varies	Don't know
Feasibility	No	Probably no	Probably yes	Yes		Varies	Don't know

Type of recommendation

Strong recommendation against the intervention	Conditional recommendation against the intervention	Conditional recommendation for either the intervention or the comparison	Conditional recommendation for the intervention	Strong recommendation for the intervention
○	○	○	●	○

Conclusions

Recommendation

We suggest the use of cognitive aids by health care providers in resuscitation (weak recommendation, very low certainty of evidence).

We do not recommend the use of cognitive aids for lay providers initiating CPR (weak recommendation, low certainty of evidence).

We did not examine the use of cognitive aids in health professional or lay rescuer training in resuscitation so no recommendation for or against can be issued

Justification

In making this recommendation we recognise that:

The EIT Task Force continues to prioritise this topic because international resuscitation councils commonly provide cognitive aids to resuscitation course participants and health care organizations (algorithms, pocket cards, flowcharts, infographics, etc.). However, it has not been determined if they are effective in improving patient outcomes or provider performance during actual resuscitation, as no evidence was found for the use of cognitive aids by trained health care providers during actual resuscitation events.

In 2021 our evidence update focused on outcomes associated with CPR quality. In the review outcomes have been associated more towards improved team performance through adherence to protocol and process.

Our recommendation has been issued differentiating health care professionals and laypersons as well as for routine use of cognitive aids during resuscitation and training for these providers as the conditions between training and clinical resuscitation differs substantially.

For lay providers, there is consistent evidence that there are potentially clinically important delays in initiating CPR when using a cognitive aid; however, the evidence for impact on CPR quality metrics (e.g. rate, depth, chest compression fraction) is less consistent. We found insufficient evidence to issue a recommendation for the use of cognitive aids in layperson training.

For health care professionals sufficient new studies provided the evidence to issue a recommendation for the use of cognitive aids during training. As no study reported the use of cognitive aids during patient resuscitation, the simulation study results might be used as a surrogate to justify the use of cognitive aids as these have been used over decades by all resuscitation councils.

Due to no studies being found in resuscitation in the review in 2019, the Task Force has previously considered the trauma resuscitation environment sufficiently similar to the cardiopulmonary resuscitation environment to extrapolate evidence that shows that trauma resuscitation teams generally adhere to resuscitation guidelines better, make fewer errors and perform key clinical tasks more frequently if they use cognitive aids. Over the last few years sufficient new studies addressed the use of cognitive aids in resuscitation (however only in an simulation environment) the Task Force decided to exclude trauma studies in this review, as there may be important differences between the cardiac arrest and trauma resuscitation clinical environments.

There were several studies that used composite scores as their primary outcome (e.g. score calculated based on completion of several clinical tasks). We included these studies for this systematic review however, given their heterogeneity, comparing and consolidating the results was not possible.

We did not examine the use of cognitive aids in health professional or lay rescuer training in resuscitation and this needs to be examined in our next review.

Subgroup considerations

For health care providers and laypersons see considerations under “Justification”.

Implementation considerations

None of the studies examined provided evidence to describe implementation concerns, e.g. training or resource implications. However, it appears easy and feasible to provide cognitive aids for health care professionals applying resuscitation to use such cognitive aids during training and actual resuscitation.

Monitoring and evaluation

N.A

Research priorities

There is urgent need for adequately powered studies investigating the impact of cognitive aids in the real-world cardiac arrest environment on the neurologic intact survival of patients.

Effective implementation strategies during training and real-life resuscitation for health care providers.

Cost effectiveness studies on the use of cognitive aids during resuscitation and training.

Which cognitive aids are more effective than others?

High quality studies of the use of cognitive aids during health professional and layperson training.

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3. Immersive technologies for resuscitation teaching (EIT 6405 - SysRev)

Question

Should Immersive technologies vs. other methods of resuscitation training be used for neonatal, pediatric and adult basic life support training in laypersons and healthcare providers?	
Population:	All laypersons and healthcare providers in any educational setting
Intervention:	Immersive technologies (virtual reality, augmented reality, mixed reality, extended reality) as part of instructional design to train neonatal, pediatric, adult basic and advanced life support
Comparison:	other methods of resuscitation training in basic and advanced life support (e.g., traditional manikin-based simulation training, other).
Main outcomes:	Knowledge acquisition and retention, skills acquisition and retention, skill performance in real CPR, willingness to help, bystander CPR rate, and patients' survival.
Setting:	in any educational setting
Perspective:	Instructional strategies for resuscitation training programs are rapidly evolving with the introduction of new educational technologies. Virtual and augmented reality represent promising new developments that may help to improve learning and performance outcomes from resuscitation training programs.1990 to now
Background:	Virtual reality (VR) involves real-time simulation and interactions through sensorial channels created by a computer and displayed on a head-mounted or smartphone device1. Augmented reality (AR) is a computer-generated holographic image that is overlaid into the real environment, allowing the user to interact with both the hologram and real objects in an integrated fashion2. Both VR and AR technology has been used in educational settings for both laypersons and healthcare providers; it's overall impact on learning and performance outcomes is unclear.

Conflict of interests:	None declared

Assessment

Problem Is the problem a priority?		
Judgement	Research evidence	Additional considerations
○ No ○ Probably no ○ Probably yes ● Yes ○ Varies ○ Don't know	Resuscitation education is a key component of the formula for survival. Current methods of training lay people and healthcare providers are often falling short, resulting in poor skill acquisition and long-term skill decay. Identification of alternative educational strategies with improved learning outcomes will help to enhance process of care and patient outcomes from cardiac arrest. Virtual reality (VR) and augmented reality (AR) provide an immersive learning environment and represent a promising alternative to traditional instructor-led training,	VR and AR technologies can be used in different ways to support training, and can be combined with other instructional methodologies such as video, manikin-based training, and/or online learning. Implementation of immersive technology comes at a cost, for both hardware and software components. It will be important to define the relative contribution of VR, AR and/or other instructional design features to learning, and to identify the optimal educational strategy for lay people and healthcare providers.
Desirable Effects How substantial are the desirable anticipated effects?		

Judgement	Research evidence	Additional considerations
○ Trivial ● Small ○ Moderate ○ Large ○ Varies ○ Don't know	Three studies examined the use of augmented reality (AR) in Basic Life Support (BLS) training2-4. Two of these studies used augmented reality to provide real-time CPR feedback2, 4, while the other study used augmented reality to provide clinical guidance during training3. A total of 11 studies explored the use of virtual reality for basic life support, with eight studies assessing use amongst lay people5-12 and three studies evaluating VR use in healthcare providers13-15. Amongst these studies, the intervention groups all featured virtual reality as the primary instructional methodology, either alone5-7, 9-12 or in combination with other features such as a provider's guide or training module8, 14, 15, or gamification13. Control groups in the basic life support studies were variable and included: instructor-led training6, 7, 11, 12, 14, video or web-based training8-10, 15, mobile-app based training5, or a tablet-based serious game13. An additional three studies described VR use for ALS training in healthcare providers16-18. One study compared virtual reality-based training to traditional instructor-led ALS training16, another compared virtual reality supplemented by a provider's guide to standard training and video-based training with the provider's guide17, and the last study compared gamified virtual	Lack of consistency of findings, variability in design of control and intervention groups, and different types of outcome measures contribute to substantial heterogeneity for AR and VR studies and across sub-groups. As such, it is not feasible to perform a meta-analysis for any of the outcomes.

	reality training to instructor led neonatal resuscitation program training using high fidelity simulation18. We did not conduct a meta-analysis due to significant heterogeneity in the design of the interventions, control groups, participant types, and outcome measures. Evidence is described below in a narrative fashion. Augmented Reality Studies CPR Depth Two studies comprising 127 participants reported CPR depth performance with and without use of augmented reality during training2, 3Both studies demonstrated no significant difference in CPR depth performance between control and intervention groups2, 3. CPR Depth Compliance Only one study of 34 participants assessed CPR depth compliance after training. This study found that participants in the augmented reality group had significantly better CPR depth compliance compared to those who received traditional training without augmented reality4. CPR Rate	

	Two studies with a total of 127 participants evaluated CPR rate immediate after training. Amongst these two studies, there was no significant difference in CPR rate performance between control and intervention groups2, 3. CPR Rate Compliance One study found no significant difference in CPR rate compliance after training when compared participants trained with and without augmented reality-assisted feedback4. Overall CPR Performance Two studies with a total of 134 participants assessed overall CPR performance with mixed results. One study of 34 participants found significantly improved overall CPR performance in the augmented reality group4, while the other study comprised of 100 participants found significantly better overall CPR performance in the control group (CPR manikin with regular audiovisual feedback system)2. Virtual Reality Studies - BLS Knowledge Knowledge Acquisition	

	Five studies with a total of 431 participants assessed participant knowledge after training. One study assessed healthcare providers13 and four studies recruited laypeople as participants8-11. In three studies there were significantly higher knowledge scores with virtual reality training compared to other forms of non-VR training, such as a PC-tablet based serious game13, an e-learning module with video8 and video-based training9. Two studies showed no difference in participant knowledge when comparing VR training to traditional training11 or video-based training10. Knowledge Retention Retention of knowledge was evaluated in three studies with a total of 358 participants. One study with kindergarten teachers demonstrated improved knowledge retention at 5 weeks post-training in the virtual reality group compared to conventional video-based training9. Two other studies showed no difference in knowledge retention at 6 months between control and intervention groups6, 11. Virtual Reality Studies - Skills Outcomes for BLS Studies No Flow Time / Chest Compression Fraction Three studies with a total of 600 participants assessed no flow time or chest compression fraction at the end of	

	training7, 14, 15. In one study, adult lay people in the instructor-led training group had significantly greater chest compression fraction during assessment compared to those trained with virtual reality7. For the outcome of no flow time, results were mixed, with one study favoring virtual reality over web-based BLS training15, and the other study favoring conventional BLS training over VR-based training14. CPR Depth Four studies comprising 724 participants reported CPR depth performance after training5, 7, 11, 12. Two of the studies who recruited adult lay people demonstrated significantly better CPR depth in the control group compared to those who received virtual reality training5, 7. The other two studies demonstrated no significant difference in CPR depth performance between groups11, 12. CPR Depth Compliance Only one study of 352 adult lay people as participants assessed CPR depth compliance after training. This study found that participants in the instructor-led CPR training group has significantly better CPR depth compliance compared to those who received virtual reality training7.	

	CPR Rate Three studies with a total of 483 participants evaluated CPR rate immediate after training. One study demonstrated higher CPR rate in the intervention group, however both control and intervention groups were within the suggested guideline range for CPR rate7; the other two studies found no difference in CPR rate performance between control and intervention groups5, 12. CPR Rate Compliance For the outcome of CPR rate compliance, two studies (593 participants) reported mixed results, with one study showing significantly improved rate compliance in the control group (instructor-led training)7, and the other study showing no difference between groups11. Chest Recoil Compliance Three studies evaluated chest recoil compliance after training. Two studies demonstrated no difference between groups11, 12, and one study reported better chest recoil compliance amongst those who received virtual reality training compared to the control group7.	

	Overall CPR Performance For the outcome of overall CPR performance (i.e. CPR scores) after training, two studies found no difference in scores when comparing virtual reality training to instructor-led training with lectures12, and when compared to video-based training10. Virtual Reality Studies - Skill Retention at 6 months: One study with 120 participants measured retention of CPR skills 6 months after training. Amongst university students, there was no difference in CPR depth, rate, or chest recoil performance at 6 months between those who received traditional training and those trained using virtual reality11. Virtual Reality Studies - Willingness to perform CPR One study with 188 participants recruited adult lay people to instructor-led CPR training or VR-based CPR training, and found that those who received instructor-led CPR training were more willing to perform CPR at 6 months post-training6. Virtual Reality Studies - Outcomes for ALS studies	

	Knowledge One study with nursing students as participants compared neonatal resuscitation program with a high fidelity simulator to NRP training with virtual reality and showed no significant difference in knowledge scores between groups immediately post-training18. Adherence to Guidelines In a study of ACLS certified clinicians, participants were randomized to receive traditional ACLS training (control), VR training with comprehensive feedback, or VR training with limited feedback16. This study found significantly improved adherence to guidelines amongst participants who received traditional training compared to those who received VR training with limited feedback. There was no significant difference in adherence to guideline when comparing the control group to VR training with comprehensive feedback. Clinical Performance One study recruited nurses and midwives and compared standard HBB training to VR-based HBB training, and assessed clinical performance using a standardized OSCE test. They found no significant difference in OSCE scores	

	between groups immediately post training and at 6 months post training17.	
Undesirable Effects How substantial are the undesirable anticipated effects?		
Judgement	Research evidence	Additional considerations
● Trivial ○ Small ○ Moderate ○ Large ○ Varies ○ Don't know	There were no detrimental effects of augmented reality or virtual reality-based training described in the studies identified in this review.	No data were found on the cost for development or maintaining of AR or VR systems and its undesirable effect for educational organisations or institutions.
Certainty of evidence What is the overall certainty of the evidence of effects?		
Judgement	Research evidence	Additional considerations
● Very low ○ Low ○ Moderate ○ High ○ No included studies	Augmented Reality Studies The quality of evidence was very low for skills outcomes, and downgraded for risk of bias, indirectness and inconsistency. Virtual Reality Studies	

	The quality of evidence was very low across all outcomes, and downgraded for risk of bias, indirectness and inconsistency.	
Values Is there important uncertainty about or variability in how much people value the main outcomes?		
Judgement	Research evidence	Additional considerations
○ Important uncertainty or variability ○ Possibly important uncertainty or variability ● Probably no important uncertainty or variability ○ No important uncertainty or variability	Knowledge and skills outcomes from resuscitation education studies are generally accepted as important outcomes. No studies on AR or VR examined skill performance in real cardiac arrest, bystander CPR rates, or patient survival.	
Balance of effects Does the balance between desirable and undesirable effects favor the intervention or the comparison?		
Judgement	Research evidence	Additional considerations

○ Favors the comparison ● Probably favors the comparison ○ Does not favor either the intervention or the comparison ○ Probably favors the intervention ○ Favors the intervention ○ Varies ○ Don't know	Augmented Reality Amongst the studies assessing the use of AR for BLS training, there was no difference between groups for the outcomes of CPR depth, CPR rate, and CPR rate compliance; mixed results for overall CPR performance, and one small study favoring AR-based training for CPR depth compliance. Overall, the evidence for AR in BLS training does not favor either the intervention or the comparison. No study was found for Advanced life support. Virtual Reality The majority of studies assessing the use of virtual reality for BLS training showed either better CPR skills outcomes for non-VR trained providers, or no difference in CPR skills outcomes between control and intervention groups. Additionally, those who received instructor-led training were more willing to perform CPR at 6 months post-training. Knowledge outcomes from VR BLS studies either favored VR training or showed no difference between groups. Studies assessing the use of VR for ALS training either favored non-VR trained providers or showed no difference in outcomes between groups. Overall, the evidence for VR in BLS training probably favors the control.	Augmented reality and virtual reality should be considered as separate teaching modalities as the technologies were used differently in the studies identified in this review.
Resources required		

How large are the resource requirements (costs)?"		
Judgement	Research evidence	Additional considerations
○ Large costs ● Moderate costs ○ Negligible costs and savings ○ Moderate savings ○ Large savings ○ Varies ○ Don't know	No evidence available.	Significant start-up costs may be associated with purchasing hardware and software required for virtual or augmented reality-based resuscitation training. This may vary depending on the type of hardware and software and the complexity and nature of content required. Associated space will also be required for immersive technology-based training. No study investigated the economic impact of AR or VR on education.
Certainty of evidence of required resources What is the certainty of the evidence of resource requirements (costs)?		
Judgement	Research evidence	Additional considerations
○ Very low ○ Low ○ Moderate ○ High ● No included studies	No evidence available.	Cost may be variable depending on the pre-existing resources within different programs. While there are certainly start-up costs associated with implementing immersive

		technology, there are also costs related to traditional manikin-based training (e.g. manikins, feedback devices etc.).
Cost effectiveness Does the cost-effectiveness of the intervention favor the intervention or the comparison?		
Judgement	Research evidence	Additional considerations
○ Favors the comparison ○ Probably favors the comparison ○ Does not favor either the intervention or the comparison ○ Probably favors the intervention ○ Favors the intervention ○ Varies ● No included studies	No evidence available.	Over time, the start-up costs associated with immersive technologies may be mitigated by ongoing savings in other areas, such as less instructor time or reduced space requirements for training. Future studies are required to assess the cost-effectiveness of training.
Equity What would be the impact on health equity?		
Judgement	Research evidence	Additional considerations

○ Reduced ○ Probably reduced ○ Probably no impact ○ Probably increased ○ Increased ○ Varies ● Don't know	No evidence available.	Virtual or augmented reality-based training may improve accessibility to those in more remote locations where instructors or manikins are not available. However, virtual and augmented reality requires hardware and software, which may potentially serve as a barrier if these resources are not available.
Acceptability Is the intervention acceptable to key stakeholders?		
Judgement	Research evidence	Additional considerations
○ No ○ Probably no ○ Probably yes ○ Yes ○ Varies ● Don't know	No evidence available.	Virtual and augmented reality are emerging and new technologies, so acceptability amongst key stakeholders is highly variable and likely to evolve over time.
Feasibility Is the intervention feasible to implement?		
Judgement	Research evidence	Additional considerations

○ No ○ Probably no ○ Probably yes ○ Yes ● Varies ○ Don't know	No evidence available.	Feasibility will depend upon the local setting, and available resources (initial and ongoing).

Summary of judgements

	Judgement						
Problem	No	Probably no	Probably yes	Yes		Varies	Don't know
Desirable Effects	Trivial	Small	Moderate	Large		Varies	Don't know
Undesirable Effects	Trivial	Small	Moderate	Large		Varies	Don't know
Certainty of evidence	Very low	Low	Moderate	High			No included studies
Values	Important uncertainty or variability	Possibly important uncertainty or variability	Probably no important uncertainty or variability	No important uncertainty or variability			
Balance of effects	Favors the comparison	Probably favors the comparison	Does not favor either the intervention	Probably favors the intervention	Favors the intervention	Varies	Don't know

	Judgement						
			or the comparison				
Resources required	Large costs	Moderate costs	Negligible costs and savings	Moderate savings	Large savings	Varies	Don't know
Certainty of evidence of required resources	Very low	Low	Moderate	High			No included studies
Cost effectiveness	Favors the comparison	Probably favors the comparison	Does not favor either the intervention or the comparison	Probably favors the intervention	Favors the intervention	Varies	No included studies
Equity	Reduced	Probably reduced	Probably no impact	Probably increased	Increased	Varies	Don't know
Acceptability	No	Probably no	Probably yes	Yes		Varies	Don't know
Feasibility	No	Probably no	Probably yes	Yes		Varies	Don't know

Type of recommendation

Strong recommendation against the intervention	Conditional recommendation against the intervention	Conditional recommendation for either the intervention or the comparison	Conditional recommendation for the intervention	Strong recommendation for the intervention
○	●	○	○	○

Conclusions

Recommendation

We suggest either the use of augmented reality or traditional methods for basic life support training of lay people and healthcare providers (weak recommendation, very low quality of evidence).

We suggest against the use of virtual reality for basic and advanced life support training of lay people and healthcare providers (weak recommendation, very low quality of evidence).

Justification

Augmented reality

- evidence was equivocal and very low quality

- only a few studies were identified

- two studies used augmented reality-based feedback, and one for clinical guidance (i.e. different applications of the technology)

- control groups were different across these 3 studies (some included CPR feedback, others did not)

Virtual Reality

- evidence was predominantly in favor of non-VR based training and very low quality

- very heterogeneous with respect to type of intervention, type of control, outcome measures

Subgroup considerations

NA

Implementation considerations

Set up costs for implementing immersive technologies should be considered and may be significant depending on resource availability.

Monitoring and evaluation

NA

Research priorities

We identified several knowledge gaps in the literature

- The relative and synergistic effect of immersive technologies when combined with other educational strategies (e.g. video, gamification, feedback etc) is unclear.

- Both augmented reality and virtual reality can be used in many different ways; the effects of these different applications should be described and explored further.

- The impact of immersive technology on knowledge and skill retention is poorly described and need to be further elucidated.

- The effect of immersive technology-based training on team-based skill performance and process measures (e.g. time to epinephrine, time to defibrillation) needs to be explored further.

- The role of the instructor when immersive technology is being used needs to be clarified - for example, when is it beneficial for the instructor to provide feedback, and what type of training does the instructor require when using immersive technology in resuscitation courses?

- The costs associated with implementing and maintaining augmented reality and virtual reality, as well as its cost effectiveness need to be explored further.

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4. Gamified learning vs. other forms of resuscitation learning (EIT 6412 - SysRev)

QUESTION

Should gamified learning vs. non-gamified learning be used for life support training?	
POPULATION:	Learners training in basic or advanced life support
INTERVENTION:	Instruction using gamified learning (use of game-like elements in the context of training (e.g. point systems, intergroup competition, leaderboards, scaffolded learning with increasing challenge, 'medals' or 'badges'))
COMPARISON:	Compared to traditional instruction or other forms of non-gamified learning
MAIN OUTCOMES:	Skill -- overall CPR performance; Skill -- CPR rate and depth; Knowledge -- NRP; Knowledge -- BLS and ALS; Skill -- ALS scenario score; Skill -- NRP scenario score; Skill -- time to PPV in neonatal resuscitation simulation; Skill -- pediatric epinephrine dosing; Knowledge -- pediatric epinephrine dosing; Attitude -- affective responses;
SETTING:	Life support education for healthcare providers/trainees and laypersons
PERSPECTIVE:	
BACKGROUND:	Increased familiarity and ease with technology and digital media are features of younger and upcoming generations. More effective teaching strategies for these learners may include a greater degree of stimulation and engagement using active participation with and alongside peers. Gamification refers to the use of game-like elements, usually in a digital format, to encourage interactive and intuitive participation by learners. Some preliminary studies have found that gamified learning (GL) results in improved knowledge and skill during CPR training, either alone or used as pre-training to a standard life support course; other studies have found no significant difference.
CONFLICT OF INTERESTS:	none

ASSESSMENT

Problem
Is the problem a priority?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ No ○ Probably no ● Probably yes ○ Yes ○ Varies ○ Don't know	Increased familiarity and ease with technology and digital media are features of younger and upcoming generations. More effective teaching strategies for these learners should include a greater degree of stimulation and engagement using active participation with and alongside peers. Gamification refers to the use of game-like elements (competition, point systems, scaffolded levels of difficulty, leaderboards) to encourage interactive and intuitive participation by learners.	While some examples in the review include simple game formats (e.g. board games, card games), the majority of examples include technology-dependent methods (e.g. video, computer, or smartphone based).

Desirable Effects
How substantial are the desirable anticipated effects?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ Trivial ● Small ○ Moderate ○ Large ○ Varies ○ Don't know	<u>Skill -- CPR overall performance</u> We included four randomized controlled trials (RCTs) with 900 intervention subjects and 789 controls. One observational study of 92 subjects was included. One RCT in nursing students using an online competitive platform for CPR performance found improved scores compared with non-users ($p<0.05$).[1] Two RCTs in pediatric healthcare providers used a leaderboard to monitor competition in CPR performance during refresher training sessions; one single center study found significantly better performance in leaderboard group ($p<0.001$)[2]; the other multicenter RCT found no effect.[3] One RCT in laypeople using team competition in CPR performance during training found better CPR performance in the competition group than controls ($p<0.05$).[4] One observational study of laypeople using a screen-based competition at CPR performance found improved performance 6 months post training (score 23% vs. 16%, $p<0.05$).[5] <u>Skill -- Chest compression rate and depth</u> We included one observational study of 65 high school students participating in a CPR "tournament" during Basic Life Support (BLS) training via a screen-based interface. Immediately post training, chest compression (CC) depth (45 vs 31 mm, $p<0.01$) and CC rate (111 vs 94, $p<0.01$) were improved from baseline. At 3 months, depth and rate remained improved over baseline but no different than immediately post training.[6] <u>Knowledge -- NRP</u> We included two observational studies of healthcare providers. One study of a board game using Neonatal Resuscitation Program (NRP) knowledge showed improved scores after playing (61% vs 49%, $p<0.001$).[7] One study of a screen-	No studies of clinical outcomes in patients

	based point system-based game in NRP led to higher scores 6 months post training (p<0.001) but no difference immediately post training.[8] Knowledge -- ALS We included two RCTs in healthcare providers with 145 intervention subjects and 144 controls. One RCT using a phone-based team game involving identifying keywords found greater improvement in scores on a multiple choice question test following life support training (p<0.05).[9] One RCT using a smartphone-based game involving Advance Life Support (ALS) scenarios with a point system during and before an ALS course found higher scores on an ALS algorithm test among game users (17 vs 16, p=0.01).[10] Skill -- ALS scenario score We included one RCT in healthcare providers with 53 intervention subjects and 52 controls. Intervention subjects used a smartphone-based game involving ALS scenarios before and during an ALS course. Scores were not significantly different between groups (79% vs 66%, p=0.09).[10] Skill -- NRP scenario score One observational study of using an online gaming portal involving NRP training found improved scores following game use (p<0.001).[11] Skill -- time to PPV in NRP scenario One observational study of using an online gaming portal involving NRP training found faster time to positive pressure ventilation in a neonatal scenario (p=0.04).[11] Skill -- pediatric epinephrine dosing We included one observational study of nurses using a leaderboard during a study period of repeated practice at preparing weight-based epinephrine dosing. Over the study period, average time to dose prep decreased by 27 seconds (p=0.02); the proportion of learners completing the task in < 2 minutes increased from 23% to 59% (p=0.03).[12] Knowledge -- pediatric epinephrine dosing We included one observational study of nurses using a leaderboard during a study period of repeated practiced at preparing weight-based epinephrine dosing. Over the study period, the proportion of learners knowing the correct concentration of epi increased from 19% to 71% (p<0.001).[12] Affective responses One RCT using a smartphone-based game in ALS training led to better self-reported confidence among users.[10] One study of a card game to enhance NRP knowledge had high levels of perceived usefulness among surveyed learners post-study.[13]	
Undesirable Effects How substantial are the undesirable anticipated effects?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**

● Trivial ○ Small ○ Moderate ○ Large ○ Varies ○ Don't know	No studies found negative effects on learner outcomes.	No studies examined the impact of GL on stress or cognitive load of learners; it seems intuitive that these constructs may be positively exploited to enhance engagement and learning if GL is effective.

Certainty of evidence

What is the overall certainty of the evidence of effects?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
● Very low ○ Low ○ Moderate ○ High ○ No included studies	The quality of evidence was very low across all outcomes, and downgraded for risk of bias, inconsistency, indirectness, and imprecision.	

Values

Is there important uncertainty about or variability in how much people value the main outcomes?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ Important uncertainty or variability ● Possibly important uncertainty or variability ○ Probably no important uncertainty or variability ○ No important uncertainty or variability	Two studies reported favorable affective responses following training from learners.[10, 13]	

Balance of effects

Does the balance between desirable and undesirable effects favor the intervention or the comparison?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ Favors the comparison ○ Probably favors the comparison ○ Does not favor either the intervention or the comparison ● Probably favors the intervention ○ Favors the intervention ○ Varies ○ Don't know	The majority of studies found a positive impact of GL on learner outcomes; while some studies found no effect on some domains, there were no published studies demonstrating a negative outcome on learners.	The value of GL should also be examined from the perspective of instructors and designers of learner curricula.

Resources required

How large are the resource requirements (costs)?"

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ Large costs ○ Moderate costs ○ Negligible costs and savings ○ Moderate savings ○ Large savings ○ Varies ● Don't know	No published studies examined cost effectiveness of GL.	Most GL elements used either video-, computer-, virtual reality-, or smartphone-based programs as platforms for GL. There were no studies that specifically described the cost or necessary resources for such methods.

Certainty of evidence of required resources

What is the certainty of the evidence of resource requirements (costs)?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ Very low ○ Low ○ Moderate ○ High ● No included studies	No published studies examined resource utilization associated with GL.	

Cost effectiveness

Does the cost-effectiveness of the intervention favor the intervention or the comparison?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ Favors the comparison ○ Probably favors the comparison ○ Does not favor either the intervention or the comparison ○ Probably favors the intervention ○ Favors the intervention ○ Varies ● No included studies	No published studies examined cost effectiveness of GL.	

Equity

What would be the impact on health equity?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ Reduced ○ Probably reduced	No published studies.	Access to digital technology platforms is likely to be a potentially limiting factor in resource-limited

○ Probably no impact ○ Probably increased ○ Increased ○ Varies ● Don't know		settings. Smartphone-based platforms may be more available in such settings.

Acceptability

Is the intervention acceptable to key stakeholders?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ No ○ Probably no ○ Probably yes ○ Yes ● Varies ○ Don't know	Two studies reported favorable affective responses following training from learners.[10, 13]	

Feasibility

Is the intervention feasible to implement?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ No ○ Probably no ○ Probably yes ○ Yes ● Varies ○ Don't know	While most studies described the creation of the GL elements used in the research, there were no examples of studies determining how to feasibly implement the GL in other settings or with other groups of instructors or learners.	It is likely that different GL elements (e.g., technology dependent) will have greater demands in terms of implementation and instructor training.

SUMMARY OF JUDGEMENTS

	JUDGEMENT						
PROBLEM	No	Probably no	**Probably yes**	Yes		Varies	Don't know
DESIRABLE EFFECTS	Trivial	**Small**	Moderate	Large		Varies	Don't know
UNDESIRABLE EFFECTS	**Trivial**	Small	Moderate	Large		Varies	Don't know
CERTAINTY OF EVIDENCE	**Very low**	Low	Moderate	High			No included studies

	JUDGEMENT						
VALUES	Important uncertainty or variability	**Possibly important uncertainty or variability**	Probably no important uncertainty or variability	No important uncertainty or variability			
BALANCE OF EFFECTS	Favors the comparison	Probably favors the comparison	Does not favor either the intervention or the comparison	**Probably favors the intervention**	Favors the intervention	Varies	Don't know
RESOURCES REQUIRED	Large costs	Moderate costs	Negligible costs and savings	Moderate savings	Large savings	Varies	**Don't know**
CERTAINTY OF EVIDENCE OF REQUIRED RESOURCES	Very low	Low	Moderate	High			**No included studies**
COST EFFECTIVENESS	Favors the comparison	Probably favors the comparison	Does not favor either the intervention or the comparison	Probably favors the intervention	Favors the intervention	Varies	**No included studies**
EQUITY	Reduced	Probably reduced	Probably no impact	Probably increased	Increased	Varies	**Don't know**
ACCEPTABILITY	No	Probably no	Probably yes	Yes		**Varies**	Don't know
FEASIBILITY	No	Probably no	Probably yes	Yes		**Varies**	Don't know

TYPE OF RECOMMENDATION

Strong recommendation against the intervention	Conditional recommendation against the intervention	Conditional recommendation for either the intervention or the comparison	**Conditional recommendation for the intervention**	Strong recommendation for the intervention
○	○	○	●	○

CONCLUSIONS

Recommendation

The Task force suggests the use of Gamified Learning (GL) to be considered as a component of resuscitation training for all types of basic and advanced life support courses (weak recommendation, very low certainty of evidence).

Justification

Overall justification: GL was associated with improved learning outcomes in at least one domain (skill, knowledge, attitude) in all studies included in the review.
Detailed justification
Desirable Effects: All of the 13 studies in this review found a positive impact on one or more learning outcome domain (skill, knowledge, attitude).
Undesirable Effects: No specific undesirable effects among learners were found.

Subgroup considerations

11 of 13 studies used technology-dependent platforms (video, computer, smartphone) to deliver GL elements to learners.[1-6, 8-12] There is insufficient evidence to compare these GL elements to other less technology enhanced methods (e.g. board games).
Only 2 studies examined outcomes in laypeople (high school students).[5, 6]

Implementation considerations

The feasibility and ease of implementing elements of GL will likely vary greatly depending on the method(s) used and the level of technology required to deliver the content.
More research is needed to clarify the instructor training needs for GL implementation and the generalizability of access and use of GL in a consistent and reproducible manner.

Monitoring and evaluation

NA

Research priorities

-- more consistent definitions of 'gamification' across research studies (e.g. use of video-based content delivery alone does not necessarily constitute a 'game' although his term is frequently used to describe such training elements)
-- studies on dissemination of GL elements and platforms to varied learner groups and settings
-- studies on cost and time requirements for implementation of GL
-- association between GL elements and differences in stress and/or cognitive load
-- impact on care delivery and/or patient outcomes

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5. Rapid cycle deliberate practice in resuscitation training (EIT 6414 - SysRev)

QUESTION

Should Rapid Cycle Deliberate Practice vs. other approaches be used for resuscitation training?	
POPULATION:	Learners training in basic or advanced life support
INTERVENTION:	Instruction using Rapid Cycle Deliberate Practice
COMPARISON:	Compared to traditional instruction or other forms of learning without Rapid Cycle Deliberate Repetition
MAIN OUTCOMES:	Time to chest compressions; Time to recognize cardiac arrest; Time to ventilate; Time to defibrillation; Time to first epinephrine; Compression fraction / No-flow fraction; No-ventilation fraction; Defibrillation within 2 or 3 min; Defibrillation pre-pause; Quality of performance (adherence to protocol); Team leader performance; Self-reported confidence; Participants' subjective perception of the teaching effectiveness; Retention;
SETTING:	In any education setting

PERSPECTIVE:	The original definition for deliberate practice was proposed by Ericsson, considering deliberate practice as individualized training with lessons with a teacher, who designs practice activities for carrying out between meetings. However, deliberate practice is often confused with repetitive practice. Rapid Cycle Deliberate Practice (RCDP), introduced by Hunt, is a type of training in which debriefing occurs within the training.
BACKGROUND:	Traditionally, debriefing occurs the simulation (after-event debriefing with reflection on action), but it could also occur within the training (reflection in action). This is the case of RCDP, an approach characterized by a stop-and-go practice with immediate feedback on the performance and ample time for repetition to improve performance. The aim of this systematic review was found evidence about the use of Rapid Cycle Deliberate Practice compared to other approach teaching.
CONFLICT OF INTERESTS:	Nothing to declare

ASSESSMENT

Problem
Is the problem a priority?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ No ○ Probably no ○ Probably yes ● Yes ○ Varies ○ Don't know	Simulation-based training for resuscitation is an important approach to acquire knowledge and both technical and non-technical skills. Often times, participants are given limited opportunity to practice and master critical skills (i.e. individual and team-based skills) during training. Within that training plays debriefing a key role in acquiring the learning outcomes (9). However, debriefing characteristics are usually inconsistently described in clinical-simulation research (10). Traditionally, debriefing occurs after trainees finalize the simulated-scenario (after-event debriefing with reflection on action). RCDP addresses these issues by incorporating stop-and-go practice with immediate feedback on the performance and ample time for repetition to improve performance (1). This approach increases time of practice and aims to enhance training methodologies to produce improvements in clinical outcomes.	Key points of RCDP (1): - There is a goal to achieve. - Stop-and-go practice with immediate feedback on the performance. - Ample time for repetition to improve performance. - “Safe” environment, fostering an atmosphere where students have no fear to make mistakes and receive feedback from a constructive perspective.

Desirable Effects
How substantial are the desirable anticipated effects?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ Trivial ● Small ○ Moderate ○ Large ○ Varies ○ Don't know	Eight studies were identified which addressed the PICOST question comparing Rapid Cycle Deliberate Practice with after-event debriefing under simulated conditions (1, 7, 4, 2, 8, 6, 5, 3). Study cohorts were comprised of residents (1, 3, 4), interns (2, 8), physicians (6), medical students (5), and a mix of fellows, nurses and respiratory therapists (7), who were involved in adult (5, 6), pediatric (1, 3, 4, 7, 8) and neonatal (2) simulated scenarios. Most of the studies reported comparisons between RCDP and other approaches after a single session of simulation-based training, lasting 20-60 minutes (2, 3, 4, 5, 6, 7). Seven were randomized studies (2, 3, 4, 5, 6, 7, 8) and one an observational study with a	Certainty of evidence from the studies were downgraded because of risk of bias, inconsistency, indirectness, and imprecision.

	before-after design (1). In addition, seven of them referred directly to RCDP (1, 2, 3, 4, 6, 7, 8) and the other one used an "In simulation debriefing" during the clinical scenario meeting the key components of the RCDP (5). No studies reported clinical outcomes. Meta-analysis was performed only for one outcome (time to chest compressions) due to the low number of studies per outcome, heterogeneity in the study designs and the reported outcome measures. **Time to chest compressions:** For the important outcome **Time to chest compressions**, we identified very-low-certainty evidence (downgraded for risk of bias, inconsistency, indirectness and imprecision) from three randomized studies (4, 2, 3) enrolling 66 participants tested individually and 41 teams, which showed no benefit from the use of Rapid Cycle Deliberate Practice when compared with after-event debriefing; the estimated standardized mean difference (SMD) for the outcome, using random effects model, was -0.1734 (95% CI: -0.6900 to 0.3431). Therefore, the SMD did not differ significantly from zero (z = -0.6581, p = 0.5105). In addition, in an observational study, participants of the RCDP group spent less time between the onset of pulseless ventricular tachycardia and initiation of chest compressions (1). **Time to recognize cardiac arrest:** One study assessed the time to recognize cardiac arrest with no differences between RCDP and after-event debriefing (6). **Time to ventilate:** One randomized study assessed time to positive pressure ventilations (from birth) (2), where participants in the intervention group initiated positive pressure ventilation within 1 minute more frequently than controls. The observational study measured time to use bag-valve mask (1), with no differences found between groups. **Time to defibrillation:** Four studies, 3 randomized studies (4, 6, 3) and 1 observational (1) study assessed time to defibrillation. The 3 randomized studies comprised 82 participants (RCDP: n=41; after-event debriefing: n=41). Two of the randomized studies found that participants from the RCDP group had significantly lower time between recognition of the rhythm and defibrillation (4, 6). In the observational study, participants of the RCDP group spent significantly less time between the onset of pulseless ventricular tachycardia and defibrillation (1). **Time to first epinephrine:** Two randomized studies assessed the time to the administration of epinephrine (4, 2). They comprised 75 participants (RCDP: n=37; after-event debriefing: n=38). One of the studies found that participants of the RCDP group had significantly shorter time to the administration of epinephrine than controls (2). **Compression fraction / No-flow fraction:** One randomized study evaluated compression fraction (6) and one observational study no-flow fraction (1). Both articles found significant differences between groups in favor of RCDP participants. **No-ventilation fraction:** The observational study analyzed the no-ventilation fraction (1), described as the proportion of time a pulseless patient received no respiratory support, and found differences between	

	groups in favor of RCDP participants. **Defibrillation within 2 or 3 min:** One randomized study evaluated successful defibrillation within 3 minutes (3) and the observational study within 2 minutes (1). In the randomized study, RCDP participants had more than 5 times the odds of defibrillation occurring within 3 minutes (3). The observational study, by means of hazard ratio, found that RCDP participants had 1.65 times the odds of defibrillating within 2 min (1). **Defibrillation pre-pause:** One randomized study (6) and the observational study (1) assessed defibrillation pre-pause. Both articles found that RCDP participants registered significantly shorter defibrillation pre-pause. **Quality of performance (adherence to protocol):** Three randomized studies evaluated quality of performance with different tools (7, 2, 8). RCDP participants reached higher scores of performance by using the Megacode Assessment Form (MCAF) (2), but no differences were found with the Simulation Team Assessment Tool (7) or Pediatric Advance Life Support performance (8). **Team leader performance:** One randomized study evaluated team leader performance, with significantly higher scores in the RCDP group (3). **Self-reported confidence:** Two randomized studies evaluated self-reported confidence (2, 5). One did not report specific information about the instrument (2). In the other study, both groups increased their confidence level with no differences between groups (5). **Participants' subjective perception of the teaching effectiveness:** One study aimed to analyze teaching effectiveness by means of 8 questions (5). In 3 of the 8 questions (help to learn effectively, help to understand the correct actions, effectiveness of the debriefing) the after-event debriefing group had high-median scores compared to the RCDP group. **Retention:** Retention of skills was analyzed in one randomized study (4-month follow-up) (2). No differences were found between groups in any variable (MCAF scores, time to positive pressure ventilations, time to chest compressions, time to epinephrine administration), although RCPD participants decreased the overall score of the MCAF in a higher proportion than controls.	

Undesirable Effects

How substantial are the undesirable anticipated effects?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS

● Trivial ○ Small ○ Moderate ○ Large ○ Varies ○ Don't know	One study reported differences in one outcome (teaching effectiveness) in favour of controls (5). No more differences in favour of controls were found in any outcome in any study.	This article was the one that used an "In simulation debriefing" during the clinical scenario meeting the key components of the RCDP.

Certainty of evidence

What is the overall certainty of the evidence of effects?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
● Very low ○ Low ○ Moderate ○ High ○ No included studies	The certainty of evidence was very low across all outcomes, and downgraded for risk of bias, inconsistency, indirectness, and imprecision.	Many outcomes were assessed only by one study or two (one observational and one randomized); the type of patient in the simulated scenario varied across the studies; outcomes measured in different ways across the studies.

Values

Is there important uncertainty about or variability in how much people value the main outcomes?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ Important uncertainty or variability ○ Possibly important uncertainty or variability ● Probably no important uncertainty or variability ○ No important uncertainty or variability	No studies reported outcomes in real cardiac arrest. One study showed that controls valued more the after-event debriefing compared with in-simulation debriefing (5). The rest of the manuscripts reported no differences or differences in favor of intervention.	This article was the one that used an "In simulation debriefing" during the clinical scenario meeting the key components of the RCDP.

Balance of effects

Does the balance between desirable and undesirable effects favor the intervention or the comparison?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ Favors the comparison ○ Probably favors the comparison ○ Does not favor either the intervention or the comparison ● Probably favors the intervention ○ Favors the intervention ○ Varies ○ Don't know	There was one outcome in which the effect favored comparators (teaching effectiveness) (5). There were three outcomes in which the effect did not favor either the intervention or the comparison: retention (2), time to recognize CA (6) and self-reported confidence (5). In most of outcomes there were found more articles that reported effects favored to intervention (time to chest compressions, time to defibrillate, compression fraction / No-flow fraction, no-blow fraction, defibrillation within 2 or 3 min, defibrillation pre-pause, Team leader performance, workload).	

Resources required

How large are the resource requirements (costs)?"

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ Large costs ○ Moderate costs ○ Negligible costs and savings ○ Moderate savings ○ Large savings ○ Varies ● Don't know	None of the studies evaluated resources required.	Development of a curriculum based on RCDP might be negligible costs and savings, but no evidence is available in this regard. However, resources for implementation or training of the instructors are topics not studied.

Certainty of evidence of required resources

What is the certainty of the evidence of resource requirements (costs)?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ Very low ○ Low ○ Moderate ○ High ● No included studies	No evidence available.	There was not found evidence about the resources for creating RCDP curriculums, training of instructors and implementation of the programs.

Cost effectiveness

Does the cost-effectiveness of the intervention favor the intervention or the comparison?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ Favors the comparison ○ Probably favors the comparison ○ Does not favor either the intervention or the comparison ○ Probably favors the intervention ○ Favors the intervention ○ Varies ● No included studies	No evidence available.	

Equity

What would be the impact on health equity?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ Reduced ○ Probably reduced	No evidence available.	

○ Probably no impact ○ Probably increased ○ Increased ○ Varies ● Don't know		

Acceptability
Is the intervention acceptable to key stakeholders?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ No ○ Probably no ● Probably yes ○ Yes ○ Varies ○ Don't know	The teaching effectiveness of RCDP approach was rated with high scores (5), and high levels of self-confidence were described by the participants after the training (5).	

Feasibility
Is the intervention feasible to implement?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ No ○ Probably no ○ Probably yes ○ Yes ○ Varies ● Don't know	Although two of the studies stated that RCDP was implemented as part of the training/curriculum (1, 8), none of the studies aimed to analyze variables related to the implementation such as instructor preference/workload or specific resources needed in comparison with other approaches. In addition, the implementation would depend on the characteristics of the setting (eg. short-term courses (few hours) vs long-term trainings (residents' training).	

SUMMARY OF JUDGEMENTS

	JUDGEMENT						
PROBLEM	No	Probably no	Probably yes	**Yes**		Varies	Don't know
DESIRABLE EFFECTS	Trivial	**Small**	Moderate	Large		Varies	Don't know
UNDESIRABLE EFFECTS	**Trivial**	Small	Moderate	Large		Varies	Don't know
CERTAINTY OF EVIDENCE	**Very low**	Low	Moderate	High			No included studies

	JUDGEMENT						
VALUES	Important uncertainty or variability	Possibly important uncertainty or variability	**Probably no important uncertainty or variability**	No important uncertainty or variability			
BALANCE OF EFFECTS	Favors the comparison	Probably favors the comparison	Does not favor either the intervention or the comparison	**Probably favors the intervention**	Favors the intervention	Varies	Don't know
RESOURCES REQUIRED	Large costs	Moderate costs	Negligible costs and savings	Moderate savings	Large savings	Varies	**Don't know**
CERTAINTY OF EVIDENCE OF REQUIRED RESOURCES	Very low	Low	Moderate	High			**No included studies**
COST EFFECTIVENESS	Favors the comparison	Probably favors the comparison	Does not favor either the intervention or the comparison	Probably favors the intervention	Favors the intervention	Varies	**No included studies**
EQUITY	Reduced	Probably reduced	Probably no impact	Probably increased	Increased	Varies	**Don't know**
ACCEPTABILITY	No	Probably no	**Probably yes**	Yes		Varies	Don't know
FEASIBILITY	No	Probably no	Probably yes	Yes		Varies	**Don't know**

TYPE OF RECOMMENDATION

Strong recommendation against the intervention	Conditional recommendation against the intervention	Conditional recommendation for either the intervention or the comparison	**Conditional recommendation for the intervention**	Strong recommendation for the intervention
○	○	○	●	○

CONCLUSIONS

Recommendation

Based on the evidence found in this systematic review the Task Force suggests that it may be reasonable to include Rapid Cycle Deliberate Practice as an instructional design feature of basic and advanced life support training (weak recommendation, very low quality of evidence).

Justification

Simulation-based training for resuscitation is an important approach to acquire knowledge and both technical and non-technical skills. Often times, participants are given limited opportunity to practice and master critical skills (i.e. individual and team-based skills) during training. Within that training plays debriefing a key role in acquiring the learning outcomes (9). However, debriefing characteristics are usually inconsistently described in clinical-simulation research (10). Traditionally, debriefing occurs after trainees finalize the simulated-scenario (after-event debriefing with reflection on action). RCDP addresses these issues by incorporating stop-and-go practice with immediate feedback on the performance and ample time for repetition to improve performance (1). This approach increases time of practice and aims to enhance training methodologies to produce improvements in clinical outcomes.

Direct evidence of the use of RCDP during resuscitation training were considered in informing the treatment recommendation.

- Although more differences in favor of RCDP were found across the studies, the only meta-analysis performed (time to chest compression) did not show a difference. Two of 4 studies found differences in this variable in favor of intervention group, one randomized (4) and one observational study (1). However, compression fraction was higher in the RDCP group in the two studies analyzed (1, 6).
- Different studies showed that RCDP group had shorter time to ventilate (1, 2), to deliver a shock (1, 4, 6), and to the administration of epinephrine (2).
- Two studies found that RCDP group had more odds of reaching defibrillation within 2 (1) and 3 min (3). Defibrillation pre-pause was also significantly shorter in intervention participants (1, 6).
- One study reported differences in one outcome (teaching effectiveness) in favor of controls (5). No more differences in favor of controls were found in any outcome in any manuscript.
- Findings were in favor of RCDP across many studies, but the majority of these studies had trainees as participants, thus making it difficult to generalize these findings to other groups such as experienced healthcare providers.

Subgroup considerations

No evidence available for laypeople, first responders (eg. lifeguards, firefighters...) or experienced healthcare providers.

Implementation considerations

For the implementation of Rapid Cycle Deliberate Practices would be necessary to educate to those personnel in charge of the training of residents, students, healthcare professionals.

Monitoring and evaluation

N/A

Research priorities

The following knowledge gaps were identified:

- The use of Rapid Cycle Deliberate Practice in other populations (laypeople, first responders, and experienced healthcare providers).
- The effect of Rapid Cycle Deliberate Practice after a medium/long-term follow-up.
- Resources required and costs of implementation of Rapid Cycle Deliberate Practice in simulation-based training curriculum of health care providers and other populations.
- The effect of the implementation of curriculums based on Rapid Cycle Deliberate Practice on clinical outcomes and patient survival.

- There is heterogeneity in the use of terms and a not standardized definition of Deliberate Practice and Rapid Cycle Deliberate Practice.

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6. Team competency training for resuscitation (EIT 6415 - SysRev)

QUESTION

Should training with a specific emphasis on teamwork competencies vs. training without a specific emphasis on teamwork competencies be used for life support training?	
POPULATION:	Learners undertaking life support training in any setting
INTERVENTION:	Life support training with a specific emphasis on teamwork competencies
COMPARISON:	Life support training without a specific emphasis on teamwork competencies
MAIN OUTCOMES:	Patient survival; CPR skill performance (course completion); CPR skill performance (beyond course completion but <1 yr); CPR skill performance (>1year); CPR quality (at course completion); CPR quality (beyond course completion but <1 year); CPR quality (> 1 year); Confidence (course completion); Confidence (beyond course completion but < 1 year); Confidence (> 1 year); Teamwork competencies (at course completion); Teamwork competencies (beyond course completion but < 1 year); Teamwork competencies >1 year); resources (time, equipment, cost)
SETTING:	Any setting of life support courses
PERSPECTIVE:	Teamwork competencies is considered to be an important barrier and facilitator for resuscitation. Investigating whether specific training of teamwork competencies improves learning following resuscitation training can impact the organization of resuscitation training worldwide and potentially improve patient care and survival outcomes.
BACKGROUND:	Resuscitation training is recommended to improve quality of care and survival outcomes following cardiac arrest. Teamwork competencies represent the interpersonal skills affecting the teamwork and is considered to be an important facilitator for clinical resuscitation. The International Liaison Committee on Resuscitation previously recommended use of specific leadership training for resuscitation courses based on very low-certainty evidence. This systematic review aimed to assess the effect of specific training on teamwork competencies as part of the resuscitation training.
CONFLICT OF INTERESTS:	Joyce Yeung had a grant to investigate introducing NTS to ALS course for Resuscitation Council UK and was excluded from study selection and bias assessment.

ASSESSMENT

Problem Is the problem a priority?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**

○ No ○ Probably no ○ Probably yes ● Yes ○ Varies ○ Don't know	No evidence was identified on the priority of this question. However, the International Liaison Committee on Resuscitation previously assessed whether specific leadership training improved learning following resuscitation training and recommended use of specific leadership training for resuscitation courses based on very low-certainty evidence (CoSTR 2020).	Resuscitation training is generally recognized as an important step to improve survival by resuscitation councils and is widely conducted all over the world. Training in teamwork competencies is generally recommended as part of the training and knowledge on the effect of including training on teamwork competencies is warranted.

Desirable Effects

How substantial are the desirable anticipated effects?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ Trivial ● Small ○ Moderate ○ Large ○ Varies ○ Don't know	**Survival** For the critical outcome of patient survival we identified one RCT which reported descriptive data on patient outcomes, reporting 11% patients died in intervention group vs 13% patients in control but not powered to make inferences. **CPR skill performance** For the important outcome of CPR skill performance at course completion, we found 11 studies (10 RCTs[3,4,7,8,11,12,13,14,16,17] and one before and after[1]). Four[1,4,11,14] of 6[1,3,4,11,12,14] studies reporting time to key resuscitation behaviours reported no significant difference between intervention and control groups. One RCT[12] reported significantly shorter time for 1 (time to chest compressions) of 5 behaviours measured and another[3] for 8 of 9 behaviours. Seven[4,8,12-14,16,17] of 8[1,4,8,12-14,16,17] studies reporting CPR performance scores found no significant difference between intervention and control groups and nor did single RCT[11] reporting rate of correct arm and shoulder positioning. One non-randomised study[1] reported higher median scores in a checklist of expected CPR acts in intervention group (95%) vs control (85%), p=0.001. A single RCT[7] reported adherence to ALS guidelines, finding greater adherence in intervention group (37.58) vs control (31.41), 95% CI: -10.3, -2.4, p=0.002). For the critical outcome of CPR skill performance beyond course completion, we found 4 RCTs[4,11,13,17]. Two[13,17] reported no significant difference in performance scores at 4 months[17] and 6 months[13]. One RCT[4] 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 group (70%) vs control (62%), p=0.014 at follow-up (time unspecified) despite finding no difference at course completion. One RCT[11] reported significantly shorter time to first meaningful resuscitation measure in intervention group at 4 months. **CPR quality** For the important outcome of CPR quality at course completion, we found 4 RCTs[6,7,9,11]. Two RCTs[6,7] measured no-flow time, one[6] reported significantly shorter no flow time in intervention group (31.4 secs) vs. in the control group (36.3 sec), (p=0.014) and the other[7] found no significant	Training of teamwork competencies resulted in improved non-technical skills. Such improved non-technical skills are associated with improved performance in clinical studies. Moreover, shortcomings of teamwork competencies have been reported as a barrier for clinical skill performance.

	difference between the intervention and control. One RCT[11] measured hands-on time and compression rate and found no difference between intervention and control group. One RCT[9] found no difference in chest compression quality or in chest compression pauses. For the critical outcome of CPR quality beyond course completion, we found one RCT[11]. Four months after intervention increased hands-on time was reported in the intervention group (120 secs) vs control (87 secs), p=0.001; higher rates of recommended rate of compression in the intervention group (19) vs. control (6), p=0.002 and higher median compressions per minute in intervention group (109 cpm) vs. control (93 cpm), p=0.001. **Confidence** For the important outcome of confidence at course completion we identified one RCT[4] which found no significant difference between intervention and control group. For the important outcome of confidence beyond course completion we identified one RCT[4] which found no significant difference between intervention and control group at follow-up (time unspecified) **Teamwork competencies** For the important outcome of teamwork competencies at course completion we identified 14 studies (12 RCTs[3-6, 9-12,14-17] and 2 non-randomised studies[1,2]). ***Communication*** Two RCTs[9,15] reported significantly greater proportion of leadership statements in intervention group vs control and three RCTs[5,14,15] identified significantly increased directed team communication in intervention group vs control. One[14] also reported increased completed closed-loop communication and follower-initiated communication in intervention group vs control. One RCT[6] measured 'teamwork verbalisations' and found significantly higher verbalisations in intervention group vs control: directed orders, task assignments, undirected orders and planning. One RCT[11] identified more leading utterances in the control group vs intervention**.** ***Decision making and leadership behaviour*** Two RCTs[8,10] reported increased leadership behaviour in intervention group vs control. One[10] trial also reported significantly increased correction of improper chest compressions in intervention group. One RCTs[9] reported increased decision-making in intervention group vs control. One non-randomised study[2] reported no significant difference in leadership behaviour between intervention and control. ***Teamwork*** One RCT[4] reported significantly higher team-level efficacy in intervention group vs control and one non-randomised study[1] reported more teamwork intervention events in intervention group vs control. Two RCTs[16,17] and a non-randomised study[2] found no significant difference in measures of teamwork between intervention and control groups. ***Non-technical skills*** Two RCTs[3,12] reported significantly higher non-technical skill performance[3] and total behavioural skills scores[12] in the intervention group vs control. ***Workload management*** Two RCTs[15,16] reported significantly improved workload management in intervention group vs control. For the important outcome of teamwork competencies beyond course completion we identified 3 RCTs[4,11,17.] One RCT[11] reported more leadership utterances, task assignments, commands and decisions about what to do in intervention group at 4 months than control group. One RCT[4] reported significantly higher self-reported teamwork in intervention group at follow-up (timepoint of FU not reported). One RCT[17] reported no significant difference between intervention and	

	control group in TEAM scores at 3 months (following no significant difference at course completion) No evidence was identified for critical outcomes of CPR skill performance and CPR quality beyond 1 year, nor for the important outcomes of confidence and teamwork competencies beyond 1 year.	

Undesirable Effects

How substantial are the undesirable anticipated effects?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
● Trivial ○ Small ○ Moderate ○ Large ○ Varies ○ Don't know	No undesirable effects were observed.	

Certainty of evidence

What is the overall certainty of the evidence of effects?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
● Very low ○ Low ○ Moderate ○ High ○ No included studies	Certainty of evidence across outcomes was low to very-low downgraded for risk of bias, and imprecision.	Greater certainty of evidence for teamwork competencies than for other outcomes

Values

Is there important uncertainty about or variability in how much people value the main outcomes?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ Important uncertainty or variability ○ Possibly important uncertainty or variability ● Probably no important uncertainty or variability ○ No important uncertainty or variability	There is no specific evidence of the variability in the value of the main outcomes.	Higher Kirkpatrick levels (i.e. patient outcomes) are by some researchers considered more important than lower Kirkpatrick levels (e.g. knowledge). However, simulation-based skills are generally considered an important proxy and prerequisite for clinical skills.

Balance of effects

Does the balance between desirable and undesirable effects favor the intervention or the comparison?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ Favors the comparison ○ Probably favors the comparison ○ Does not favor either the intervention or the comparison ○ Probably favors the intervention ● Favors the intervention ○ Varies ○ Don't know	Several studies reported improved skill performance when training teamwork competencies in contrast to not training teamwork competencies and no undesirable effects were observed.	

Resources required

How large are the resource requirements (costs)?"

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ Large costs ○ Moderate costs ○ Negligible costs and savings ○ Moderate savings ○ Large savings ● Varies ○ Don't know	No evidence on cost and cost-effectiveness was identified.	Some studies used extra training on teamwork competencies, which resulted in longer training with presumably higher costs. In other cases, training on teamwork competencies did not prolong the course why costs are presumed to be similar.

Certainty of evidence of required resources

What is the certainty of the evidence of resource requirements (costs)?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ Very low ○ Low ○ Moderate ○ High ● No included studies	No evidence was identified	Some studies used extra training on teamwork competencies or use of extra simple device needed (videos, computers) which resulted in longer training with presumably higher costs. In other cases, training on teamwork competencies did not prolong the course why costs are presumed to be similar.

Cost effectiveness

Does the cost-effectiveness of the intervention favor the intervention or the comparison?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS

○ Favors the comparison ○ Probably favors the comparison ○ Does not favor either the intervention or the comparison ○ Probably favors the intervention ○ Favors the intervention ○ Varies ● No included studies	No studies were identified.	Assuming that training in teamwork competencies would not increase costs significantly, the cost-effectiveness would probably benefit the intervention.

Equity

What would be the impact on health equity?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ Reduced ○ Probably reduced ● Probably no impact ○ Probably increased ○ Increased ○ Varies ○ Don't know	We found no evidence and training in teamwork competencies are not believed to impact equity.	

Acceptability

Is the intervention acceptable to key stakeholders?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ No ○ Probably no ● Probably yes ○ Yes ○ Varies ○ Don't know	We found no evidence on acceptability.	Training in teamwork competencies is generally accepted as important and already widely implemented.

Feasibility

Is the intervention feasible to implement?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ No ○ Probably no ● Probably yes	There was not reported any difficulties in implementing the intervention in the included studies.	Teamwork competencies is already widely included in resuscitation training.

○ Yes ○ Varies ○ Don't know		

SUMMARY OF JUDGEMENTS

	JUDGEMENT						
PROBLEM	No	Probably no	Probably yes	**Yes**		Varies	Don't know
DESIRABLE EFFECTS	Trivial	**Small**	Moderate	Large		Varies	Don't know
UNDESIRABLE EFFECTS	**Trivial**	Small	Moderate	Large		Varies	Don't know
CERTAINTY OF EVIDENCE	**Very low**	Low	Moderate	High			No included studies
VALUES	Important uncertainty or variability	Possibly important uncertainty or variability	**Probably no important uncertainty or variability**	No important uncertainty or variability			
BALANCE OF EFFECTS	Favors the comparison	Probably favors the comparison	Does not favor either the intervention or the comparison	Probably favors the intervention	**Favors the intervention**	Varies	Don't know
RESOURCES REQUIRED	Large costs	Moderate costs	Negligible costs and savings	Moderate savings	Large savings	**Varies**	Don't know
CERTAINTY OF EVIDENCE OF REQUIRED RESOURCES	Very low	Low	Moderate	High			**No included studies**
COST EFFECTIVENESS	Favors the comparison	Probably favors the comparison	Does not favor either the intervention or the comparison	Probably favors the intervention	Favors the intervention	Varies	**No included studies**
EQUITY	Reduced	Probably reduced	**Probably no impact**	Probably increased	Increased	Varies	Don't know
ACCEPTABILITY	No	Probably no	**Probably yes**	Yes		Varies	Don't know
FEASIBILITY	No	Probably no	**Probably yes**	Yes		Varies	Don't know

TYPE OF RECOMMENDATION

Strong recommendation against the intervention	Conditional recommendation against the intervention	Conditional recommendation for either the intervention or the comparison	**Conditional recommendation for the intervention**	Strong recommendation for the intervention
○	○	○	●	○

CONCLUSIONS

Recommendation

Based on the evidence found in this systematic review the Task Force suggests that teaching teamwork competencies be included in BLS and all kind of advanced life support training (weak recommendation, very low quality of evidence).

Justification

- We considered evidence from both observational and randomized studies. This was because the randomized studies generally had some concerns or significant bias and because the observational studies were not believed to have any confounding by indication.
- We identified no harmful or negative effects of team competence training and several studies reported that training in teamwork competencies improved clinical skill performance when compared to training resuscitation without specific emphasis on teamwork competencies.
- Clinical studies suggest that a lack of teamwork competencies is a barrier to successful resuscitation. Moreover, teamwork competencies have been associated with improved skill performance during clinical resuscitation attempts.
- We valued that training in teamwork competencies is widely accepted and implemented in resuscitation courses. It is likely cost-effective despite no study investigated that.

Subgroup considerations

The specific teamwork competencies being trained should likely be tailored to the type of resuscitation course aiming to train contextualized skills (technical and non-technical).

Implementation considerations

We consider training in teamwork competencies to be widely accepted but the best way of implementation is still unclear.
The studies included suggest that training in teamwork competencies may be implemented using a variety of methods, e.g. lectures, videos, simulation-based team training, and debriefing. The instructional design might be tailored for the needs of the learners

Monitoring and evaluation

No monitoring needed.

Research priorities

Overall, we identified lacking evidence on transfer from training to clinical resuscitation performance and no study how such trainings influence patient outcome.
We were unable to identify the optimal instructional design and the optimal duration of training on teamwork competencies.
We found no evidence on whether training of certain teamwork competencies are more important than other teamwork competencies and whether this depends on the group of learners.
We did not identify any studies evaluating the teaching of team competencies outside the hospital environment
We found no evidence on cost-effectiveness and no studies from low-resource settings.

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