BLS 2025 CoSTR Appendix A – Evidence to Decision Tables

Bystander CCO vs CPR (BLS 2100)

QUESTION

Question: In adults and children with cardiac arrest, does the delivery (without dispatcher assistance) of continuous chest compressions with or without ventilations) compared with standard CPR by bystanders improve patient outcomes?	
POPULATION:	Adults and children with cardiac arrest
INTERVENTION:	Continuous chest compressions with or without ventilations delivered by bystanders without dispatcher assistance
COMPARISON:	Standard CPR, defined as any compression-to-ventilation ratio delivered by bystanders without dispatcher assistance. Comparator groups that receive no CPR or mechanical CPR were excluded from the review. Studies reporting only unadjusted data for outcomes were excluded.
MAIN OUTCOMES:	Favourable neurological survival (as measured by cerebral performance category or modified Rankin Score) at discharge or 30-days and at any time interval after 30-days; Survival to discharge or 30 days survival; Survival to any time interval after discharge or 30 days survival; Return of spontaneous circulation (ROSC); Quality of life as measured by any indicator or score.
SETTING:	Out-of-hospital setting
PERSPECTIVE:	
BACKGROUND:	This topic was prioritized for review due to the time since the previous systematic review.(Ashoor 2017 112)
CONFLICT OF INTERESTS:	None

ASSESSMENT

Problem Is the problem a priority?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
○ No ○ Probably no ○ Probably yes **X** Yes ○ Varies ○ Don't know	Conventional cardiopulmonary resuscitation (C-CPR) consists of manual chest compressions and ventilation to maintain oxygenation until return of spontaneous circulation is achieved. Ventilations result in frequent interruptions in chest compressions, however, which can reduce coronary and aortic blood flow during cardiac arrest and has been associated with poorer survival in animal models (Kern 2002 645). Similarly, higher chest compression fraction (total resuscitation time spent performing chest compressions) has been associated with improved outcomes in observational studies (Christenson 2009 1241). One strategy to improve chest compression fraction and reduce interruptions in chest compression is to perform continuous chest compression (compression only CPR, CCO-CPR). However, there is also concern that CCO-CPR compression may be harmful for patients who require more effective ventilations, such as asphyxial arrests or drowning (Berg 2000 1743).	
Desirable Effects How substantial are the desirable anticipated effects?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
○ Trivial **X** Small	Three observational studies compared bystander compression-only CPR (CCO-CPR) with conventional CPR	Given the included studies were conducted without dispatcher

○ Moderate ○ Large ○ Varies ○ Don't know	(C-CPR) at a ratio of 15:2 (Bohm 2007 2908, Ong 2008 119) and 30:2 (Bobrow 2010 1447) in adults without dispatcher-assisted CPR (DA-CPR) instructions (DA-CPR). As 15:2 CPR is no longer recommended, all outcomes, including these studies, were downgraded for indirectness. ***For the critical outcome of favorable neurological function,*** we identified no studies without dispatcher assistance. Indirect evidence of very-low certainty (downgraded for risk of bias, imprecision and indirectness) from one cohort study of combined bystander (76% of cases) and DA-CPR (24% of cases) suggests favorable neurological function (adjusted OR 2.22, 95%CI: 1.17 to 4.21) with CO-CPR compared to 15:2 CPR in 4,068 adult bystander-witnessed OHCAs.(SOS-Kanto Study Group 2007 920) ***For the critical outcome of survival to hospital discharge or 30 days,*** we identified very-low certainty of evidence (downgraded for risk of bias, imprecision and indirectness) from three cohort studies.(Bohm 2007 2908, Ong 2008 119, Bobrow 2010 1447) One study in 5,272 adult presumed cardiac OHCAs reported significantly higher survival to hospital discharge with CCO-CPR compared to 30:2 CPR (adjusted OR 1.60, 95%CI: 1.08 to 2.35).(Bobrow 2010 1447) The remaining two studies, which examined all age OHCAs, reported no difference between the two CPR strategies for survival to 30 days and 15:2 CPR (adjusted OR 1.18, 95%CI: 0.89 to 1.56)(Bohm 2007 2908) or hospital discharge (adjusted OR 1.32, 95%CI: 0.35 to 4.94).(Ong 2008 119) ***Bystander (without DA-CPR) compression-only CPR compared with conventional CPR in adults: BLS 2220 TF SR,*** *we identified very-low certainty of evidence (downgraded for risk of bias, imprecision and indirectness) from one cohort study.(Bohm 2007 2908) This all-age cohort study (n=11,275) reported no difference in survival to hospital admission with CCO-CPR compared to 15:2 CPR (adjusted OR 1.03, 95%CI: 0.86 to 1.23).* ***For the important outcome of ROSC,*** we identified very-low certainty of evidence (downgraded for risk of bias, imprecision and indirectness) from one cohort study.(Ong 2008 119) This all-age cohort study (n=441) reported no difference in ROSC with CCO-CPR compared to 15:2 CPR (adjusted OR 1.02, 95%CI: 0.60 to 1.73).(Ong 2008 119)	assistance, it could be assumed that the CPR was performed by CPR trained individuals or off-duty health care professionals. Three additional studies reported no difference in unadjusted patient outcomes between CCO-CPR and C-CPR.(Waalewijn 2001 273, Panchal 2013 435) One study conducted in the 1980's, reported higher OHCA survival when 15:2 was correctly performed compared to incorrectly (31% vs 8%) or when compared to CCO-CPR (31% vs 20%).(Van Hoeyweghen 1993 47) Rates of correctly applied 15:2 were higher in bystanders who were healthcare professionals than lay bystanders (58% vs 42%).(Van Hoeyweghen 1993 47) Three trials comparing DA-CPR CCO-CPR and C-CPR found no difference in patient outcomes. (Hallstrom 2000 1546, Rea 2010 423, Svensson 2010 434) Two adult studies, which included DA-CPR, found no difference in good neurological outcomes between bystander CCO-CPR and C-CPR in respiratory/asphyxial OHCAs.(Fukuda 2017 493, Javaudin 2021 812) A pilot RCT, including DA-CPR, showed no difference in survival at 1-day between CCO-CPR and C-CPR when delivered by trained laypersons.(Riva 2024 e010027) Effective chest compressions generate cumulative coronary perfusion pressure, which falls to near zero when compressions stop. Therefore, early effective chest compressions are vital to establishing and maintaining coronary perfusion pressure.(Nassar 2017 1061)

Undesirable Effects
How substantial are the undesirable anticipated effects?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ Large ○ Moderate ○ Small ○ Trivial **X** Varies ○ Don't know	No undesirable effects were seen in adult populations. No data in pediatric only populations was found.	A review found compression-only CPR results in a higher total number of chest compressions. However, as it continues, rescuers may experience fatigue, which can lead to a reduction in the depth of compressions compared to those delivered in conventional CPR with pauses for breaths.(Min Ko 2016 882) Opening the airway and delivery of ventilations is technical, and bystanders,

		especially if untrained or minimally trained, are typically unable to deliver effective ventilations during simulated CPR.(Beard 2015 138) Concerns that rescue breaths may not be taught in BLS/CPR training if CCO is strongly recommended.
Certainty of evidence What is the overall certainty of the evidence of effects?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
X Very low o Low o Moderate o High o No included studies	The certainty of evidence for all outcomes was very-low. Downgraded for risk of bias, imprecision and indirectness. All direct data is observational and conducted in the era of 15:2 CPR.	The main TANGO-2 RCT currently underway will provide high-quality evidence on this issue for trained bystanders.(Riva 2024 e010027)
Values Is there important uncertainty about or variability in how much people value the main outcomes?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
o Important uncertainty or variability o Possibly important uncertainty or variability o Probably no important uncertainty or variability **X** No important uncertainty or variability	The is no uncertainty, the COSCA document highlights the importance of good neurological outcomes.(Haywood 2018 e783, Haywood 2018 147)	
Balance of effects Does the balance between desirable and undesirable effects favor the intervention or the comparison?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
o Favors the comparison o Probably favors the comparison o Does not favor either the intervention or the comparison **X** Probably favors the intervention o Favors the intervention o Varies o Don't know	Despite the theoretical risk of suboptimal oxygenation in patients receiving CCO-CPR, there is no data suggesting a negative impact on patient outcomes. Given that CCO-CPR is easier to deliver and has resulted in increased rates of bystander CPR, the evidence probably favors CCO-CPR.	
Resources required How large are the resource requirements (costs)?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
o Large costs o Moderate costs **X** Negligible costs and savings o Moderate savings o Large savings o Varies o Don't know	Negligible impact on resources as both treatment strategies require similar investment in staff and resources.	It is possible the CCC is easier to teach and may be more practical in resource-limited environments. Data from one RCT (Nichol 2015 2203) and observation studies suggest that CCC is associated with more adherence to protocol compared to standard CPR.(Schmicker 2021 31)
Certainty of evidence of required resources What is the certainty of the evidence of resource requirements (costs)?		

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
o Very low o Low o Moderate o High **X** No included studies	There were no economic evaluations of the two treatment strategies.	
Cost effectiveness Does the cost-effectiveness of the intervention favor the intervention or the comparison?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
o Favors the comparison o Probably favors the comparison **X** Does not favor either the intervention or the comparison o Probably favors the intervention o Favors the intervention o Varies o No included studies	CCC is likely to be as cost-effective as standard CPR.	
Equity What would be the impact on health equity?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
o Reduced o Probably reduced o Probably no impact **X** Probably increased o Increased o Varies o Don't know	In the out-of-hospital hospital setting, it is likely that CCC would improve treatment equity compared to standard CPR though increases in CPR rates.	
Acceptability Is the intervention acceptable to key stakeholders?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
o No o Probably no o Probably yes **X** Yes o Varies o Don't know	Public surveys show chest-compression only CPR for strangers is preferable.(Cheskes 2016 253, Bray 2017 158)	
Feasibility Is the intervention feasible to implement?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
o No o Probably no o Probably yes **X** Yes o Varies o Don't know	The task force placed high value on the importance of providing high-quality chest compressions and simplifying resuscitation logistics for providers and noted the support for the clinical benefit of bundles of care involving minimally interrupted cardiac resuscitation.	

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	Large	Moderate	**Small**	Trivial		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	**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
○	○	**X**	○	○

Treatment Recommendations

We recommend that chest compressions be performed for all adults in cardiac arrest (good practice statement). We suggest that bystanders who are trained, able and willing, give chest compressions with rescue breaths for adults in cardiac arrest (weak recommendation, very-low-certainty evidence).

Justification

Evidence suggests chest compression-only CPR is comparable to 15:2 CPR in adults, and is preferred by the public and easier to learn and recall. Rescue breaths are recommended for cardiac arrests caused by asphyxial and drowing events, and in situations where EMS response times are long. Both types of CPR are better than no CPR, and both should be taught in CPR training.

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DA – CCO vs. CPR (BLS 2122)

QUESTION

Question: In adults and children with cardiac arrest treated out-of-hospital, does dispatcher-assisted continuous chest compressions without ventilations compared with dispatcher-assisted standard CPR with ventilations improve patient outcomes?	
POPULATION:	Adults and children in out-of-hospital cardiac arrest
INTERVENTION:	Dispatcher-assisted chest compression-only CPR (CCO-CPR)
COMPARISON:	Dispatcher-assisted conventional CPR (C-CPR) with compressions and ventilations
MAIN OUTCOMES:	Favourable neurological survival (as measured by cerebral performance category or modified Rankin Score) at discharge or 30-days and at any time interval after 30-days; Survival to discharge or 30 days survival; Survival to any time interval after discharge or 30 days survival; Return of spontaneous circulation (ROSC); Quality of life as measured by any indicator or score.
SETTING:	Out-of-hospital setting
PERSPECTIVE:	
BACKGROUND:	This topic was prioritized for review due to the time since the previous systematic review (Ashoor 2017 112)
CONFLICT OF INTERESTS:	The following Task Force members and other authors declared an intellectual conflict of interest and this was acknowledged and managed by the Task Force Chairs and Conflict of Interest committees: Theresa Olasveengen

ASSESSMENT

Problem Is the problem a priority?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
o No o Probably no o Probably yes X Yes o Varies o Don't know	Conventional cardiopulmonary resuscitation (CPR) consists of manual chest compressions and positive-pressure ventilation to maintain oxygenation until spontaneous circulation is restored. Ventilations result in frequent interruptions in chest compressions, however, which can reduce coronary and aortic blood flow during cardiac arrest and has been associated with poorer survival in animal models. Similarly, higher chest compression fraction (total resuscitation time spent performing chest compressions) has been associated with improved outcomes in observational studies. One strategy to improve chest compression fraction and reduce interruptions in chest compression is to perform continuous chest compressions. However, there is also concern that continuous chest compression may be harmful for patients who require more effective ventilations, such as asphyxial arrests or drowning.	To improve bystander response, there is value in limiting the steps required for the dispatcher to review. Further, chest compression-only CPR can be learned quickly, even during an event via dispatcher instructions.
Desirable Effects How substantial are the desirable anticipated effects?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
o Trivial X Small o Moderate o Large o Varies o Don't know	Interruptions in chest compressions have been associated with poorer clinical outcomes in observational studies (Christenson 2009 1241). Pauses for ventilations are a significant source of interruptions in chest compressions and may have negative impacts on coronary and aortic blood flow (Berg 2001 2465). ***For the critical outcome of favorable neurological function,*** we identified one RCT (Rea 2010 423), one	

	observational study limited to only DA-CPR (Goto 2021 408), and three observational studies with combined B-CPR and DA-CPR cases (Javaudin 2021 812, Kitamura 2018 29, SOS-Kanto Study Group 2007 920). Indirect evidence of very-low certainty (downgraded for risk of bias and indirectness) from two cohort studies of combined bystander and DA-CPR suggests favorable neurological function with CCO-CPR compared to 15:2 CPR (adjusted OR 2.22, 95%CI: 1.17 to 4.21; SOS-Kanto Study Group 2007 920) and combined 15:2 and 30:2 CPR (adjusted OR 1.12, 95%CI: 1.06 to 1.19; Kitamura 2018 29). The remaining three studies, including the RCT, reported no difference between the two CPR strategies for survival with good neurological outcomes and either 15:2 CPR (e.g., risk difference 1.50, 95%CI: -1.40 to 4.40; Javaudin 2021 812) or 30:2 CPR (e.g., adjusted OR 0.92, 95%CI: 0.78 to 1.08; Goto 2021 408). ***For the critical outcome of survival to hospital discharge or 30 days,*** we identified low to very-low certainty of evidence (downgraded for risk of bias, imprecision and indirectness) from 2 RCTs (Hallstrom 2000 1546, Svensson 2010 434), both using a 15:2 comparison, and three cohort studies (Goto 2021 408, Javaudin 2021 812, Kitamura 2018 29, Olasveengen 2008 914, Wnent 2021 101) that suggested improved survival or no difference in outcomes. One observational study in 143,500 presumed medical-origin OHCAs of all ages (Kitamura 2018 29) reported significantly higher odds of 30-day survival with CCO-CPR compared to C-CPR of either 15:2 or 30:2 (adjusted OR 1.05, 95%CI: 1.01 to 1.10). The remaining two RCTs and two observational studies reported no differences between the two CPR strategies for survival to hospital discharge (e.g., risk difference 4.20, 95%CI: -1.50 to 9.80; Hallstrom 2000 1546) or 30-day survival (e.g., risk difference 1.70, 95%CI: -1.20 to 4.60; Svensson 2010 434).	
Undesirable Effects How substantial are the undesirable anticipated effects?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
○ Large ○ Moderate X Small ○ Trivial ○ Varies ○ Don't know	***For the critical outcome of survival to hospital discharge or 30 days,*** we identified very-low certainty of evidence (downgraded for risk of bias, imprecision and indirectness) from two observational studies, one of 5,406 all-aged OHCAs (Wnent 2021 101) and the other of 24,947 adult bystander-witnessed OHCAs (Goto 2021 408). These studies reported significantly lower odds of survival to hospital discharge for CCO-CPR compared to 15:2 and 30:2 CPR (adjusted OR 0.69, 95%CI: 0.53 to 0.90; Wnent 2021 101) and 30-day survival to CCO-CPR compared to 30:2 CPR (adjusted OR 0.72, 95%CI: 0.59, 0.88; Goto 2021 408).	
Certainty of evidence What is the overall certainty of the evidence of effects?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
○ Very low X Low ○ Moderate	The overall quality of evidence was rated as low to very low for all outcomes primarily due to a very serious risk of bias. The individual observational studies were all at a critical risk of bias due to confounding.	

o High o No included studies		
Values Is there important uncertainty about or variability in how much people value the main outcomes?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
o Important uncertainty or variability X Possibly important uncertainty or variability o Probably no important uncertainty or variability o No important uncertainty or variability	There five studies included that considered the impact of DA-CCC and standard DA-CPR on neurologically favourable survival, including one RCT (Rea 2010 423). No studies examined quality of life outcomes or longer-term patient outcomes.	
Balance of effects Does the balance between desirable and undesirable effects favor the intervention or the comparison?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
o Favors the comparison o Probably favors the comparison o Does not favor either the intervention or the comparison X Probably favors the intervention o Favors the intervention o Varies o Don't know	Despite the theoretical risk of suboptimal ventilations in patients receiving DA-CCC, there is limited data suggesting a negative impact on survival. Conversely, there is some observational data to indicate potential patient harm from interruptions in chest compressions or bystander refusal to initiate chest compressions. Furthermore, standard CPR involving a compression-to-ventilation ratio is hard to achieve for bystanders, with or without dispatcher assistance.	
Resources required How large are the resource requirements (costs)?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
o Large costs o Moderate costs X Negligible costs and savings o Moderate savings o Large savings o Varies o Don't know	Negligible impact on resources as both treatment strategies require similar investment in staff and resources.	
Certainty of evidence of required resources What is the certainty of the evidence of resource requirements (costs)?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
o Very low o Low o Moderate o High X No included studies	There were no economic evaluations of the two treatment strategies.	
Cost effectiveness Does the cost-effectiveness of the intervention favor the intervention or the comparison?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**

o Favors the comparison o Probably favors the comparison X Does not favor either the intervention or the comparison o Probably favors the intervention o Favors the intervention o Varies o No included studies	CCC is likely to be as cost-effective as standard CPR.	
Equity What would be the impact on health equity?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
o Reduced o Probably reduced o Probably no impact X Probably increased o Increased o Varies o Don't know	Bystanders may be more willing to provide care to a cardiac arrest victim when ventilations are not required. Bystander CPR rates are also known to be lower among certain populations and for victims of certain characteristics.	
Acceptability Is the intervention acceptable to key stakeholders?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
o No o Probably no o Probably yes X Yes o Varies o Don't know	Many systems around the world have already implemented dispatcher instructions using CO-CPR.	
Feasibility Is the intervention feasible to implement?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
o No o Probably no o Probably yes X Yes o Varies o Don't know	The Task Force placed high value on the importance of providing high-quality chest compressions and simplifying bystander instructions.	

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	Large	Moderate	**Small**	Trivial		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
o	o	o	o	X

CONCLUSIONS

Recommendation

We recommend that dispatchers provide chest compression-only CPR instructions to callers for adults with suspected OHCA (strong recommendation, low-certainty of evidence).

Justification

- In making these recommendations, the task force acknowledged the very-low to low-quality evidence, but strongly endorsed the 2020 ILCOR Consensus on Science that all rescuers should perform chest compressions for all patients in cardiac arrest.
- Bystander CPR more than doubles OHCA survival (Sasson 2010 63). We placed a higher emphasis on the importance of providing high-quality chest compressions and increasing the overall rate of bystander CPR over providing rescue breaths in adults, particularly as these are harder to instruct on the emergency call.
- Increases in rates of bystander CPR and patient outcomes have been reported following the introduction of dispatcher-assisted CCO- or compression-focused CPR in adults (Bray 2011 1393, Iwami 2015 415, Kitamura 2012 2834, Malta Hansen 2015 255). Using a CO-CPR strategy may increase the willingness of bystanders to respond during a cardiac arrest.
- Most bystander CPR for adults is given with DA-CPR instructions, even in the presence of CPR-trained lay-bystanders (Riva 2024 e010027).
- The ongoing TANGO2 (Telephone Assisted CPR. AN evaluation of efficacy amonGst cOmpression only and standard CPR) trial is designed to evaluate whether compression-only cardiopulmonary resuscitation (CPR) by trained laypersons is noninferior to standard CPR in adult out-of-hospital cardiac arrest (NCT03981107). This study will provide additional insight, and likely prompt the task force to revisit this review.
- In making these recommendations, the task force took into consideration heterogeneity in the body of evidence, particularly related to implementation of DA-CPR. Despite this, most included studies suggested either

a slight improvement or no difference in patient outcomes for dispatcher-assisted CCO-CPR and C-CPR, regardless of patient population or comparison ratio.

- The task force excluded from this review one observational study previously included (Kitamura 2011 3) due to the study not reporting adjusted data.

Research priorities

Current knowledge gaps include but are not limited to:

- What are the identifying key words used by callers that are associated with cardiac arrest?
- Should there be "trigger" words or phrases from the bystander that are so likely to indicate cardiac arrest that the dispatcher can skip parts of the protocol and shorten the time to dispatch and to CPR instruction?
- What is the impact of adherence to or failure to follow dispatch protocols?
- What is the optimal instruction sequence for coaching callers in dispatcher-assisted CPR?
- What is the impact of telephone CPR instructions on non-cardiac etiology arrests such as drowning, trauma, asphyxia in adult and pediatric patients?
- What is the impact of language barriers to performance?
- How many chest compressions should be given, and for how long, before ventilation instructions are introduced?
- Should resuscitation instructions be modified in the context of advanced directives from the victim asking not to be resuscitated?

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AED Accessibility Locked Cabinets (BLS 2123)

QUESTION

Short PICO title here	
POPULATION:	Adults and children in out-of-hospital cardiac arrest settings
CONCEPT:	The benefits and harms of placing automatic external defibrillators (AEDs) in locked versus unlocked cabinets
MAIN OUTCOMES:	Any outcome, including AED outcomes (e.g. AED use, time to AED use, AED vandalism or theft)
SETTING:	Public access defibrillation
PERSPECTIVE:	Rapid defibrillation is critical to improving patient outcomes
BACKGROUND:	Concerns about theft, vandalism, and misuse of AEDs have led to the implementation of security measures, including the use of locked cabinets to house these devices in public areas.(O'Callaghan 2019 75, Fortington 2020 617, Lac 2023 100348) Field visits to AED locations, as recorded in registries or apps, have shown high proportions of AEDs in key-locked cabinets in some regions. While locked cabinets aim to protect AEDs, they may also cause delays in AED access during emergencies. No reviews have been conducted examining the impact of locked AED cabinets on patient or AED (e.g. theft, vandalism, and misuse) outcomes.
CONFLICT OF INTERESTS:	Academic only: JB and GP are authors on included papers.

ASSESSMENT

Problem
Is the problem a priority?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ No ○ Probably no ○ Probably yes ø **Yes** ○ Varies ○ Don't know	Rapid defibrillation is critical to improving patient outcomes, as each minute of delay in attempting defibrillation reduces the chances of survival and good functional outcomes.(De Maio 2003 242, Drennan 2014 1623) Patients who receive defibrillation from bystanders have the greatest chance of survival (Nehme 2019 85). Ensuring an AED's accessibility and 24/7 availability during emergencies poses significant challenges. Concerns about theft, vandalism, and misuse of AEDs have led to the implementation of security measures, including the use of locked cabinets to house these devices in public areas(O'Callaghan 2019 75, Fortington 2020 617, Lac 2023 100348). While locked cabinets aim to protect AEDs, they may also cause delays in AED access during emergencies. There is emerging evidence of high proportions of AEDs locked in cabinets in some regions (Zhang 2019 120). AEDs cabinets are typically locked with a code or key. Additional security may also be present (e.g. locked in a room in a locked cabinet).	The BLS Task Force prioritized this topic, which has not been reviewed before, to address community concerns about the need for additional security measures to prevent AED theft, vandalism, and misuse(O'Callaghan 2019 75, Fortington 2020 617, Lac 2023 100348).

Desirable Effects
How substantial are the desirable anticipated effects?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ Trivial ø Small ○ Moderate ○ Large ○ Varies	Ten articles fulfilled our eligibility criteria (Peberdy 2006 59, Ludgate 2012 , Benvenuti 2013 S69, Brugada 2014 S57, Telec 2018 181, Uhm 2018 534, Salerno 2019 1, Cheema 2022 S80, Ng 2022 97, Page 2024 110227).	AEDs can be recovered through tracking devices (Page 2024 110227). It is possible that some "stolen" AEDs were used in an emergency and not returned.

○ Don't know	• No studies examining patient outcomes were found. • The majority of studies reported low rates of theft and vandalism (<2.0%), (Peberdy 2006 59, Ludgate 2012 , Benvenuti 2013 S69, Brugada 2014 S57, Salerno 2019 1, Cheema 2022 S80, Page 2024 110227). The only study comparing unlocked and locked AED cabinets showed low rates of theft in both cabinet types, with the lowest rates seen in locked cabinets (0.3% vs. 0.1%)(Cheema 2022 S80). • Two simulation studies showed significantly slower AED retrieval when additional security measures were used, including locked cabinets (Telec 2018 181, Uhm 2018 534). • One survey of first responders reported half (24/45) were injured, most (62.5%) injuries occurred by using body parts to break the glass necessary to access a key to unlock the AED (NG 2022 97).	

Undesirable Effects How substantial are the undesirable anticipated effects?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
○ Trivial ○ Small ○ Moderate ○ Large ○ Varies ø Don't know	• No studies examining patient outcomes were found. • Locked cabinets can cause harm to rescuers (e.g. cuts from breaking glass) and some rescuers seem to have issues follow the unlocking instructions on cabinets (e.g. use of hammer rather than body parts to break glass to retrieve keys) (Yu 2022). • The cost to replace stolen or vandalized AEDs may be an issue in low-resource settings (e.g. community groups with limited funding). • AED retrieval was longer in two simulation studies when accessed through security measures including locked cabinets (Uhm 2008, Telec 2018).	Of 24 injured rescuers, one reported they would not be willing to access an AED in future emergencies as a result of the injuries sustained in AED retrieval (Yu 2022). 24/7 access to codes or keys to unlock cabinets is necessary. AEDs in locked cabinets may make the public think they cannot use them. To be effective, AEDs must be retrieved and used before EMS arrive.

Certainty of evidence What is the overall certainty of the evidence of effects?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
○ Very low ○ Low ○ Moderate ○ High **ø No included studies**	N/A	While no evaluation of the certainty of evidence was performed, a high proportion of included studies were not peer-reviewed: • Four papers were conference abstracts (Ludgate 2012 , Benvenuti 2013 S69, Brugada 2014 S57, Cheema 2022 S80) • Two were letters to the Editor (Salerno 2019 1,

		Page 2024 110227)
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 **ø** Probably no important uncertainty or variability ○ No important uncertainty or variability	Patients' value longer term outcomes (Haywood 2018 e783, Haywood 2018 147). Patient outcomes and HRQoL was not addressed in the available studies. The public are concerned about AED theft and vandalism. The cost to replace stolen or vandalized AEDs may be an issue in low-resource settings (e.g. community groups with limited funding).	
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 **ø Varies** ○ Don't know	The balance of effects is likely to vary depending on the setting. Although theft and vandalism was seen in both locked and unlocked cabinets, the cost of replacement of AEDs in low resource settings may be prohibitive and if locked cabinets are not an option these setting may not purchase AEDs.	Some regions have opted to lock their public access defibrillators with a code that can be retrieved by calling the emergency number to encourage rescuers to call an ambulance as a first action. A 2022 ILCOR Scientific Statement, which focuses on optimizing public access defibrillation, advises against using locked cabinets. If locked cabinets are used, instructions for unlocking them need to be clear and ensure no delays in access (Brooks 2022 204, Brooks 2022 204).
Resources required How large are the resource requirements (costs)?"		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
○ Large costs **ø Moderate costs** ○ Negligible costs and savings ○ Moderate savings ○ Large savings ○ Varies ○ Don't know	There are costs associated with purchasing a locked cabinet and replacing a AED that is stolen or vandalized.	
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 **ø No included studies**	No studies of resources or cost have been published.	
Cost effectiveness Does the cost-effectiveness of the intervention favor the intervention or the comparison?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**

o Favors the comparison o Probably favors the comparison o Does not favor either the intervention or the comparison o Probably favors the intervention o Favors the intervention **ø Varies** o No included studies	The cost-effectiveness of locked versus unlocked cabinets is unknown.	AED programs are cost-effective in high income regions (Andersen 2019 250).
Equity What would be the impact on health equity?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
o Reduced o Probably reduced o Probably no impact o Probably increased o Increased o Varies **ø Don't know**	No studies have examined the impact on health equity.	Cost of replacing an AED lost to theft or vandalism may be an issue in low resource settings.
Acceptability Is the intervention acceptable to key stakeholders?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
o No o Probably no o Probably yes o Yes **ø Varies** o Don't know	The acceptability of locked and unlocked AED cabinets is likely to vary depending on the setting	
Feasibility Is the intervention feasible to implement?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
o No o Probably no o Probably yes **ø Yes** o Varies o Don't know	Locked and unlocked cabinet are already in use.	

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
○	○	ø	○	○

CONCLUSIONS

Recommendation

We advises against using locked cabinets (Good Practice Statement).
If locked cabinets are used, instructions for unlocking them must be clear and ensure minimal delays in access (Good Practice Statement).
Emergency Medical Services should devise strategies to return public access defibrillators when used (Good Practice Statement).

Justification

Public defibrillation is associated with the best cardiac arrest outcomes, but AEDs must retrieved in time to be used. Existing evidence is poor, but suggests locked cabinets only slightly deter theft and vandalism, but may also cause delay in access and harm rescuers. In giving an option of locked cabinets, we recognize the cost of replacing of an AED may be prohibitive in some settings.

Subgroup considerations

n/a

Implementation considerations

Public awareness campaigns on the use of AEDs may deter theft and vandalism (Brugada 2014 S57).
If locked cabinets are used, the methods for locking cabinets needs consideration. Delays in access should be minimal and unlocking cabinets should not result in harm to rescuers. The mechanism (e.g. keys, codes) for unlocking cabinets should be available 24/7 and easily obtainable. Where possible, codes should be integrated into AED registries and available in the emergency call.
Emergency Medical Services should devise strategies to return public access defibrillators when used.
Tracking devices may result in the return of stolen or missing AEDs.

Monitoring and evaluation

AED registries should record whether AED cabinets are locked and monitor and report theft and vandalism.

Research priorities

Peer-reviewed research and human studies are needed on this topic, particularly studies focusing on real-life retrieval and the impact of security strategies on delivery times and patient outcomes.

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ABC vs CAB (BLS 2201)

QUESTION

Should CPR commence with compressions (30:2) or ventilations (2:30)?	
PROBLEM:	Adults and children in any setting (in-hospital or out-of-hospital) with cardiac arrest
OPTION:	commencing CPR with compressions first (30:2)
COMPARISON:	commencing CPR with ventilation first (2:30)
MAIN OUTCOMES:	*Critical*: Survival with favorable neurological outcome at hospital discharge or 30-days, Survival at hospital discharge or 30 days, Survival with favourable neurological outcome to one-year, Survival to one-year, Event survival, Any ROSC. *Important*: Time to commencement of rescue breaths, Time to commencement of first compression, Time to completion of first CPR cycle, Ventilation rate, Compression rate, Chest compression fraction, Minute ventilation
SETTING:	in-hospital or out-of-hospital
PERSPECTIVE:	Traditionally, cardiopulmonary resuscitation (CPR) commenced with opening the airway and ventilations then, chest compressions (i.e. A-B-C). However, airway and breathing are technical skills and previous systematic reviews by the International Liaison Committee on Resuscitation (ILCOR) have found that starting CPR with compressions in simulation studies resulted in faster times to key elements of resuscitation (rescue breaths, chest compressions, completion of first CPR cycle).
BACKGROUND:	CPR compression—ventilation sequences CAB versus ABC represents a compromise between the need to generate blood flow and the need to supply oxygen to the lungs
CONFLICT OF INTERESTS:	No conflicts to declare

ASSESSMENT

Problem Is the problem a priority?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
○ No ○ Probably no ○ Probably yes ● Yes ○ Varies ○ Don't know	Since the 2020 ILCOR review of this PICOST,[1,2] there is ongoing debate in the scientific literature regarding the merits of commencing resuscitation with chest compressions prior to ventilations. Internationally, most adult BLS guidelines commence chest compressions prior to ventilations; however, there is variability in pediatrics and aquatic rescue with different approaches in various jurisdictions.	
Desirable Effects How substantial are the desirable anticipated effects?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
○ Trivial ● Small ○ Moderate ○ Large ○ Varies ○ Don't know	Delivering high-quality chest compressions as early as possible is vital to high-quality CPR and optimizes the chance of ROSC and survival after cardiac arrest. However, patients who suffer cardiac arrest from respiratory or asphyxia causes (eg. children, drowning) will benefit from additional ventilatory support.	Indirect evidence from before-and-after OHCA registry studies in adults, which examined changes in dispatcher telephone CPR instructions[3] and the implementation of guideline changes[4,5], suggests that switching from the A-B-C to C-A-B approach was associated with increased rates of bystander CPR[3] and improved patient outcomes.[3,4,5] Similar data on in-hospital cardiac arrest show conflicting evidence in patient outcomes.[6,7] One large registry study from Japan demonstrated increased bystander CPR rates in children

		with bystander-witnessed OHCAs after compression-only CPR was introduced.[8] Whether the change in sequence to CAB by some ILCOR member councils has resulted in more infants and children receiving compression-only CPR overall is unknown, although available data continues to support the combination of compressions and breaths is needed for optimal pediatric CPR.[9,10] ROSC and survival to hospital discharge. Coronary perfusion pressure is generated by effective chest compressions and is cumulative, therefore when chest compressions stop, it falls to near zero. Early effective chest compressions are vital to establishing and maintaining coronary perfusion pressure. [11] Time to first compression is associated with better patient outcomes, including good neurological outcomes in adults.[12]
Undesirable Effects How substantial are the undesirable anticipated effects?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
○ Large ○ Moderate ● Small ○ Trivial ○ Varies ○ Don't know	Starting CPR with compressions first results in faster times to key elements of resuscitation, such as time to commencement of chest compressions, time to start and complete the first cycle of compressions, and a higher chest compression fraction. One simulated study in pediatric resuscitation found starting with compressions delayed time to commencement of rescue breaths in cardiac arrest, but the differences was of questionable clinical significance.	Opening the airway and delivery of ventilations is technical, and bystanders, especially if untrained or minimally trained, are typically unable to deliver effective ventilations during simulated CPR.[13] Further evidence suggests that delivering the A-B-C approach has more errors in CPR[14]; and that lay-bystanders prefer C-A-B, and it is easier to learn and retain[14]. The delivery of non-mouth-to-mouth ventilation requires the retrieval and preparation of equipment (e.g. bag-valve-mask, pocket mask), which, when multiple rescuers are present, can occur during chest compressions.
Certainty of evidence What is the overall certainty of the evidence of effects?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
● Very low ○ Low	This systematic review did not identify any human studies, but identified 5 manikin studies; 1 randomized study [15] focused on adult resuscitation, 2	

○ Moderate ○ High ○ No included studies	randomized studies focused on pediatric resuscitation, [16,17] and 2 observational studies focused on adult resuscitation [18,19]. **Outcome** / **Relative importance** / **Certainty of the evidence (GRADE)** Time to commencement of chest compressions – RCTs and non RCTs — IMPORTANT — ⊕◯◯◯ VERY LOW Time to commencement of rescue breaths – RCTs — IMPORTANT — ⊕◯◯◯ VERY LOW Time to completion of first CPR cycle - RCT — IMPORTANT — ⊕◯◯◯ VERY LOW Ventilation rate -RCT — IMPORTANT — ⊕◯◯◯ VERY LOW Compression rate -RCT and non RCTs — IMPORTANT — ⊕◯◯◯ VERY LOW Chest compression fraction (CCF) - RCT and non RCTs — IMPORTANT — ⊕◯◯◯ VERY LOW Minute alveolar ventilation in the first minute of resuscitation — IMPORTANT — ⊕◯◯◯ VERY LOW Time to diagnosis of need for resuscitation (unresponsive, respiratory arrest, cardiac arrest) - RCT — IMPORTANT — ⊕◯◯◯ VERY LOW	

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 data on critical patient outcomes.	

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	Mankin studies show minimal differences in times to key resuscitation elements, but most favour commencing with compressions.	

○ Varies ○ Don't know		

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 relevant published data was identified that answers this question. In many jurisdictions, CAB is already in place in adult and paedatric BLS so resource requirements are small. In jurisdictions where ABC is used, there are a number of resources required to implement CAB in preference to ABC including investments required to train rescuers, reconfiguration of CPR feedback devices and AEDs, and production of educational materials.	

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 relevant published data was identified for review so unable to provide any certainty here.	

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 relevant published data was identified that answers this question	

Equity

What would be the impact on health equity?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ Reduced ○ Probably reduced ○ Probably no impact ○ Probably increased ○ Increased ○ Varies	No relevant published data was identified that answers this question.	

● Don't know		
Acceptability Is the intervention acceptable to key stakeholders?		
JUDGEMENT	**RESEARCH EVIDENCE – CHECK CURRENT FLOW CHARTS**	**ADDITIONAL CONSIDERATIONS**
○ No ○ Probably no ● Probably yes ○ Yes ○ Varies ○ Don't know	In adults, the recommendation of CAB in preference to ABC will be acceptable to resuscitation key stakeholders as there is no significant deviation from current practice. In children, there is international variability so a recommendation of CAB in preference to ABC may create some debate.	Due to the public's concerns with mouth-to-mouth ventilations,[20] commencing CPR with airway and ventilations may result in no bystander CPR being provided.
Feasibility Is the intervention feasible to implement?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
○ No ○ Probably no ● Probably yes ○ Yes ○ Varies ○ Don't know	In adults, many BLS guidelines recommend CAB in preference to ABC thus the intervention (CAB) presents no significant deviation from current practices. In children, feasibility will be more problematic given the degree of international variation in BLS guidelines.	

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	Large	Moderate	**Small**	Trivial		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	Probably favors the intervention	Favors the intervention	Varies	**No included studies**

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

CONCLUSIONS

Recommendation

In adults and children in cardiac arrest, we suggest commencing CPR with compressions rather than ventilations (weak recommendation, very-low-certainty evidence).

Justification

For most outcomes CAB resulted in faster times to key elements of resuscitation (rescue breaths, chest compressions, completion of first CPR cycle) across the five papers reviewed. This very small delay in commencing rescue breaths with CAB may be acceptable given the decreased time to other elements of resuscitation, however it should be noted that the certainty of the evidence is very low and all studies reviewed were manikin studies. There was also consideration given to training requirements of a single approach versus separate approaches for adults and children.

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CPR Ratios (BLS 2202)

QUESTION

Short PICO title here	
POPULATION:	Adults and children with out-of-hospital cardiac arrest (OHCA)
INTERVENTION:	Any cardiopulmonary resuscitation (CPR) ratio delivered by emergency medical services (EMS)
COMPARISON:	Eligible comparator groups include a CPR ratio different from the one in the intervention arm delivered by EMS. Comparator groups that receive no CPR or compared manual CPR with mechanical CPR were excluded from the review. Studies including automated CPR or any use of mechanical devices will only be included if administered to all treatment arms.
MAIN OUTCOMES:	Favourable neurological survival (as measured by cerebral performance category or modified Rankin Score) at discharge or 30-days and at any time interval after 30-days; Survival to discharge or 30 days survival; Survival to any time interval after discharge or 30 days survival; Return of spontaneous circulation (ROSC); Quality of life as measured by any indicator or score.
SETTING:	Out-of-hospital setting
PERSPECTIVE:	
BACKGROUND:	This topic was prioritized for review due to the time since the previous systematic review (Ashoor 2017 112)
CONFLICT OF INTERESTS:	None

ASSESSMENT

Problem Is the problem a priority?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
o No o Probably no o Probably yes X Yes o Varies o Don't know	Conventional cardiopulmonary resuscitation (CPR) consists of manual chest compressions and positive-pressure ventilation to maintain oxygenation until return of spontaneous circulation is achieved. -During cardiopulmonary resuscitation (CPR), chest compressions are often interrupted to provide ventilation, undertake rhythm analysis or prioritise other tasks (sometimes in error). Data from animal studies indicate that ventilations can result in frequent interruptions in chest compressions which may reduce coronary and aortic blood flow during cardiac arrest and result in poorer outcomes (Kern 2002 645). Animal data also suggest that a CV ratio of 30:2 is associated with better haemodynamics and coronary perfusion pressure compared to 15:2 (Yannopoulos 2006 1444). One strategy to minimise pauses in chest compressions is to increase the compression to ventilation ratio, although this strategy risks a reduction in effective oxygenation during cardiac arrest.	
Desirable Effects How substantial are the desirable anticipated effects?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
o Trivial X Small o Moderate o Large o Varies	For the critical outcome of favourable neurological survival at discharge or 30-days, we identified very low certainty evidence (downgraded for risk of bias and serious indirectness) from two cohort studies (Kudenchuk 2012 1787, Berdowski 2010 1101). In one	

○ Don't know	cohort study (Kudenchuk 2012 1787), the implementation of the 2005 resuscitation guidelines consisting of a CV ratio of 30:2 (among other interventions) was associated with an improvement in neurologically favourable survival at hospital discharge compared to a prior period consisting of a CV ratio of 15:2 (OR 1.56, 95% CI: 1.11, 2.18). In comparison, the other study (Berdowski 2010 1101) found no change in outcomes for patients treated under the 2005 resuscitation guidelines. For the critical outcome of survival to hospital discharge or 30-day survival, we identified very low certainty evidence (downgraded for risk of bias and serious indirectness) from six cohort studies. Five studies (Steinmetz 2008 908, Olasveengen 2009 407, Sayre 2009 469, Deasy 2011 984, Kudenchuk 2012 1787) involved retrospective before-after analyses of the implementation of the 2005 resuscitation guidelines, consisting of a CV ratio of 30:2 (compared to 15:2) among other resuscitation practice changes. In three cohort studies of OHCA from all rhythms, the implementation of a CV ratio of 30:2 compared to 15:2 improved the risk-adjusted odds of survival in Sayre 2009 469 (AOR 1.8 (95% CI: 1.2, 2.7) and Steinmetz 2008 908 (AOR 2.5, 95% CI: 1.4, 4.6), but not in Olasveengen 2009 407 (AOR 1.42, 95% CI: 0.79, 2.57). For OHCA with initially shockable rhythms, Deasy 2011 984 reported an improvement in the risk-adjusted odds of survival to hospital discharge with a CV ratio of 30:2 compared with 15:2 (AOR 1.62, 95% CI: 1.33-1.98), which was completely attenuated after adjustment for the temporal trend (AOR 1.07, 95% CI: 0.71, 1.62). In OHCA patients with initial non-shockable rhythms, the implementation of a CV ratio of 30:2 compared to 15:2 increased the risk adjusted odds of survival in Kudenchuk 2012 1787 (AOR 1.53, 95% CI: 1.14, 2.05), but not in Deasy 2011 984 (AOR 1.19, 95% CI: 0.82, 1.73). A before-after study (Garza 2009 2597) of 200 bystander witnessed OHCA from initial shockable rhythms reported an improvement in survival to hospital discharge following the implementation of a bundled change in resuscitation practice consisting of a CV ratio of 50:2 compared to 5:1 (AOR 2.17, 95% CI: 1.26-3.73). For the critical outcome of return of spontaneous circulation, we identified very low certainty evidence (downgraded for risk of bias and serious indirectness) from one cohort study (Hostler 2007 446) of 1243 OHCA patients which showed no change in the risk-adjusted odds of return of spontaneous circulation with a CV ratio of 30:2 compared to 15:2 (OR 1.31, 95% CI: 0.99, 1.73).	

Undesirable Effects

How substantial are the undesirable anticipated effects?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
X Trivial ○ Small ○ Moderate	Although a number of the studies included demonstrated no impact from the changes in practice that included a change in CV ratio, none demonstrated harmful impacts	

o Large o Varies o Don't know	on patient outcomes. Among the six studies that were excluded from the review due to a lack of adjustment for confounding (Robinson 2010 1648, Aufderheide 2010 1357, Maisch 2010 998, Lick 2011 36, Schewe 2015 232, Yanagawa 2010 340), we also did not find any evidence of harm from the implementation of a CV ratio of 30:2.	
Certainty of evidence What is the overall certainty of the evidence of effects?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
X Very low o Low o Moderate o High o No included studies	The certainty of evidence for all outcomes was very low, d. Downgraded for risk of bias and serious indirectness. All studies included in this review suffered from serious indirectness, where a change to CV ratio was delivered or introduced as part of a bundle of care consisting of other changes, such as increases in CPR duration cycles, removal of stacked shocks, removal of post-shock rhythm checks and fewer interruptions to chest compressions. It is possible that the benefits observed in these studies are not related to a change in CV ratio, but other changes occurring at the same time. For instance, in one study (Rae 2006 2760), an improvement in survival to hospital discharge was observed in bystander witnessed OHCA from initial shockable rhythms after the implementation of the 2005 resuscitation guidelines without adopting the change to a CV ratio of 30:2.	
Values Is there important uncertainty about or variability in how much people value the main outcomes?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
o Important uncertainty or variability X Possibly important uncertainty or variability o Probably no important uncertainty or variability o No important uncertainty or variability	Only two studies were identified that provided adjusted estimates of the intervention effect for favourable neurological survival at discharge or 30-days. In one study (Kudenchuk 2012 1787), the implementation of the 2005 resuscitation guidelines consisting of a CV ratio of 30:2 was associated with an improvement in neurologically favourable survival at hospital discharge (Cerebral Performance Category score 1–2) compared to a prior period consisting of a CV ratio of 15:2. In another cohort study (Berdowski 2010 1101), patients treated under the 2005 resuscitation guidelines consisting of a CV ratio of 30:2 (among other interventions) was associated with no change in neurologically favourable survival at 30-days (Cerebral Performance Category score 1–2). No studies examined quality of life outcomes or longer-term patient outcomes.	
Balance of effects Does the balance between desirable and undesirable effects favor the intervention or the comparison?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
o Favors the comparison o Probably favors the comparison o Does not favor either the intervention or the comparison X Probably favors the intervention	Despite the theoretical risk of suboptimal ventilations in patients receiving higher CV ratios, we did not identify any evidence of harm following the implementation of practice changes involving a CV ratio of 30:2 compared to 15:2. It is possible that higher CV ratios may introduce greater risk of suboptimal oxygenation and ventilation.	

o Favors the intervention o Varies o Don't know		
Resources required How large are the resource requirements (costs)?"		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
o Large costs o Moderate costs X Negligible costs and savings o Moderate savings o Large savings o Varies o Don't know	Negligible impact on resources as all CV ratios require similar investment in staff and resources.	
Certainty of evidence of required resources What is the certainty of the evidence of resource requirements (costs)?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
o Very low o Low o Moderate o High X No included studies	There were no economic evaluations of the two treatment strategies.	
Cost effectiveness Does the cost-effectiveness of the intervention favor the intervention or the comparison?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
o Favors the comparison o Probably favors the comparison X Does not favor either the intervention or the comparison o Probably favors the intervention o Favors the intervention o Varies o No included studies	All CV ratios identified in this review are likely to be as cost-effective as the control.	
Equity What would be the impact on health equity?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
o Reduced o Probably reduced X Probably no impact o Probably increased o Increased o Varies o Don't know	Unlikely ~~the~~ that any CV ratio would enhance equitable access to resuscitation.	
Acceptability Is the intervention acceptable to key stakeholders?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**

o No o Probably no X Probably yes o Yes o Varies o Don't know	A CV ratio of 30:2 has been embedded in resuscitation guidelines since 2005.	

Feasibility Is the intervention feasible to implement?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
o No o Probably no o Probably yes X Yes o Varies o Don't know	The task force placed a high priority on consistency with our 2005, 2010, 2015 and 2020 treatment recommendations, which recommend the use of a CV ratio of 30:2.	

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
o	o	o	X	o

CONCLUSIONS

Recommendation

We suggest a compression–ventilation ratio of 30:2 compared with any other compression–ventilation ratio in adult patients in cardiac arrest (weak recommendation, very low-certainty evidence).

Justification

- In making this recommendation, the task force placed a high priority on consistency with our 2005, 2010, 2015 and 2020 treatment recommendations and the findings identified in this review, which suggest that the bundle of care (which included changing to a CV ratio of 30:2 from 15:2) resulted in more lives being saved.
- We note that there would likely be substantial resource implications (e.g., reprogramming, retraining) associated with a change in recommendation, and an absence of any data addressing our critical outcomes to suggest our current recommendation should be changed.
- As all the studies identified in this review were undertaken around the time of the 2005 resuscitation guideline changes, the task force felt there was little benefit in further reviews examining a CV ratio of 15:2. Future studies and reviews should focus on the benefit of longer compression to ventilation ratios, compared to the current recommendation of 30:2.
- All studies included in this review suffered from serious indirectness, where a change to CV ratio was delivered or introduced as part of a bundle of care consisting of other changes, such as increases in CPR duration cycles, removal of stacked shocks, removal of post-shock rhythm checks and fewer interruptions to chest compressions. It is possible that the benefits observed in these studies are not related to a change in CV ratio, but other changes occurring at the same time.
- The task force excluded from this review five studies (Rae 2006 2760, Hung 2010 569, Becker 2008 22, Hinchey 2010 348, Bigham 2011 979) comparing patient outcomes between the 2005 and 2000 resuscitation guideline periods, because they either did not specify changes to CV ratios or did not adopt changes to CV ratios. In one study (Rae 2006 2760), an improvement in survival to hospital discharge was observed in bystander witnessed OHCA from initial shockable rhythms after the implementation of the 2005 resuscitation guidelines without adopting the change to 30:2.

Subgroup considerations

Implementation considerations

We note that there would likely be substantial resource implications (e.g., reprogramming, retraining) associated with a change in recommendation, and an absence of any data addressing our critical outcomes to suggest our current recommendation should be changed.

Monitoring and evaluation

Research priorities

Current knowledge gaps include but are not limited to:

1. What is the true effect 30:2 versus 15:2 without any other concurrent changes in practice?
2. Is there a benefit of longer compression to ventilation ratios, compared to 30:2?
3. What is the ability of CPR providers to deliver two effective ventilations during the short allotted pause in chest compressions during CPR?
4. Is there a ratio-dependent critical volume of air movement required to maintain oxygenation?

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Duration of CPR Cycles (BLS 2212)

QUESTION

Should does pausing chest compressions at another interval vs. pausing chest compressions every two minutes to assess the cardiac rhythm be used for adults who are in cardiac arrest ?	
POPULATION:	Adults and children in any setting (in-hospital or out-of-hospital) with cardiac arrest and a shockable rhythm at any time during cardiopulmonary resuscitation (CPR)
INTERVENTION:	does pausing chest compressions at another interval
COMPARISON:	pausing chest compressions every two minutes to assess the cardiac rhythm
MAIN OUTCOMES:	Survival with favourable neurological outcome, Survival, ROSC, Coronary perfusion pressure, Cardiac output.
SETTING:	in any setting
PERSPECTIVE:	
BACKGROUND:	The ideal time interval to assess cardiac rhythm should balance the interruptions in chest compressions with rescuer fatigue and the ability to detect a change in clinical state.
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	ROSC is associated with achieving and sustaining adequate coronary perfusion pressure[1]. Longer duration CPR cycles may help to generate increased coronary perfusion pressure[2] and improve the likelihood of successful defibrillation[3]. Conversely, longer duration CPR cycles may also be associated with increased rescuer fatigue that adversely impacts the likelihood of achieving ROSC[4]. Furthermore, shorter CPR cycles may be associated with more frequent pauses leading to increased no-flow time adversely impacting the likelihood of achieving ROSC[5].	

Desirable Effects
How substantial are the desirable anticipated effects?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ Trivial ○ Small ● Moderate ○ Large ○ Varies ○ Don't know	Longer duration CPR cycles may help to generate increased coronary perfusion pressure[2] and improve the likelihood of successful defibrillation[3]	

Undesirable Effects
How substantial are the undesirable anticipated effects?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ Large ● Moderate ○ Small ○ Trivial ○ Varies ○ Don't know	Longer duration CPR cycles are associated with increased rescuer fatigue adversely impacting the likelihood of achieving ROSC[4]. Shorter CPR cycles may be associated with more frequent pauses leading to increased no-flow time adversely impacting the likelihood of achieving ROSC[5].	

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	There were few studies directly addressing the topic of the timing of pausing chest compression for rhythm analysis. The two studies examined not only the timing of pausing chest compressions but also whether shock should be given before CPR.	

Outcomes	Importance	Certainty of the evidence (GRADE)
[3 min vs 1 min] Survival to hospital discharge with favorable neurological outcome follow up: range 30 days to 1 years	CRITICAL	⨁◯◯◯ VERY LOW[a,b,c]
[3 min vs 1 min] Survival to hospital discharge follow up: range 30 days to 1 years	CRITICAL	⨁◯◯◯ VERY LOW[a,b,c]
[3 min vs 1 min] ROSC	IMPORTANT	⨁◯◯◯ VERY LOW[a,b,c]
[1 min vs 2 min] Survival to discharge	CRITICAL	⨁◯◯◯ VERY LOW[a,b,c]
[1 min vs 2 min] ROSC	IMPORTANT	⨁◯◯◯ VERY LOW[a,b,c]

a. Not blinded
b. Small sample size
c. Trial originally addressed different question; a guideline change partway through this trial resulted in different pause intervals for rhythm analysis

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	The outcomes of interest are: Survival to hospital discharge with good neurological outcome and survival to hospital discharge were ranked as critical outcomes. Return of spontaneous circulation (ROSC) was ranked as an important outcome	

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	There was no significant outcome associated with the intervention from the 2 RCTs.	

Outcomes	With pausing chest compressions every two minutes to assess the cardiac rhythm	With does pausing chest compressions at another interval	Difference	Relative effect (95% CI)

favor either the intervention or the comparison ○ Probably favors the intervention ○ Favors the intervention ○ Varies ○ Don't know	[3 min vs 1 min] Survival to hospital discharge with favorable neurological outcome follow up: range 30 days to 1 years	115 per 1,000	**192 per 1,000** (97 to 345)	**78 more per 1,000** (18 fewer to 230 more)	**OR 1.84** (0.83 to 4.07)	
	[3 min vs 1 min] Survival to hospital discharge follow up: range 30 days to 1 years	146 per 1,000	**221 per 1,000** (120 to 371)	**75 more per 1,000** (26 fewer to 226 more)	**OR 1.66** (0.80 to 3.46)	
	[3 min vs 1 min] ROSC	458 per 1,000	**558 per 1,000** (418 to 688)	**99 more per 1,000** (40 fewer to 229 more)	**OR 1.49** (0.85 to 2.60)	
	[1 min vs 2 min] Survival to discharge	180 per 1,000	**88 per 1,000** (38 to 188)	**92 fewer per 1,000** (142 fewer to 7 more)	**OR 0.44** (0.18 to 1.05)	
	[1 min vs 2 min] ROSC	532 per 1,000	**505 per 1,000** (371 to 640)	**26 fewer per 1,000** (160 fewer to 109 more)	**OR 0.90** (0.52 to 1.57)	

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	Modifying the timing of the cardiac rhythm check has no direct cost. However, it will require considerable investment in re-training, changes to training materials and changes to device software, all of which present considerable indirect costs.	

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 data available.	

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 data available.	
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 published data available.	
Acceptability Is the intervention acceptable to key stakeholders?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
○ No ○ Probably no ● Probably yes ○ Yes ○ Varies ○ Don't know	Previous guidelines have used different time periods (e.g. 1 min, 3 min) for rhythm analysis, and were successfully implemented.	
Feasibility Is the intervention feasible to implement?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
○ No ○ Probably no ● Probably	Retraining rescuers using the new approach will be necessary.	

yes o Yes o Varies o 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	Large	**Moderate**	**Small**	Trivial		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
o	•	o	o	o

CONCLUSIONS

Recommendation

We suggest rescuers should assess the cardiac rhythm every two minutes (weak recommendation, very-low certainty of evidence).

Justification

There is not enough evidence to recommend for or against pausing chest compressions at another interval compared to pausing chest compressions every two minutes to assess the cardiac rhythm in adults who are in cardiac arrest in any setting.

Subgroup considerations

Prehospital response intervals longer than five minutes have been shown to have more favourable outcomes (ROSC, survival to discharge and survival with good neurological outcome) from three minutes of CPR before the first defibrillation followed by chest compression every three minutes to check the cardiac rhythm.

Implementation considerations

Monitoring and evaluation

Research priorities

1. Does the optimal interval differ for patients with different initial cardiac rhythms?
2. Does the duration between collapse and EMS arrival affect the optimal interval?
3. Do different intervals interfere with the overriding goal of minimising interruptions in chest compressions?
4. Does the newer ECG machines reliably remove artefact during CPR and enable the analysis of cardiac rhythm without pausing?
5. What is the relationship between rescuer fatigue, chest compression quality, and the optimal interval?

EMS CCO vs. CPR (BLS 2221)

QUESTION

Question: In adults and children with cardiac arrest treated by emergency medical services, does continuous chest compressions with or without ventilations compared with standard CPR improve patient outcomes?	
POPULATION:	Adults and children in any setting (in-hospital or out-of-hospital) with cardiac arrest
INTERVENTION:	Continuous chest compressions delivered by emergency medical services (EMS) with or without ventilations
COMPARISON:	Standard CPR, defined as any compression-to-ventilation ratio delivered by EMS. Comparator groups that receive no CPR or compared manual CPR with mechanical CPR were excluded from the review. Studies including automated CPR or any use of mechanical devices were only be included if administered to all treatment arms.
MAIN OUTCOMES:	Favourable neurological survival (as measured by cerebral performance category or modified Rankin Score) at discharge or 30-days and at any time interval after 30-days; Survival to discharge or 30 days survival; Survival to any time interval after discharge or 30 days survival; Return of spontaneous circulation (ROSC); Quality of life as measured by any indicator or score.
SETTING:	Out-of-hospital
PERSPECTIVE:	
BACKGROUND:	
CONFLICT OF INTERESTS:	BLS TF Members Laurie Morrison and Christian Vaillancourt are co-authors on the ROC CCC trial (Nichol 2015 2203)

ASSESSMENT

Problem Is the problem a priority?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
○ No ○ Probably no ○ Probably yes **X** Yes ○ Varies ○ Don't know	Conventional cardiopulmonary resuscitation (CPR) consists of manual chest compressions and positive-pressure ventilation to maintain oxygenation until return of spontaneous circulation is achieved. Ventilations result in frequent interruptions in chest compressions, however, which can reduce coronary and aortic blood flow during cardiac arrest and has been associated with poorer survival in animal models (Kern 2002 645). Similarly, higher chest compression fraction (total resuscitation time spent performing chest compressions) has been associated with improved outcomes in observational studies (Christenson 2009 1241). One strategy to improve chest compression fraction and reduce interruptions in chest compression is to perform continuous chest compression with 1) asynchronous ventilations or 2) passive oxygenation via face mask. However, there is also concern that continuous chest compression may be harmful for patients who require more effective ventilations, such as asphyxial arrests or drowning (Berg 2000 1743).	In resource-limited environments including the prehospital setting, there is value in limiting resuscitation logistics wherever possible. Some systems have achieved this by performing continuous chest compression with passive oxygenation which may help prioritise other treatments. There has also been widespread adoption of high-performance CPR among EMS systems which focus on providing minimally interrupted chest compressions.
Desirable Effects How substantial are the desirable anticipated effects?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
○ Trivial **X** Small ○ Moderate ○ Large	Interruptions in chest compressions have been associated with poorer clinical outcomes in observational studies (Christenson 2009 1241). Pauses for ventilations are a significant source of interruptions in chest compressions	A strategy of CCC has been shown to significantly improve chest compression fraction in a large cluster RCT (Nichol 2015 2203).

○ Varies ○ Don't know	and may have negative impacts on coronary and aortic blood flow (Berg 2001 2465). Asynchronous positive pressure ventilation may achieve similar oxygenation without compromising chest compression quality. However, based on a large cluster RCT undertaken in North America (Nichol 2015 2203) the likely benefit to patient outcomes is small. In this RCT, adherence to protocol was low and it is possible that larger differences in patient outcomes exist with greater compliance to CCC strategy. Studies adopting minimally interrupted cardiac resuscitation (Bobrow 2008 1158) have demonstrated larger impacts on patient outcomes, particularly in patients with witnessed shockable OHCA. These studies, however, have typically examined minimally interrupted cardiac resuscitation as a bundle with other resuscitation practice changes and therefore the directness of evidence is uncertain.	
Undesirable Effects How substantial are the undesirable anticipated effects?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
○ Large ○ Moderate **X** Small ○ Trivial ○ Varies ○ Don't know	Based on a large cluster RCT undertaken in North America (Nichol 2015 2203), CCC was not inferior to standard CPR in the intention-to-treat analysis. However, in the per-protocol population, the survival rate was significantly lower in the CCC group compared to the standard CPR group (adjusted difference, −2.0 percentage points; 95% CI, −2.9 to −1.1; P<0.001), although the groups were imbalanced and larger numbers of patients were excluded due to noncompliance. Adjustment for pretreatment confounders attenuated the difference in the survival rate between the treatment groups in the per protocol analysis (difference, −0.3 percentage points; 95% CI, −1.1 to 0.4; P = 0.38). In another large observational study (Schmicker 2021 31) from the Resuscitation Outcomes Consortium, the association between treatment groups was attenuated by adherence to the intended strategy. For the intended strategy of CCC, survival was significantly lower when adhered to (adjusted OR: 0.72 [95% CI: 0.64, 0.81]), while for the intended strategy of 30:2, survival was higher when adhered to (adjusted OR: 1.05 [95% CI: 0.90, 1.22]). This may suggest some harm with a CCC strategy.	Presently, there is a lack of scientific evidence to support the use passive oxygenation during OHCA. It is possible that passive oxygenation may be inferior to PPV, which may be more clinically important in OHCA precipitated by asphyxia or drowning. It is also possible that PPV may be more effective for oxygenation but too difficult to achieve in practice. As such, the net benefit of PPV may be smaller than passive oxygenation or asynchronous ventilations using PPV.
Certainty of evidence What is the overall certainty of the evidence of effects?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
○ Very low ○ Low **X** Moderate ○ High ○ No included studies	The CoSTR included 4 studies; one large moderate-quality cluster RCT with crossover (Nichol 2015 2203) and 3 other very-low-quality cohort studies. The Task Force gave greater weight to the certainty of evidence derived from the cluster RCT as it addressed the PICOST directly. The certainty of evidence in the RCT was downgraded due to risk of bias from baseline differences (witness status and cluster), lack of blinding of intervention, lack of protection against contamination in the treatment strategies, and indirectness due to a low rate of protocol compliance. The certainty of evidence from the remaining cohort studies were also downgraded due to a high risk of residual	

	confounding, high rates of non-adherence to treatments, and indirectness from the use of a bundled intervention.	
Values Is there important uncertainty about or variability in how much people value the main outcomes?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
o Important uncertainty or variability **X** Possibly important uncertainty or variability o Probably no important uncertainty or variability o No important uncertainty or variability	There was only one study included that considered the impact of CCC and standard CPR on neurologically favourable survival, however, this was a large RCT (Nichol 2015 2203). No studies examined quality of life outcomes or longer-term patient outcomes.	
Balance of effects Does the balance between desirable and undesirable effects favor the intervention or the comparison?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
o Favors the comparison o Probably favors the comparison o Does not favor either the intervention or the comparison **X** Probably favors the intervention o Favors the intervention o Varies o Don't know	Despite the theoretical risk of suboptimal ventilations in patients receiving CCC, there is limited data suggesting a negative impact on survival. Conversely, there is some observational data to indicate potential patient harm from interruptions in chest compressions. Furthermore, standard CPR involving a compression-to-ventilation ratio is hard to achieve, and in practice may result in asynchronous ventilations.	
Resources required How large are the resource requirements (costs)?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
o Large costs o Moderate costs **X** Negligible costs and savings o Moderate savings o Large savings o Varies o Don't know	Negligible impact on resources as both treatment strategies require similar investment in staff and resources.	It is possible the CCC is easier to teach and may be more practical in resource-limited environments. Data from one RCT (Nichol 2015 2203) and observation studies suggest that CCC is associated with more adherence to protocol compared to standard CPR (Bobrow 2008 1158; Schmicker 2021 31).
Certainty of evidence of required resources What is the certainty of the evidence of resource requirements (costs)?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
o Very low o Low o Moderate o High X No included studies	There were no economic evaluations of the two treatment strategies.	
Cost effectiveness Does the cost-effectiveness of the intervention favor the intervention or the comparison?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**

o Favors the comparison o Probably favors the comparison **X** Does not favor either the intervention or the comparison o Probably favors the intervention o Favors the intervention o Varies o No included studies	CCC is likely to be as cost-effective as standard CPR.	
Equity What would be the impact on health equity?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
o Reduced o Probably reduced **X** Probably no impact o Probably increased o Increased o Varies o Don't know	In the EMS setting, it is unlikely that CCC would improve treatment equity compared to standard CPR.	
Acceptability Is the intervention acceptable to key stakeholders?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
o No o Probably no o Probably yes **X** Yes o Varies o Don't know	Many EMS systems around the world have already implemented CCC or minimally interrupted cardiac resuscitation.	
Feasibility Is the intervention feasible to implement?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
o No o Probably no o Probably yes **X** Yes o Varies o Don't know	The task force placed high value on the importance of providing high-quality chest compressions and simplifying resuscitation logistics for EMS systems and noted the support for the clinical benefit of bundles of care involving minimally interrupted cardiac resuscitation.	

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	Large	Moderate	**Small**	Trivial		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
o	o	**X**	o	o

Treatment Recommendation

We recommend that EMS providers perform CPR with 30 compressions to 2 ventilations or continuous chest compressions with positive pressure ventilations delivered without pausing chest compressions in adults in cardiac arrest (strong recommendation, moderate-certainty evidence).

In-hospital CCO vs. CPR (BLS 2222)

QUESTION

Question: In adults and children with cardiac arrest does continuous chest compressions with or without ventilations compared with standard CPR delivered by in-hospital providers improve patient outcomes?	
POPULATION:	Adults and children in any setting (in-hospital or out-of-hospital) with cardiac arrest
INTERVENTION:	Continuous chest compressions with or without ventilations delivered by in-hospital providers
COMPARISON:	Standard CPR, defined as any compression-to-ventilation ratio, delivered by in-hospital providers. Comparator groups that received no CPR or compared manual CPR with mechanical CPR were excluded from the review. Studies including automated CPR or any use of mechanical devices were included if administered to all treatment arms.
MAIN OUTCOMES:	Favourable neurological survival (as measured by cerebral performance category or modified Rankin Score) at discharge or 30-days and at any time interval after 30-days; Survival to discharge or 30 days survival; Survival to any time interval after discharge or 30 days survival; Return of spontaneous circulation (ROSC); Quality of life as measured by any indicator or score.
SETTING:	In-hospital setting (including emergency departments)
PERSPECTIVE:	
BACKGROUND:	This topic was prioritized for review due to the time since the previous systematic review.(Ashoor 2017 112)
CONFLICT OF INTERESTS:	None

ASSESSMENT

Problem Is the problem a priority?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
o No o Probably no o Probably yes **X** Yes o Varies o Don't know	Conventional cardiopulmonary resuscitation (CPR) consists of manual chest compressions and positive-pressure ventilation to maintain oxygenation until return of spontaneous circulation is achieved. Ventilations result in frequent interruptions in chest compressions, however, which can reduce coronary and aortic blood flow during cardiac arrest and has been associated with poorer survival in animal models (Kern 2002 645). Similarly, higher chest compression fraction (total resuscitation time spent performing chest compressions) has been associated with improved outcomes in observational studies (Christenson 2009 1241). One strategy to improve chest compression fraction and reduce interruptions in chest compression is to perform continuous chest compression with 1) asynchronous ventilations or 2) passive oxygenation via face mask. However, there is also concern that continuous chest compression may be harmful for patients who require more effective ventilations, such as asphyxial arrests or drowning (Berg 2000 1743).	In resource-limited environments, there is value in limiting resuscitation logistics wherever possible. Some EMS systems have achieved this by performing continuous chest compression with passive oxygenation which may help prioritise other treatments. There has also been widespread adoption of high-performance CPR among EMS systems which focus on providing minimally interrupted chest compressions.
Desirable Effects How substantial are the desirable anticipated effects?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
o Trivial **X** Small o Moderate o Large	Interruptions in chest compressions have been associated with poorer clinical outcomes in observational studies (Christenson 2009 1241). Pauses for ventilations are a significant source of interruptions in chest compressions	A strategy of CCC has been shown to significantly improve chest compression fraction in a large cluster RCT in EMS (Nichol 2015 2203).

○ Varies ○ Don't know	and may have negative impacts on coronary and aortic blood flow (Berg 2001 2465). Asynchronous positive pressure ventilation may achieve similar oxygenation without compromising chest compression quality. **For the critical outcome of survival,** we identified very-low quality evidence (downgraded for risk of bias and very serious imprecision) from one cohort study in adults.(Lee 2013 158) In adjusted analysis from this study patients who received mechanical chest compressions and tracheal intubation with positive pressure ventilations without pausing chest compressions had increased adjusted survival to hospital discharge (adjusted odds ratio [aOR] = 2.43, 95%CI: 1.15 to 5.12) when compared to those who received mechanical chest compressions interrupted for ventilations at a ratio of 5 compressions to 1 ventilation. **For the critical outcome of return of spontaneous circulation,** we identified very-low quality evidence (downgraded for risk of bias and very serious imprecision) from one cohort study in adults.(Lee 2013 158) In the adjusted analysis, patients who received mechanical chest compressions and tracheal intubation with positive pressure ventilations without pausing chest compressions had increased return of spontaneous circulation (adjusted odds ratio [aOR] = 1.62, 95%CI: 1.07 to 2.43) when compared to those who received mechanical chest compressions interrupted for ventilations at a ratio of 5 compressions to 1 ventilation.	
Undesirable Effects How substantial are the undesirable anticipated effects?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
○ Large ○ Moderate **X** Small ○ Trivial ○ Varies ○ Don't know		
Certainty of evidence What is the overall certainty of the evidence of effects?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
X Very low ○ Low ○ Moderate ○ High ○ No included studies	The certainty of evidence for all outcomes was very low. Downgraded for risk of bias, imprecision and indirectness. The mechanical CPR devices are not in widespread use, particularly the models use in the single study. The CPR provided in the control arm was not at a ratio recommended by international guidelines or ILCOR. The only study that directly examined this PICOST was conducted with a before-and-after design that, although adjusted for demographic and cardiac arrest characteristics, did not account for potential temporal differences in resuscitation efficiencies between study periods.	
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	There was only one study included that considered the impact of CCC and standard CPR on neurologically	

uncertainty or variability o Probably no important uncertainty or variability **X** No important uncertainty or variability	favourable survival.(Lee 2013 158) No studies examined quality of life outcomes or longer-term patient outcomes.	
Balance of effects Does the balance between desirable and undesirable effects favor the intervention or the comparison?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
o Favors the comparison o Probably favors the comparison o Does not favor either the intervention or the comparison **X** Probably favors the intervention o Favors the intervention o Varies o Don't know	Despite the theoretical risk of suboptimal ventilations in patients receiving CCC, there is limited data suggesting a negative impact on survival. Conversely, there is some observational data to indicate potential patient harm from interruptions in chest compressions. Furthermore, standard CPR involving a compression-to-ventilation ratio is hard to achieve, and in practice may result in asynchronous ventilations.(Schmicker 2021 31)	One large high-quality RCT in EMS reported no difference in patient outcomes with ventilations at a rate of 10/min without pausing compressions compared with a 30:2 ratio before intubation.(Nichol 2015 2203)
Resources required How large are the resource requirements (costs)?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
o Large costs o Moderate costs **X** Negligible costs and savings o Moderate savings o Large savings o Varies o Don't know	Negligible impact on resources as both treatment strategies require similar investment in staff and resources.	It is possible the CCC is easier to teach and may be more practical in resource-limited environments. Data from one RCT (Nichol 2015 2203) and observation studies suggest that CCC is associated with more adherence to protocol compared to standard CPR.(Schmicker 2021 31)
Certainty of evidence of required resources What is the certainty of the evidence of resource requirements (costs)?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
o Very low o Low o Moderate o High **X** No included studies	There were no economic evaluations of the two treatment strategies.	
Cost effectiveness Does the cost-effectiveness of the intervention favor the intervention or the comparison?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
o Favors the comparison o Probably favors the comparison **X** Does not favor either the intervention or the comparison o Probably favors the intervention o Favors the intervention o Varies o No included studies	CCC is likely to be as cost-effective as standard CPR.	
Equity What would be the impact on health equity?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**

o Reduced o Probably reduced **X** Probably no impact o Probably increased o Increased o Varies o Don't know	In the in-hospital setting, it is unlikely that CCC would improve treatment equity compared to standard CPR.	
Acceptability Is the intervention acceptable to key stakeholders?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
o No o Probably no o Probably yes o Yes o Varies **X** Don't know	Unknown.	
Feasibility Is the intervention feasible to implement?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
o No o Probably no o Probably yes **X** Yes o Varies o Don't know	The task force placed high value on the importance of providing high-quality chest compressions and simplifying resuscitation logistics for providers and noted the support for the clinical benefit of bundles of care involving minimally interrupted cardiac resuscitation.	

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	Large	Moderate	**Small**	Trivial		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	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
○	○	**X**	○	○

Treatment Recommendations

In-hospital providers should perform CPR with 30 compressions to 2 ventilations or continuous chest compressions with positive pressure ventilations delivered without pausing chest compressions in adults in cardiac arrest (Good Practice Statement).

Justification

Evidence from one study and studies in EMS do not indicate harm with continuous compressions with ventilations. The good practice statement for practice before an advanced airway is placed was added to fill the treatment gap and provide guidance for immediate CPR.

Data on the same question in EMS found no high-quality evidence to support the superiority of either CCC or standard CPR for patient outcomes in OHCA. The task force also placed high-value on providing consistent recommendations for EMS and in-hospital providers, noting that the evidence in EMS is supported by one large RCT.(Nichol 2015 2203)

The task force also placed a relatively high value on the importance of providing high-quality chest compressions and simplifying resuscitation logistics for providers and noted support for the clinical benefit of bundles of care involving minimally interrupted cardiac resuscitation. Evidence suggests that a CV ratio of 30:2 may be much harder to achieve in practice and would ultimately result in asynchronous ventilations.(Schmicker 2021 31)

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Hand Position During Compressions (BLS 2502)

QUESTION

Should any other location for chest compressions vs. delivery of chest compressions on the lower half of the sternum be used for [health problem and/or population]?	
POPULATION:	Adults and children in any setting (in-hospital or out-of-hospital) with cardiac arrest
INTERVENTION:	any other location for chest compressions
COMPARISON:	delivery of chest compressions on the lower half of the sternum
MAIN OUTCOMES:	Any clinical outcome. Survival to hospital discharge with good neurological outcome and survival to hospital discharge were ranked as critical outcomes. Return of spontaneous circulation (ROSC) was ranked as an important outcome. Physiological outcomes including blood pressure, coronary perfusion pressure or $EtCO_2$ were also considered important outcomes.
SETTING:	Cardiac arrest
PERSPECTIVE:	Health care provider
BACKGROUND:	The previous ILCOR recommendations are from the 2010 CoSTR.{Sayre 2010 S298; Koster 2010 e48} The BLS task force performed a TF based systematic review to update this recommendation.
CONFLICT OF INTERESTS:	The following Task Force members and other authors declared an intellectual conflict of interest and this was acknowledged and managed by the Task Force Chairs and Conflict of Interest committees: Olasveengen: author on one of the included papers

ASSESSMENT

Problem
Is the problem a priority?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ No ● Probably no ○ Probably yes ○ Yes ○ Varies ○ Don't know	None	There is broad consensus that optimizing chest compressions during cardiac arrest is vital to improve patient survival. There is limited focus on hand placement within the resuscitation research community, but concerns of injury and emphasis on correct hand placement are important topics during CPR training courses - and evidence to support current recommendations are lacking.

Desirable Effects
How substantial are the desirable anticipated effects?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ Trivial ○ Small ○ Moderate ○ Large ○ Varies ● Don't know	There were no studies reporting the critical outcomes of favorable neurologic outcome, survival, or ROSC. For the important outcome of physiological end points, we identified 3 very low certainty studies (downgraded for bias, indirectness, and imprecision).{Orlowski 1986 667; Cha 2013 691; Qvigstad 2013 1203} One crossover study in 17 adults with prolonged resuscitation from non-traumatic cardiac arrest observed improved peak arterial pressure during compression systole (114 ± 51 mm Hg versus 95 ± 42 mm Hg) and end-tidal carbon dioxide (ETCO2; 11.0 ± 6.7 mm Hg versus 9.6 ± 6.9 mm Hg) when compressions were performed in the lower third of the sternum compared with the center of the chest, whereas arterial pressure during compression recoil peak right atrial pressure and coronary perfusion pressure did not	There is no evidence evaluating effects or even associations between hand position and patient outcomes. Studies looking at various hand positions and physiological parameters such as blood pressure or EtCO2 indicate finding optimal hand position might impact patient outcomes.

	differ.{Cha 2013 691} A second crossover study in 30 adults observed no difference between ETCO2 values and hand placement.{Qvigstad 2013 1203} A further crossover study in 10 children observed higher peak systolic pressure and higher mean arterial blood pressure when compressions were performed on the lower third of the sternum compared with the middle of the sternum.{Orlowski 1986 667}	
Undesirable Effects How substantial are the undesirable anticipated effects?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
○ Large ○ Moderate ○ Small ○ Trivial ○ Varies ● Don't know	The studies identified did not report any harm from varying hand placement, but their numbers were very small.	Potential undesirable effects could be harm related to compressing too far caudally or to any of the side which would have the potential for organ damage. Additionally, any strategy that complicated the resuscitation risks negatively affecting quality of CPR.
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	Only evidence of surrogate outcomes and indirect evidence - very low certainty.	
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 uncertainty about the value of the critical outcomes of favorable neurologic outcome, survival, or ROSC. There is less certainty about the important outcome of physiological end points.	Cardiac arrest mortality remains very high, and there is no important uncertainty or variability in how much people value improved survival from cardiac arrest, or how much resuscitation experts value high quality CPR.
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	Very low certainty evidence suggests optimizing hand placement could add to the effectiveness of chest compressions during CPR, but there is currently no proven strategy for how to identify the optimal compression point. The studies identified did not report any harm from varying hand placement, but their numbers were very small. As there is little evidence evaluating potential harmful effects, experimentation to find optimal compression point should only be done in a research setting.	
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	Depending on the technology used to identify optimal hand placement, implementing new strategies could come at substantial cost. If strategies use monitoring already in common practice, the costs are limited to education and training. These are always hard to estimate because re-training CPR at set intervals is already recommended, and additional costs are therefore mostly related to changing educational content.
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 specific evidence was identified.	
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 specific evidence was identified.	
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 reason to expect any specific impacts on health equity. No specific evidence was identified.	Depending on the technology that might be used to guide hand placement, need for expensive equipment could potentially negatively impact health equity.
Acceptability Is the intervention acceptable to key stakeholders?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
○ No ● Probably no ○ Probably yes ○ Yes ○ Varies	No specific evidence related to stakeholder acceptability was identified.	As the certainty of current evidence is very low, and there is a potential for harm and potential for added cost – a change to hand position for chest compressions is likely to NOT be

○ Don't know		acceptable to stakeholders before more evidence has been evaluated.

Feasibility
Is the intervention feasible to implement?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ No ○ Probably no ● Probably yes ○ Yes ○ Varies ○ Don't know	The few studies identified would indicate it could be feasibly to develop strategies to assess alternative hand placement recommendations or strategies to identify individual hand placement during CPR.	

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	Large	Moderate	Small	Trivial		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

We suggest performing chest compressions on the lower half of the sternum on adults in cardiac arrest (weak recommendation, very low certainty evidence).

Justification

The existing ILCOR treatment recommendation was published in 2010{Sayre 2010 S298; Koster 2010 e48}: "For adults receiving chest compressions, it is reasonable for rescuers to place their hands on the lower half of the sternum." This topic was not reviewed in detail for the 2015 CoSTR.

Imaging studies were excluded from the current systematic review as they do not report clinical outcomes for patients in cardiac arrest, but they do provide some supportive background information. Imaging studies examining hand position for chest compressions describe the optimal position for compressions based on the anatomical structures underlying the recommended and alternative hand positions. Evidence from recent imaging studies indicates that, in most adult and pediatric patients, the maximal ventricular cross-sectional area underlies the lower third of the sternum/xiphisternal junction, and the ascending aorta and left ventricular outflow tract underlie the center of the chest.{Park 2018 e576; Lee 2018 1; Nestaas 2016 54; Cha 2013 615; Papadimitriou 2013 549; Holmes 2015 401}. Imaging studies also suggest there might be important differences in anatomy between individuals depending on factors including age, Body Mass Index, congenital cardiac disease and pregnancy, and as such one specific hand placement strategy might not provide optimal compressions across a range of persons.{Park 2016 303; Lee 2018 1; Holmes 2015 401}. However, there is an absence of robust clinical evidence reporting survival outcomes or harm from any alternate hand position for chest compressions.

In reconfirming the recommendation to perform chest compressions on the lower half of the sternum, with rewording to be consistent with the GRADE process, we placed a high value on consistency with previous recommendations, in the absence of compelling clinical data suggesting the need to change the recommended approach. The BLS Task Force acknowledges that every change in guidelines comes with a significant risk and cost as CPR educators and providers are asked to change current practice and implement new treatment strategies. Important gaps remain in evaluating how to identify optimal hand placement and/or compression point for individuals in cardiac arrest using physiologic feedback or incorporating previous imaging.

Subgroup considerations

None

Implementation considerations

None

Monitoring and evaluation

None

Research priorities

Current knowledge gaps include but are not limited to:

- Associations between different hands-positions during CPR and patient outcomes
- Should strategies to identify optimal individual hand placement during CPR be developed?
- Which physiological parameter is most useful in evaluating optimal hand placement during CPR?

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Head-Up CPR (BLS 2503)

QUESTION

Should Head up CPR vs. standard CPR be used for cardiac arrest?	
POPULATION:	Adults and children in any setting (in-hospital or out-of-hospital) with cardiac arrest
INTERVENTION:	Head-up CPR or Head-up CPR bundle (e.g., Head Up Position: HUP, Active Compression/Decompression: ACD, and the Impedance Threshold Device: ITD)
COMPARISON:	Standard or compression-only CPR in supine position
MAIN OUTCOMES:	Critical outcomes: Survival to hospital discharge with good neurological outcome, survival to hospital discharge, event survival, survival to 30 days, survival to 30 days with good neurological outcome Important outcome: Return of spontaneous circulation (ROSC)
SETTING:	In-hospital and out-of-hospital setting
PERSPECTIVE:	
BACKGROUND:	
CONFLICT OF INTERESTS:	The following Task Force members and other authors declared an intellectual conflict of interest, and this was acknowledged and managed by the Task Force Chairs and Conflict of Interest committees: Guillaume Debaty

ASSESSMENT

Problem Is the problem a priority?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
○ No ○ Probably no ○ Probably yes ● Yes ○ Varies ○ Don't know	Mortality after cardiac arrest remains high, and there is broad consensus that new treatments and strategies are needed.	
Desirable Effects How substantial are the desirable anticipated effects?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
○ Trivial ○ Small ○ Moderate ○ Large ○ Varies ● Don't know	The systematic review search identified 375 studies, of which 15 studies were selected for full-text screening. There were three observational studies[i,ii,iii] and no RCTs included. These three observational studies came from the same research initiative. The studies by Moore and Bachista obtained their Intervention patients from the same registry that included patients who received head-up CPR. This is referred to as the ACE (Automated Controlled Elevation)-CPR registry (2019-2020) in the Moore paper and as the AHUP (automated head/thorax-up positioning)-CPR registry (2019-2021) in the Bachista paper. To obtain their comparator	

	patients, both studies utilized the large NIH-funded RCTs conducted approximately 10 years earlier: Moore drew from the ROC PRIMED study (conducted from 2007 to 2009) [iv], ROC ALPS study (conducted from 2012 to 2015)[v], and ResQTrial (conducted from 2006 to 2009),[vi] while Bachista used the ROC PRIMED study and the ResQTrial. **Good Neurological Outcome and Survival to Hospital Discharge** For the critical outcomes of survival to hospital discharge with a good neurological outcome and survival to hospital discharge, we identified very-low-certainty evidence (downgraded for serious risk of bias) from three observational studies (Pepe, 2019; Moore, 2022; Bachista, 2024).[1,2,3] The observational study conducted by Pepe et al.[1] included 2,322 adult out-of-hospital cardiac arrest patients. It compared outcomes before and after the introduction of the head-up / torso up chest compression technique. A bundle comprising the mechanical CPR device with an ITD was compared with a bundle comprising the former (mechanical CPR device with ITD) but with the addition of: 1. Applied oxygen with deferral of positive pressure ventilation for a few minutes (number of minutes not specified), 2. A pit crew approach for rapid placement of the mechanical CPR device and, 3. Placement of the patient in the reverse Trendelenburg position (20 degrees), with the specific time frame not clarified. Metrics such as average Emergency Medical Services (EMS) crew response intervals, relative frequency of ECG presentations, gender, and frequency of cases witnessed by bystanders were similar between groups. Details about survival with good neurological outcomes was limited to a mention that about 35–40% of those resuscitated ultimately achieved “intact neurologic status”, defined as “modified Rankin Score < 3” in both the pre- and post-intervention groups “wherever tracked”. Missing rates in both groups were unreported. The study by Moore et al. included 227 adult OHCA patients who	

	received the head-up CPR bundle enrolled in the ACE-CPR registry from 2019 to 2020, and 5,196 adult OHCA patients who received conventional CPR with supine positioning enrolled in three RCTs conducted from 2005 to 2015 at high-performing pre-hospital systems in the United States.[2] The study found no statistically significant difference for survival to hospital discharge between the head-up CPR group and the conventional CPR group (9.5% [21/222] vs. 6.7% [58/860], OR 1.44, 95% CI 0.86–2.44) or in survival to hospital discharge with favorable neurological status (5.9% [13/222] vs. 4.1% [35/860], OR 1.47, 95% CI 0.76–2.82). The odds ratio of cumulative survival to hospital discharge between conventional-CPR and head-up CPR groups, based on the time interval from the 9–1–1 emergency call to head-up CPR start after propensity-score matching, was 1.65 (95% CI 0.93-2.94) for < 20 mins and 0.82 (95% CI 0.23 – 2.97) for 20-38 mins, indicating no statistically significant difference. Similarly, the odds ratio of cumulative survival to hospital discharge with favourable neurological function between conventional-CPR and head-up CPR groups was 1.85 (95% CI 0.91-3.74) for < 20 mins and 0.42 (95% CI 0.05 – 3.39) for 20-38 mins, indicating no statistically significant difference. The study by Bachista et al. focused on patients with nonshockable rhythms and included 380 adult out-of-hospital nonshockable cardiac arrests who received the head-up CPR bundle in the AHUP-CPR registry, which is the same head-up CPR registry mentioned earlier.[3] As a comparison group, the study included 1,852 adult out-of-hospital nonshockable cardiac arrests who received conventional CPR with supine positioning enrolled in two different RCTs in the United States. The study showed that the unadjusted likelihood of survival to hospital discharge in the head-up CPR group was 7.4% (28/380) versus 3.1% (58/1,852) in the conventional CPR group (OR 2.46, 95% CI 1.55–3.92), which remained higher after propensity score matching, 7.6%	

	(27/353) in the head-up CPR group versus 2.8% (10/353) in the conventional CPR group (OR 2.84, 95% CI 1.35–5.96). The head-up CPR bundle was also associated with higher probabilities of survival with favorable neurological function (4.2% [15/353] vs. 1.1% [4/353]; OR 3.87, 95% CI 1.27–11.78). **ROSC** For the important outcome of ROSC, the observational study by Pepe et al. demonstrated an increased rate of successful resuscitation (defined as hospital arrival with sustained spontaneous circulation) from a mean of 17.87% (n = 806) to a mean of 34.22% (n = 1,356). The Moore study showed no statistically significant difference in the rate of ROSC between the head-up CPR group and the conventional CPR group (33% [74/222] vs. 33% [282/860], OR 1.02, 95% CI 0.75–1.49). The Bachista study indicated that ROSC rates were not statistically different between the head-UP CPR group and the conventional CPR group in unadjusted analyses (33% [125/380] vs. 29% [535/1,852], OR 1.21, 95% CI 0.95–1.53), nor in adjusted analyses with propensity score matching (33% [118/353] vs. 29% [101/353], OR 1.25, 95% CI 0.91–1.72).	
Undesirable Effects How substantial are the undesirable anticipated effects?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
○ Large ○ Moderate ○ Small ○ Trivial ○ Varies ● Don't know	In an observational study (December 31, 2021), there was no observed safety/complication issues reported in 965 OHCA patients who received head-up CPR from 11 EMS systems in the United States.[3]	
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	This topic was prioritized by the BLS Task Force based on new observational studies since our previous systematic review in 2021.[vii] In this systematic review, we identified very low certainty evidence that the head-up CPR bundle is	

	associated with better survival and neurological outcomes. Head-up CPR is a newer resuscitation strategy, first described in 2014, that involves gradual elevation of the head after CPR has been initiated, to improve cerebral perfusion, coronary perfusion, and possibly ventilation during CPR.[viii,ix] Although the intervention may sound simple, previous studies have suggested that it is more complex than initially thought.[x] Animal studies have indicated that head-up CPR is most effective when used with ACD and ITD, as there is inadequate arterial pressure to create upward flow and achieve cerebral perfusion pressure in the absence of these devices.[xi,xii,xiii] Based on these findings, head-up CPR is often performed as part of a bundled approach, including the use of ACD and ITD devices.[1,2,3,xiv] The BLS Task Force recognized that the currently available evidence is still limited, highlighted by the absence of RCTs or observational studies with adequate comparisons. The implementation of the studied head-up CPR bundle requires the purchase of expensive equipment, which includes an automated head/thorax-up positioning device, a mechanical CPR device, and an ITD, as well as significant training. The task force concluded that there is not sufficient clinical evidence to support the use of head-up CPR or head-up CPR bundle during CPR except in the setting of clinical trials or research initiatives. The task force identified several distinct methods in the studies reviewed. Although the bundle approach that includes head-up position with automated head/thorax-up positioning device, ACD, and ITD has been adopted by certain EMS agencies in the United States, the systematic review did not find clinical evidence supporting a particular bundle approach or indicating that the sole use of head-up elevation is superior to other bundles. For example, a pilot study conducted by Kim et al. in Korea in 2022, which lacked a comparison group, described a method that used a 15 cm high	

	wedge on the bed to raise the head approximately 15 cm without elevating the chest while using a mechanical CPR device but no other devices.[xv] The study indicated that 4 (14.3%) patients who received head-up CPR survived to hospital admission, 1 (3.6%) survived to discharge, and 1 (3.6%) had neurologically intact survival at discharge. The aforementioned study by Pepe et al.[1] described a head-up CPR method in which a scoop stretcher was used to elevate the head and torso by placing a hard case toward the top of the stretcher with a mechanical CPR device attached to the scoop stretcher. This approach differs from the newer head-up CPR bundle, which uses an automated head/thorax-up positioning device rather than a stretcher. The best approach (e.g., angle, use of other devices) needs to be determined in future research. Timing of the head elevation might be an important factor. Animal studies suggest that the greatest cerebral perfusion pressure is achieved with a 2-minute priming period in a flat position, followed by gradual elevation of the head and thorax over an additional 2 minutes when combined with the use of ACD and ITD.[xvi,xvii] An observational study conducted by Moore et al. focusing on the impact of time to deployment of the head-up CPR bundle, showed that faster deployment was associated with a higher incidence of ROSC.[xviii] This study, along with previous animal studies, suggests that faster deployment is associated with better neurological outcomes. However, clinical studies on this topic are limited, and the BLS Task Force does not find the current evidence sufficient to make a specific recommendation on this matter.	
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	There is no important uncertainty about how much people value improving survival after 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	As both desirable and undesirable effects are very uncertain, balancing them is not really possible.	

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	Implementation of the most studied head-up CPR bundle (HUP, ACD, and ITD) requires the purchase of expensive equipment, including an automated head/thorax-up positioning device, a mechanical CPR device, and an impedance threshold device. It also necessitates a substantial amount of education and training both in the use of this equipment and in the deployment of head-up CPR itself.	

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	The cost of an automated head/thorax-up positioning device, a mechanical CPR device, and an impedance threshold device are significant when implemented in resuscitation systems, as is the cost of training and education. There are no important uncertainties regarding the required cost/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	The reported better short- and long-term outcomes at certain EMS agencies in the United States are encouraging. If the outcomes are generalizable to other resuscitation systems, the intervention might be cost-effective. However, there is not enough evidence to determine the effectiveness of head-up CPR, and no evidence assessing its cost-effectiveness.	

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	As the strategy requires expensive equipment, health equity would likely be negatively impacted.	
Acceptability Is the intervention acceptable to key stakeholders?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
○ No ● Probably no ○ Probably yes ○ Yes ○ Varies ○ Don't know	Due to the significant cost of implementation and absence of RCTs or observational studies with adequate comparisons, it is unlikely to be an acceptable strategy for key stakeholders. The Basic Life Support Task Force does not find the current evidence sufficient to recommend routine use of this strategy and encourages further research before its clinical deployment.	
Feasibility Is the intervention feasible to implement?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
○ No ○ Probably no ○ Probably yes ○ Yes ○ Varies ● Don't know	The bundle approach that includes head-up position with automated head/thorax-up positioning device, ACD, and ITD has been adopted by certain EMS agencies in the United States, however, the feasibility of broader implementation is not known.	

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	Large	Moderate	Small	Trivial		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

The treatment recommendation remains unchanged from 2021:
We suggest against the routine use of head-up CPR during CPR (weak recommendation, very-low-certainty evidence).
We suggest that the usefulness of head-up CPR during CPR be assessed in clinical trials or research initiatives (weak recommendation, very-low-certainty evidence).

Justification

This topic was prioritized by the BLS Task Force based on new observational studies since our previous systematic review in 2021.[7] In this systematic review, we identified very low certainty evidence that the head-up CPR bundle is associated with better survival and neurological outcomes.
Head-up CPR is a newer resuscitation strategy, first described in 2014, that involves gradual elevation of the head after CPR has been initiated, to improve cerebral perfusion, coronary perfusion, and possibly ventilation during CPR.[8,9] Although the intervention may sound simple, previous studies have suggested that it is more complex than initially thought.[10] Animal studies have indicated that head-up CPR is most effective when used with ACD and ITD, as there is inadequate arterial pressure to create upward flow and achieve cerebral perfusion pressure in the absence of these devices.[11,12,13] Based on these findings, head-up CPR is often performed as part of a bundled approach, including the use of ACD and ITD devices.[1,2,3,14]
The BLS Task Force recognized that the currently available evidence is still limited, highlighted by the absence of RCTs or observational studies with adequate comparisons. The implementation of the studied head-up CPR bundle requires the purchase of expensive equipment, which includes an automated head/thorax-up positioning device, a mechanical CPR device, and an ITD, as well as significant training. The task force concluded that there is not sufficient clinical evidence to support the use of head-up CPR or head-up CPR bundle during CPR except in the setting of clinical trials or research initiatives.
The task force identified several distinct methods in the studies reviewed. Although the bundle approach that includes head-up position with automated head/thorax-up positioning device, ACD, and ITD has been adopted by certain EMS agencies in the United States, the systematic review did not find clinical evidence supporting a particular bundle approach or indicating that the sole use of head-up elevation is superior to other bundles.
For example, a pilot study conducted by Kim et al. in Korea in 2022, which lacked a comparison group, described a method that used a 15 cm high wedge on the bed to raise the head approximately 15 cm without elevating the chest while using a

mechanical CPR device but no other devices.[14] The study indicated that 4 (14.3%) patients who received head-up CPR survived to hospital admission, 1 (3.6%) survived to discharge, and 1 (3.6%) had neurologically intact survival at discharge.
The aforementioned study by Pepe et al.[1] described a head-up CPR method in which a scoop stretcher was used to elevate the head and torso by placing a hard case toward the top of the stretcher with a mechanical CPR device attached to the scoop stretcher. This approach differs from the newer head-up CPR bundle, which uses an automated head/thorax-up positioning device rather than a stretcher. The best approach (e.g., angle, use of other devices) needs to be determined in future research. Timing of the head elevation might be an important factor. Animal studies suggest that the greatest cerebral perfusion pressure is achieved with a 2-minute priming period in a flat position, followed by gradual elevation of the head and thorax over an additional 2 minutes when combined with the use of ACD and ITD.[15,16] An observational study conducted by Moore et al. focusing on the impact of time to deployment of the head-up CPR bundle, showed that faster deployment was associated with a higher incidence of ROSC.[17] This study, along with previous animal studies, suggests that faster deployment is associated with better neurological outcomes. However, clinical studies on this topic are limited, and the BLS Task Force does not find the current evidence sufficient to make a specific recommendation on this matter.

Subgroup considerations

We initially considered performing a subgroup analysis focused on initial cardiac rhythms (i.e., cardiac arrest with shockable versus non-shockable rhythms); however, the limited number of studies (three), two of which came from the same registry, did not allow for such an analysis.

Implementation considerations

As above

Monitoring and evaluation

As above

Research priorities

1. We found there was no RCT that evaluated the effect of head-up CPR or head-up CPR bundle.
2. Head-up CPR has mainly been evaluated as a bundle with mechanical CPR with ACD and the use of an ITD.
3. The optimal approach—such as the angle and timing of head elevation—if head-up CPR proves to be beneficial, still needs to be determined in the future.

References:

Pad Position and Placement (BLS 2601)

QUESTION

Should the use of large pad size vs. small pad be used for adults and children with cardiac arrest and a shockable rhythm at any time during cardiopulmonary resuscitation?	
POPULATION:	Adults and children with cardiac arrest and a shockable rhythm at any time during cardiopulmonary resuscitation (CPR)
INTERVENTION:	The use of any specific pad size/orientation and position
COMPARISON:	Reference standard pad size/orientation and position
MAIN OUTCOMES:	**Critical:** Survival with favourable neurological outcome at hospital discharge or 30-days Survival at hospital discharge or 30 days **Important:** Return of spontaneous circulation (ROSC) Termination of VF Rates of refibrillation.
SETTING:	in- and out-of-hospital cardiac arrest
PERSPECTIVE:	**PATIENT**
BACKGROUND:	A SR on this topic was performed in 2010. In 2019, the topic was re-evaluated by the BLS task force with a scoping review, followed by evidence updates in 2021 and 2022. At the end of 2022 the topic related to the pads position has been challenged by a cluster-randomized trial with crossover (Cheskes, 2022, 1947) evaluating, among new defibrillation strategies, the vector-change (VC) defibrillation to the anterior-posterior (AP) position, compared with the standard (anterior-lateral) defibrillation in adult patients with refractory ventricular fibrillation (VF) during out-of-hospital cardiac arrest (OHCA). Another recent retrospective before-after study (Steinberg; 2022; 16) on electronic defibrillator data, included shocks from OHCA with initial VF or pulseless VT. In the pre- dataset, 207 patients received 1023 shocks with AP pad placement, compared with 277 patients from the post- dataset who received 1020 shocks with AL pad placement.
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	Survival from sudden cardiac arrest is low. Patients who present in an shockable rhythm have a higher rate of good outcome. Approximately 20% of VF patients, however, will remain in VF despite standard resuscitation interventions. In addition, transthoracic impedance (TTI) may vary based on pad size and orientation and this may have an impact on shock success. Different pad orientations may also result in a higher voltage gradient in different area of the myocardium from where fibrillation may start/restart.	
Desirable Effects How substantial are the desirable anticipated effects?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
○ Trivial ○ Small ● Moderate ○ Large ○ Varies	Improvement in ROSC, long term survival, and neurologic outcome are desirable. However, there are no studies in patients at early-stage VF/pulseless VT directly comparing the effects of different pad positions on defibrillation success, ROSC and long term survival.	In 2022 the topic related to the pads position has been challenged by a cluster-randomized trial with crossover (Cheskes, 2022, 1947) evaluating, among new defibrillation strategies, the

○ Don't know	Indeed, the recent trial from Cheskes, 2022, compared vector change vs. standard pad position, i.e. AP vs. AL position, only in refractory VF patients. Most studies evaluates cardioversion (eg, AF) or secondary endpoints (eg, TTI).	vector-change (VC) defibrillation to the anterior-posterior (AP) position, compared with the standard (anterior-lateral (AL)) defibrillation in adult patients with refractory ventricular fibrillation (VF) during out-of-hospital cardiac arrest (OHCA). Refractory VF was defined as an initial presenting rhythm of VF or pulseless ventricular tachycardia (VT) that was still present after three consecutive standard defibrillations. A total of 136 patients were assigned to receive standard defibrillation while 144 received VC defibrillation. Survival to hospital discharge was more common in the VC group than in the standard group (21.7% vs. 13.3%; RR, 1.71; 95% CI, 1.01 to 2.88). No difference in good neurological outcome (RR 1.48 [95% CI, 0.81 to 2.71]) nor in ROSC (RR 1.39 [95% CI, 0.97–1.99]) was reported between VC vs. standard defibrillation. Termination of VF occurred 79.9% of VC defibrillations compared to 67.6% of standard ones (RR 1.18 [95% CI, 1.03 to 1.36]).
Undesirable Effects How substantial are the undesirable anticipated effects?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
○ Trivial ○ Small ○ Moderate ○ Large ○ Varies ● Don't know	Available evidence is inconclusive	
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 randomized trial from Cheskes, 2022, compared vector change vs. standard pad position only in refractory VF patients. This is the first showing a benefit from VC compared with SD for VF termination and survival to discharge and only a possible benefit for ROSC and survival with favorable neurologic outcome (not statistically significant). There are no other studies in patients on early-stage VF/pulseless VT directly comparing the effects of various pad positions on patient outcome. A recent observational pre-post implementation study evaluated effects of large vs. small pad size on defibrillation success evaluated on ECG recorded by AEDs; again no data on patient outcome are available.	Several old studies have evaluated the role of pad and paddle size in relationship to TTI
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		
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 is no evidence in favour the intervention or the comparison for the initial treatment of shockable cardiac arrest. However, if we consider the condition of refractory VF, although the certainty of evidence is very low, the existing evidence suggests a beneficial effect with VC compared with standard AL pad position in VF termination and survival with good neurological outcome.	For pad size there are old studies mainly focusing on TTI, showing that smaller pads or paddles are ssociated with higher TTI. A recent obervational study from 2022, investigating large vs. small pad sizes showed no difference in defibrillation success after a BTE shock.
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 data are available. Nevertheless, modifing the pad position on the chest is costless. Manufactors may bare some cost in aligning instructions with correct pad placement.	Additional costs may be expected in the case of VC for refracorty VF, in which a second pair of pads are applied.
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		Changing pad orientation could require some cost for training.
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		
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 data are available. Nevertheless, modifing the pad position on the chest is costless	Additional costs may be expected in the case of VC for refracorty VF, in which a second pair of pads are applied.
Acceptability Is the intervention acceptable to key stakeholders?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
○ No ○ Probably no ● Probably yes ○ Yes ○ Varies ○ Don't know	If beneficial, stakeholders will likely accept the intervention	
Feasibility Is the intervention feasible to implement?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
○ No ○ Probably no ● Probably yes ○ 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	Probably favors the intervention	Favors the intervention	Varies	**No included studies**

			the comparison				
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

For defibrillator manufacturers:

There is insufficient evidence to recommend a specific pad or paddle size for optimal external defibrillation in adults (Good Practice Statement).

Manufacturers should standardize adult pad or paddle placement in the anterior-lateral position (Good Practice Statement). One pad or paddle should be placed below the right clavicle, just to the right of the upper sternal border, and the other with its center in the left mid-axillary line, below the armpit.

Manufacturers should provide clear instructions to ensure proper contact between the pad or paddle and the skin, along with diagrams that accurately show the ILCOR-recommended pad and paddle positions (Good Practice Statement).

For CPR providers using an AED:

Follow the manufacturer's AED guidance and instructions for adult pad placement (Good Practice Statement).

For CPR providers trained in manual defibrillation:

In adults, place defibrillator pads or paddles in the anterior-lateral position to optimize placement speed and minimize interruptions to chest compressions (Good Practice Statement). One pad/paddle should be positioned below the patient's right clavicle, just to the right of the upper sternal border. The other pad/paddle should be placed on the patient's left mid-axillary line, below the armpit.

In adults, if the initial anterior-lateral position is not feasible, consider using the anterior-posterior pad position if trained (Good Practice Statement). Place the anterior pad on the left side of the chest, between the midline and the nipple. For female patients, place the anterior pad to the left of the lower sternum, ensuring it avoids breast tissue as much as possible. The posterior pad should be placed on the left side of the patient's spine, just below the scapula.

Pad or paddle placement should avoid breast tissue (Good Practice Statement).

For healthcare professionals trained in vector change:

For adults in refractory ventricular fibrillation (persistent VF after three defibrillations), consider changing pads to the anterior-posterior pad position (Good Practice Statement). Place the anterior pad on the left side of the chest, between the midline of the chest and the nipple. For female patients, place the anterior pad to the left of the lower sternum, ensuring it avoids breast tissue as much as possible. The posterior pad should be placed on the left side of the patient's spine, just below the scapula.

This treatment recommendation does not replace the existing treatment recommendation on vector change and double sequential defibrillation for advanced life support providers (Berg 2023, e187; Berg 2023, 109992).

In making these recommendations, the task forces considered the following:

- Approximately 20% of patients remain in a shockable rhythm despite standard resuscitation interventions. Transthoracic impedance varies based on pad size and position, and this may impact shock success. Different pad orientations/positions may also result in a higher current density in different areas of the myocardium from where fibrillation may start/restart.
- No studies directly compare the effects of different pad placements on patient outcomes outside of refractory shockable rhythms.

- In clinical practice, BLS and ALS providers are unable to select pads sizes beyond what is provided by their healthcare organization. Therefore the Task Force realized that recommending the use of a specific pad size does not apply to providers.
- The four studies included were at serious risk of bias, and only one was a RCT (Cheskes, 2022, 1947).
- A secondary analysis of the DOSE VF trial (Cheskes, 2024, 110186), which explored the relationship between alternative defibrillation strategies employed and the type of VF, defined as shock-refractory VF or recurrent VF (e.g. persistent VF after each shock) or recurrent VF (e.g. absence of VF for at-least 5 sec after the shock, followed by spontaneous refibrillation), on patient outcomes, showed that vector-change defibrillation compared to standard pads placement, was not superior for VF termination, ROSC, or survival for shock-refractory VF; for recurrent VF, vector-change defibrillation was superior to standard pads placement only for VF termination, but not for ROSC or survival.
- In Yin (2023), transthoracic impedance was higher for smaller electrodes than the larger electrodes, but defibrillation success was equivalent. The study, however, has important biases in its design. It included no data on ROSC or survival and focused only on the biphasic truncated exponential defibrillation waveform. Based on the above assumptions, no evidence exists that any specific pad size/orientation and position differing from the standard anterior-lateral improves any critical or important outcome. However, defibrillator manufacturers likely have proprietary data unavailable in the public sphere.
- Two observational studies in adults (Kerber 1981 676; Yin 2023 109754) and three in children (Atkins 1994 90; Atkins 1988 914; Samson 1995 544) showed that transthoracic impedance was significantly higher with small-sized pads/paddles than large-sized pads/paddles. Lower transthoracic impedance results in higher current flow, possibly allowing for higher defibrillation success. Another observational study (Kastreva 2006 1009) evaluated transthoracic impedance in volunteers measured according to the interelectrode voltage drop obtained by passage of a low amplitude high-frequency current between the two self-adhesive electrodes in anterior-posterior and anterior-lateral positions without delivering a shock. Lower transthoracic impedance was measured in the anterior-posterior compared to the anterior-lateral position.
- An observational study included 123 cardiac arrests (Dalzell 1989 741). Pad diameters were small (8/8 cm) in 26 cardiac arrests, intermediate (8/12 cm) in 63 arrests and large (12/12 cm) in 34 cardiac arrests. Transthoracic impedance significantly decreased with increasing pad size. A single monophasic shock of 200 J (delivered energy) was successful in 8 of 26 (31%) arrests using small pads, in 40 of 63 (63%) with intermediate pads and in 28 of 34 (82%) with large pads (p=0.0003). Whether these results can be transferred to biphasic, impedance-compensated defibrillation waveforms remains unclear.
- There are no studies examining defibrillation pad size or orientation for IHCA. However, the evidence reported in this document could be applied to the IHCA, with additional downgrading for indirectness.
- Paddles may still be in use in some low-resource ALS settings. However, the Task Force acknowledges that the anterior-posterior position is not feasible with paddles and that paddle sizes are those standard as provided by the manufacturer. The Task Force did not foresee future development in the use of paddles.
- In atrial fibrillation, although some studies have shown that antero-posterior electrode placement is more effective than the traditional antero-apical position in elective cardioversion, the majority have failed to demonstrate any clear advantage of any specific electrode position. Moreover, transmyocardial current during defibrillation is likely to be maximal when the electrodes are placed so that the area of the heart that is fibrillating lies directly between them (i.e. ventricles in ventricular fibrillation/tachycardia, atria in atrial fibrillation). Therefore, the optimal electrode position may not be the same for ventricular and atrial arrhythmias and conclusions for one condition cannot be directly translated/applied to the other.
- AEDs have pictoral representation to guide providers in correct pad positioning. However, there is a wide variation in this pictoral guidance and evidence suggests that correct anatomical pad placement is poor, such that a clearer, more effective diagram is urgently needed. In a recent study, untrained bystanders failed to achieve accurate defibrillation pad placement, when guided by current defibrillation pad diagrams (Deakin 2019 282). Manufacturers of defibrillators should follow best practice, and align pad placement with ILCOR recommendations.
- In most cases, bias was assessed per comparison rather than per outcome, since there were no meaningful differences in bias across outcomes. In cases where differences in risk of bias existed between outcomes this was noted.

Subgroup considerations

none

Implementation considerations

Implementation of a different pad position and/or a VC strategy would require training. Instructions for BLS providers should be clear and easy to be followed.

Monitoring and evaluation

Since current evidence is inconclusive, we suggest the resuscitation systems to collect and analyze data on pad orientation and outcome of shockable cardiac arrest.

Research priorities

- No RCTs have compared different pad positions with standard positions in any patient population, in the first 3 shocks.
- No RCTs compared different pad sizes in any patient population.
- No studies examined the paediatric/in-hospital setting.
- No studies have evaluated pad placement in unique populations.
- No studies evaluated the interaction between pad size and orientation.
- Only surrogate outcomes were evaluated for pads size (i.e. transthoracic impedance).

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Bra Removal (BLS 2605)

QUESTION

Short PICO title here	
POPULATION:	Adults and children in cardiac arrest
CONCEPT	Adverse events and outcomes associated with pad placement and/or defibrillation without removing the patient's bra/brassiere (including those with metal components)
CONTEXT	In patients wearing a bra/brassiere in any setting (in-hospital or out-of-hospital)
BACKGROUND:	In preparation for defibrillation, defibrillator pads or paddles must come into full contact with the skin of the chest wall and avoid contact with metal objects. Some Resuscitation guidelines recommend the removal of all clothes covering the chest,[1] this includes bras as they may contain metal (e.g. underwire and clips) under the assumption that this may result in the defibrillator malfunctioning or harm to the patient.
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	This topic was chosen for review by the BLS Task Force because of ongoing controversies in the published literature: • In preparation for defibrillation, defibrillator pads or paddles must come into full contact with the skin of the chest wall and avoid contact with metal objects. Some Resuscitation guidelines recommend the removal of all clothes covering the chest, including bras, as they may contain metal (e.g., underwire, and clips), under the assumption that this may result in the defibrillator malfunctioning or harm to the patient or rescuer.[1] • However, a growing body of research has identified that women are less likely to receive CPR and defibrillation by the public.[2,3] Public opinion surveys show that some members of the public do not feel comfortable exposing women's breasts, and fear accusations of inappropriate touching and sexual assault.[4] These concerns may impact bystanders' willingness to perform CPR and defibrillation and explain why rates are lower in women.[4] Whether it is necessary to remove such undergarments is unknown.	
Desirable Effects How substantial are the desirable anticipated effects?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
○ Trivial ○ Small ○ Moderate	Bystander defibrillation is associated with the greatest survival from out-of-hospital cardiac arrest, but rates are	

● Large ○ Varies ○ Don't know	lower in women.[3,4] Removing barriers to the public applying pads is a significant outcome. Harms to patient skin may be minor.	
Undesirable Effects How substantial are the undesirable anticipated effects?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
○ Trivial ○ Small ○ Moderate ○ Large ○ Varies ● Don't know	Delays in defibrillation and incorrect pad placement is undesirable. Harms to defibrillators may be significant.	
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 was not assessed, but most of the existing evidence lacks per-review and full methods. Three studies met inclusion criteria, including one animal study[5] and two simulation mannikin studies.[6,7] Two studies were published as conference abstracts from the same group of authors who were employed by a company that develops and manufactures AEDs.[5,6]	
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 may be cultural and religious variabilities and sensitivities.	
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	• We found no evidence reporting patient outcomes or any case studies reporting adverse events about defibrillation without removing a bra. • In the animal study, published as a conference abstract, investigators gave 126 shocks (200J) to four pigs via self-adhering AED pads that were in direct contact with the metal underwire of a bra.[5] The authors report 100% 1st shock success, with no adverse events: no arcing or redirection of current, scorching or burning of the bra or pig's skin, and no adverse events to the rescuer or AED. • A simulation study, published as a conference abstract, of 78 untrained AED users tested the impact of the addition of bra removal on time to place pads or the delivery of the first	

	shock.[6] No differences were seen in these times for clothed male or female manikins. ● The remaining fully reported simulation study, in 69 rescuers using an AED, noted that male rescuers were less likely to completely de-robe the female manikin than female rescuers (13.3% vs 66.7%, p=0.002). When interviewed, participants cited being unaware of the need to remove the bra, social norms, and concerned for the patient's modesty, and men did not want to remove more clothing than necessary.[7]	
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	There is no evidence.	
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	There is no evidence.	
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	There is no evidence.	
Equity What would be the impact on health equity?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
○ Reduced ○ Probably reduced ○ Probably no impact ● Probably increased ○ Increased	May reduce some of the inequities seen in the application of AED pads and public defibrillation seen in women.	

○ 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	Although insufficient studies were identified to support a more specific systematic review of defibrillation while wearing a bra at this time, the Task Force felt the need to highlight and address the inequality in AED application in women by making Good Practice Statements to highlight this issue to the international community.	
Feasibility Is the intervention feasible to implement?		
JUDGEMENT	**RESEARCH EVIDENCE**	**ADDITIONAL CONSIDERATIONS**
○ No ○ Probably no ○ Probably yes ● Yes ○ Varies ○ Don't know	Some regions are already implementing defibrillation and training without removing a bra.	

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

CONCLUSIONS

Recommendation

There is insufficient evidence to guide the routine removal of a bra, but it may not always be necessary to remove a bra for defibrillation. Pads must be placed on bare skin in the correct position, which may be possible by adjusting the bra's positioning rather than removing it (Good Practice Statement).
Manufacturers should develop realistic manikins that reflect different body sizes that can impact pad placement (Good Practice Statement).
Where possible, CPR training should cover defibrillation for patients wearing bras, focusing on correct pad placement and minimizing pauses in compressions (Good Practice Statement).

Justification

- Although insufficient studies were identified to support a more specific systematic review of defibrillation while wearing a bra at this time, the Task Force felt the need to highlight and address the inequality in AED application in women by making Good Practice Statements to highlight this issue to the international community.
- We put greater weight on placing the pads in the right place over routine bra removal.
- Implementing the Good Practice Statements may reduce inequity, address an important problem, align with the goals of the relevant organisations, may benefit society, and are likely to be acceptable and feasible.

Subgroup considerations

n/a

Implementation considerations

A single adjustable manikin is likely to be preferred over different types.
BLS training materials may require adjustment.

Monitoring and evaluation

Monitoring and peer-review publishing of the implementation of these practices will be important guide future recommendations.

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