Evidence Update Worksheet

BLS ALS-030A Defb pad size and placement

Worksheet author(s): Giuseppe Ristagno
Task Force: BLS
Date Submitted to SAC rep for peer review and approval: January 9th, 2023
SAC rep:

PICOST / Research Question: Paddle size and placement for defibrillation - In adult cardiac arrest (prehospital [OHCA], in-hospital [IHCA]) (P), does the use of any specific paddle/pad size/orientation and position (I) compared with standard resuscitation or other specific paddle/pad size/orientation and position) (C), improve outcomes (e.g. Successful defibrillation, ROSC, survival) (O).
Outcomes: Survival to hospital discharge with good neurological outcome and survival to hospital discharge were ranked as critical outcomes. ROSC was ranked as an important outcome. Termination of VF and rates of recurrence of fibrillation/refibrillation were included as important outcomes.

Year of last full review: 2020 (Scoping review); Evidence Updates in 2021 and 2022.

Current ILCOR Consensus on Science and Treatment Recommendation for this PICOST: It is reasonable to place pads on the exposed chest in an anterior-lateral position. An acceptable alternative position is anterior-posterior. In large breasted individuals, it is reasonable to place the left electrode pad lateral to or underneath the left breast, avoiding breast tissue. Consideration should be given to the rapid removal of excessive chest hair before the application of pads, but emphasis must be on minimizing delay in shock delivery. There is insufficient evidence to recommend a specific electrode size for optimal external defibrillation in adults. However, it is reasonable to use a pad size >8 cm.

Current Search Strategy (for an existing PICOST) included in the attached approved PICOST

1	Electric Countershock/
2	Defibrillators/
3	(defibrillat* or AED or electroversion? or electro-version? or cardioversion? or cardio-version? or electric countershock? or electric counter-shock?).tw,kf.
4	(cardiac adj2 stimulator?).tw,kf.
5	or/1-4 [DEFIBRILLATORS]
6	Cardiography, Impedance/ or Electric Impedance/ or Electric Conductivity/
7	((transthoracic adj2 (impedance or resistance)) or TTI or TTR).tw,kf.
8	(electric* adj2 (conductiv* or impedance)).tw,kf.
9	((orientation? or position* or placement or placed or placing or situated or shape? or size? or rectangl* or square or anterior* or posterior* or anteroposterior* or antero-posterior* or lateral* or lateroposterior* or latero-posterior* or longitudinal* or transverse*) adj2 (pad? or paddle? or electrode? or defibrillat* or AED)).tw,kf.
10	or/6-9 [IMPEDANCE]
11	5 and 10
12	exp Animals/ not (exp Animals/ and Humans/)
13	11 not 12 [ANIMAL-ONLY REMOVED]
14	exp Child/ not (exp Adult/ or Adolescent/)
15	exp Infant/ not (exp Adult/ or Adolescent/)
16	13 not (14 or 15) [CHILD- AND INFANT-ONLY REMOVED]
17	(comment or editorial or news or newspaper article).pt.
18	(letter not (letter and randomized controlled trial)).pt.
19	16 not (17 or 18) [OPINION PIECES REMOVED]
20	19 and (2009* or 2010* or 2011* or 2012* or 2013* or 2014* or 2015* or 2016* or 2017* or 2018* or 2019*).dt.
21	20 use ppez
22	cardioversion/
23	defibrillator/ or exp external defibrillator/

24	(defibrillat* or AED or electroversion? or electro-version? or cardioversion? or cardio-version? or electric countershock? or electric counter-shock?).tw,kw.
25	(cardiac adj2 stimulator?).tw,kw.
26	or/22-25 [DEFIBRILLATORS]
27	impedance cardiography/ or impedance/ or electric conductivity/ or electric resistance/
28	((transthoracic adj2 (impedance or resistance)) or TTI or TTR).tw,kw.
29	(electric* adj2 (conductiv* or impedance)).tw,kw.
30	((orientation? or position* or placement or placed or placing or situated or shape? or size? or rectangl* or square or anterior* or posterior* or anteroposterior* or antero-posterior* or lateral* or lateroposterior* or latero-posterior* or longitudinal* or transverse*) adj2 (pad? or paddle? or electrode? or defibrillat* or AED)).tw,kw.
31	or/27-30 [IMPEDANCE]
32	26 and 31
33	exp animal experimentation/ or exp animal model/ or exp animal experiment/ or nonhuman/ or exp vertebrate/
34	exp human/ or exp human experimentation/ or exp human experiment/
35	32 not (33 not 34) [ANIMAL-ONLY REMOVED]
36	exp adolescent/ not (exp adult/ and exp adolescent/)
37	exp child/ not (exp adult/ and exp child/)
38	fetus/ not (exp adult/ and fetus/)
39	35 not (36 or 37 or 38) [UNDER 18 REMOVED]
40	editorial.pt.
41	letter.pt. not (randomized controlled trial/ and letter.pt.)
42	39 not (40 or 41) [OPINION PIECES REMOVED]
43	conference abstract.pt.
44	42 not 43 [CONFERENCE ABSTRACTS REMOVED]
45	44 and (2009* or 2010* or 2011* or 2012* or 2013* or 2014* or 2015* or 2016* or 2017* or 2018* or 2019* or 2020* or 2021* or 2022*).dc.
46	45 use oemezd
47	Electric Countershock/
48	Defibrillators/
49	(defibrillat* or AED or electroversion? or electro-version? or cardioversion? or cardio-version? or electric countershock? or electric counter-shock?).tw,kw.
50	(cardiac adj2 stimulator?).tw,kw.
51	or/47-50 [DEFIBRILLATORS]
52	Cardiography, Impedance/ or Electric Impedance/ or Electric Conductivity/
53	((transthoracic adj2 (impedance or resistance)) or TTI or TTR).tw,kw.
54	(electric* adj2 (conductiv* or impedance)).tw,kw.
55	((orientation? or position* or placement or placed or placing or situated or shape? or size? or rectangl* or square or anterior* or posterior* or anteroposterior* or antero-posterior* or lateral* or lateroposterior* or latero-posterior* or longitudinal* or transverse*) adj2 (pad? or paddle? or electrode? or defibrillat* or AED)).tw,kw.
56	or/52-55 [IMPEDANCE]
57	51 and 56
58	exp Child/ not (exp Adult/ or Adolescent/)
59	exp Infant/ not (exp Adult/ or Adolescent/)
60	57 not (58 or 59) [CHILD- AND INFANT-ONLY REMOVED]
61	conference abstract.pt.
62	60 not 61 [CONFERENCE ABSTRACTS REMOVED]
63	62 and (2009* or 2010* or 2011* or 2012* or 2013* or 2014* or 2015* or 2016* or 2017* or 2018* or 2019*).up,pd,dp,dr.
64	63 use coch [COCHRANE DATABASE OF SYSTEMATIC REVIEWS]
65	63 use cctr [COCHRANE CENTRAL]
66	63 use acp [ACP JOURNAL CLUB]
67	63 use dare [DATABASE OF ABSTRACTS OF REVIEWS OF EFFECTS]
68	63 use clcmr [COCHRANE METHODOLOGY REGISTER DATABASE]
69	63 use clhta [HEALTH TECHNOLOGY ASSESSMENT DATABASE]
70	63 use cleed [NATIONAL HEALTH SERVICE ECONOMIC EVALUATION DATABASE]
71	21 or 46 or 64 or 65 or 66 or 67 or 68 or 69 or 70 [ALL DATABASES - NO DUPLICATES REMOVED]
72	remove duplicates from 71 [TOTAL UNIQUE RECORDS]

73   72 use ppez [MEDLINE UNIQUE RECORDS]
74   72 use oemezd [EMBASE UNIQUE RECORDS]
75   72 use coch [COCHRANE DATABASE OF SYSTEMATIC REVIEWS UNIQUE RECORDS]
76   72 use cctr [CENTRAL UNIQUE RECORDS]
77   72 use acp [ACP JOURNAL CLUB UNIQUE RECORDS]
78   72 use dare [DATABASE OF ABSTRACTS OF REVIEWS OF EFFECTS UNIQUE RECORDS]
79   72 use clcmr [COCHRANE METHODOLOGY REGISTER DATABASE]
80   72 use clhta [HEALTH TECHNOLOGY ASSESSMENT DATABASE]
81   72 use cleed [NATIONAL HEALTH SERVICE ECONOMIC EVALUATION DATABASE]

New Search strategy: (for a new PICOST should be outlined here as per Evidence Update Process): N.A.
Database searched: Medline Embase
Time Frame: (existing PICOST) – updated from end of last search January 11th, 2022
Time Frame: (new PICOST) – at the discretion of the Task Force: January 2022 – December 2022
Date Search Completed: January 3rd, 2023
Search Results (Number of articles identified and number identified as relevant): 40 articles identified /
4 reviewed / 2 relevant
Inclusion/Exclusion Criteria: RCTs and nonrandomized studies (non-RCTs, interrupted time series, controlled before-and-after studies, cohort studies) were eligible for inclusion. Unpublished studies (eg, conference abstracts, trial protocols) were excluded. In addition, animal/lab studies, mathematical models, simulation and mannikin studies, algorithm studies with no outcome data, studies on double sequential defibrillation approaches, and unpublished studies (e.g., conference abstracts, trial protocols) and reviews were excluded.

Summary of Evidence Update:
A cluster-randomized trial with crossover (Cheskes, 2022, 1947) evaluated, among new defibrillation strategies, the vector-change (VC) defibrillation to the anterior-posterior (AP) position, compared with the standard (sternal-apical (SA)) 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]).
A 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 SA pad placement. No difference was observed in defibrillation efficacy between AP and SA pad placements (82.1 % vs 82.2 %, p = 0.99; OR 1.08 [95% CI, 0.61–1.91], p = 0.8).

Relevant Guidelines or Systematic Reviews

Organization (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations
ILCOR; Wyckoff; 2022	Systematic review	Paddle Size and Placement for Defibrillation (Evidence update)	0	n.a.	Unchanged from 2020 ScopRev

RCT:

Study Acronym; Author; Year Published	Aim of Study; Study Type; Study Size (N)	Patient Population	Study Intervention (# patients) / Study Comparator (# patients)	Endpoint Results (Absolute Event Rates, P value; OR or RR; & 95% CI)	Relevant 2° Endpoint (if any); Study Limitations; Adverse Events
DOSE VF; Cheskes, 2022	**Study Aim:** To investigate new defibrillation strategies to improve outcomes in patients with refractory ventricular fibrillation **Study Type:** Cluster-randomized trial with crossover	**Inclusion Criteria:** OHCA with refractory ventricular fibrillation of presumed cardiac causes	**Intervention:** Vector-change (VC) defibrillation (switching defibrillation pads to an anterior–posterior position) (#144 patients) **Comparison:** standard sternal-apical (SA) defibrillation (#136 patients)	**1° endpoint:** Survival to hospital discharge RR, 1.71; 95% CI, 1.01 to 2.88)	**2° endpoint:** • Termination of ventricular fibrillation 1.18 (1.03–1.36) • ROSC 1.39 (0.97–1.99) • Good neurological outcome (mRS<3) 1.48 (0.81–2.71) **Study Limitations:** • Focus on refractory VF • Presence of third study group not considered for this PICOST: Double sequential external defibrillation (DSED; rapid sequential shocks from 2 defibrillators) (#125 patients) • Early termination of the study due to paramedic staffing shortages caused by COVID-19 pandemics • Inclusion in the analyses of patients previously enrolled in a randomized, controlled pilot trial • No data on post-ROSC care

Nonrandomized Trials, Observational Studies

Study Acronym; Author; Year Published	Study Type/Design; Study Size (N)	Patient Population	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/Conclusion Comment(s)
Steinberg; 2022	**Study Type:** Retrospective study on electronic defibrillator data	**Inclusion Criteria:** Defibrillation attempts from patients with initial ventricular	**1° endpoint:** Defibrillation efficacy defined as termination of VF/VT five seconds post-shock.	No difference was observed in defibrillation efficacy between Antero-Posterior (AP) and

	Design: before and after analysis **Study Size (N):** 484	fibrillation (VF) or pulseless ventricular tachycardia (VT)	OR 1.08, 95% CI: 0.61–1.91, p=0.8	Sternal-Apical (SA) pad placement

Reviewer Comments: *(including whether this PICOST should have a systematic or scoping review***)**

There are new no studies directly comparing the effects of various pads placements on defibrillation success, ROSC, and survival. Indeed, the RCT from Cheskes 2022 evaluated 3 different defibrillation strategies and was specifically narrowed to refractory VF/VT, i.e. after 3 CPR/defibrillation cycles, while no data on earlier-stage VF is available. The retrospective study from Steinberg 2022 is a pre-post analysis on defibrillator data, with bias design and no data on ROSC and survival.

No new studies on pads size are available.

Thus, update systematic review for 2023 is not needed. In the instance of refractory VF, the 2022 ALS Sequential Defibrillation Strategy for Cardiac Arrest with Refractory Shockable Rhythm CoSTR recommends: In settings where double sequential defibrillation would require allocation of significant additional resources, we suggest that a vector change defibrillation strategy (placement of defibrillation pads in the anterior-posterior position instead of anterior-lateral) may be considered for adult patients with cardiac arrest who remain in ventricular fibrillation or pulseless ventricular tachycardia after 3 or more consecutive shocks. (weak recommendation, low to very low certainty of evidence).

Reference list: *(List by ILCOR ref standard (last name first author, year of publication, first page number) and insert hyperlink to all articles identified as relevant (if available on PubMed)*

- Steinberg, 2022, 16 https://pubmed.ncbi.nlm.nih.gov/35276312/
- Cheskes, 2022, 1947 https://pubmed.ncbi.nlm.nih.gov/36342151/

Evidence Update Worksheet

BLS 342 Barrier Devices

Worksheet author(s): Federico Semeraro, Tommaso Scquizzato
Task Force: BLS
Date Submitted to SAC rep for peer review and approval: Dec 2022
SAC rep:

PICOST / Research Question: *(Attach SAC representative approved completed PICOST template)*
BLS 342 In rescuers performing CPR on adult or paediatric patients (out-of-hospital and in-hospital) (P), does the use of barrier devices (I) as opposed to no such use (C), improve outcome (O) (eg. lower infection risk)?

Year of last full review: 2005

Current ILCOR Consensus on Science and Treatment Recommendation for this PICOST:
Providers should take appropriate safety precautions when feasible and when resources are available to do so, especially if a victim is known to have a serious infection (eg, HIV, tuberculosis, HBV, or SARS).

Current Search Strategy (for an existing PICOST) included in the attached approved PICOST
Database(s): Ovid MEDLINE <1946 to December 21, 2022>
Search Strategy:
1   Cardiopulmonary Resuscitation/   20922
2   Infectious Disease Transmission, Patient-to-Professional/   5437
3   1 and 2 50
4   Respiration, Artificial/   55847
5   2 and 4 52
6   5 not 3 50
7   3 or 6   100
8   Respiratory Protective Devices/   2423
9   1 and 8 8
10   9 not 7   6
11   8 and 4 21
12   masks/ 7064
13   11 not 7 17
14   7 or 13   117
15   12 and 2 204
16   15 not 14   197
17   16 or 14 314
18   1 and 12 82
19   18 not 17   77
20   17 or 19 391

New Search strategy: no

Database searched: Ovid MEDLINE

Time Frame: (existing PICOST) – updated from end of last search (please specify)
February 15, 2021 (date of previous search) to December 21, 2022

Time Frame: (new PICOST) – at the discretion of the Task Force (please specify)
no

Date Search Completed: December 22, 2022

Search Results (Number of articles identified and number identified as relevant): 391, 1 new and relevant

Summary of Evidence Update:

Relevant Guidelines or Systematic Reviews

Organization (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations
Queiroga AC 2022	Consensus Statement	Drowning resuscitation procedures during the COVID-19 pandemic	n/a	Seven core elements were identified by the participants and analyzed by the working group and were then grouped into 4 categories: (1) prevention and mitigation of the risks of becoming infected, (2) resuscitation of drowned persons during the COVID-19 pandemic, (3) organizational responsibilities, and (4) organizations unable to meet the recommended guidelines.	Because direct contact is necessary for resuscitation, PPE should be used. At minimum, PPE includes gloves, a face mask (preferably N95, FPP2, or FFP3), and eye protection. There are indications that the use of PPE in drowning situations and lifeguard settings may be more complex than in emergency medical services (EMS) or in hospital settings. Proposals for alternative PPE that would significantly reduce the time to start CPR without having to put on a full protective gown have been reported. Further, organizations must have protocols in place for safe decontamination and disposing of PPE and offer training to rescuers on these processes.
Couper 2020	Systematic review	Three questions: (1) aerosol generation associated with key interventions; (2) risk of airborne infection transmission associated with key interventions;	Eleven studies included: two cohort studies, one case control study, five case reports, and three manikin randomised controlled trials.	We did not find any direct evidence that chest compressions or defibrillation either are or are not associated with aerosol generation or transmission of infection. Data from manikin	It is uncertain whether chest compressions or defibrillation cause aerosol generation or transmission of COVID-19 to rescuers. There is very limited evidence and a rapid need for further studies.

| | | | | studies indicates that donning of personal protective equipment delays treatment delivery. Studies provided only indirect evidence, with no study describing patients with COVID-19. Evidence certainty was low or very low for all outcomes. | |

RCT:

Study Acronym; Author; Year Published	Aim of Study; Study Type; Study Size (N)	Patient Population	Study Intervention (# patients) / Study Comparator (# patients)	Endpoint Results (Absolute Event Rates, P value; OR or RR; & 95% CI)	Relevant 2° Endpoint (if any); Study Limitations; Adverse Events
Barcala-Furelos 2020	Simulation / manikin pilot study was carried out to determine the feasibility of the pre-assembled kit of face-mask and HEPA filter adapted on a pre-set plastic-blanket	Ten rescuers took part in the pilot study.	Intervention: Use of plastic blanket with HEPA filter	The average time to wear PPE and place the pre-assembly kit on the victim was 82 s [IC 58-105]. After 10 min the quality of the resuscitation (QCPR) was 91% [87-94]. Quality chest compressions (CC) were 22% better than ventilations (V). Most of the rescuers (60%) thought that placing the plastic blanket on the victim on the beach was somewhat simple or very simple.	Author conclusion: Plastic blanket plus basic ventilations equipment resource could be a new alternative to be considered for lifeguards to keep ventilation on use while reducing risk transmission
Adelborg 2014	A randomised crossover comparison of mouth-to-face-shield ventilation and mouth-to-	Surf lifeguards	Intervention: Mouth-to-face-shield Control:	Thirty surf lifeguards (mean (SD) age: 25.1 (4.8) years; 21 male, 9 female) were randomly assigned to perform 2 x 3 min of	Author conclusion: Mouth-to-face-shield ventilation increases interruptions in chest compressions, reduces the proportion of

	pocket-mask ventilation by surf lifeguards in a manikin		Mouth-to-pocket-mask	cardiopulmonary resuscitation on a manikin using mouth-to-face-shield ventilation (AMBU LifeKey) and mouth-to-pocket-mask ventilation (Laerdal Pocket Mask). Interruptions in chest compressions per cycle were increased with mouth-to-face-shield ventilation (mean (SD) 8.6 (1.7) s) compared with mouth-to-pocket-mask ventilation (6.9 (1.2) s, p < 0.0001). The proportion of effective ventilations was less using mouth-to-face-shield ventilation (199/242 (82%)) compared with mouth-to-pocket-mask ventilation (239/240 (100%), p = 0.0002). Tidal volume was lower using mouth-to-face-shield ventilation (mean (SD) 0.36 (0.20) l) compared with mouth-to-pocket-mask ventilation (0.45 (0.20) l, p = 0.006). No differences in inspiratory times were observed between mouth-to-face-shield ventilation and mouth-to-pocket-mask ventilation	effective ventilations and decreases delivered tidal volumes compared with mouth-to-pocket-mask ventilation.
Adelborg 2011	A randomised crossover comparison of mouth-to-pocket and bag-mask ventilation to mouth-to-mouth ventilation by surf	Surf lifeguards	Intervention: 1. Mouth-to-pocket-mask ventilation 2. Bag-mask-ventilation	A total of 60 surf lifeguards were included (67% male, 33% female, mean age 25 years). Interruptions in chest compressions were significantly reduced	Author conclusion: MMV reduces interruptions in chest compressions and produces a higher proportion of effective ventilations during lifeguard CPR. This

| | lifeguards in a manikin | | Control: Mouth-to-mouth | by MMV (8.9 +/- 1.6 s) when compared to MPV (10.7 +/- 3.0 s, P < 0.001) and BMV (12.5 +/- 3.5s, P < 0.001). Significantly more effective ventilations (visible chest rise) were delivered using MMV (91%) when compared to MPV (79%, P < 0.001) and BMV (59%, P < 0.001). The inspiratory time was longer during MMV (0.7 +/- 0.2 s) and MPV (0.7 +/- 0.2s, P < 0.001 for both) compared to BMV (0.5 +/- 0.2s). Tidal volumes were significantly lower using BMV (0.4 +/- 0.2L) compared to MMV (0.6 +/- 0.2L, P < 0.001) and MPV (0.6 +/- 0.3 L, P < 0.001), whereas no differences were observed when comparing MMV and MPV. | suggests that CPR quality is improved using MMV compared to MPV and BMV. |

Nonrandomized Trials, Observational Studies
None

Reviewer Comments:
Although there are several publications evaluating barrier devices such as facemasks, shields and surgical masks to prevent spread in aerosols or COVID-19, none of the papers identified in 2022 were related to CPR. A consensus document on minimizing risk of infection in the COVID-19 pandemic when providing cardiopulmonary resuscitation to a drowned person published in 2022 was found. No need for full review.

Reference list:
Queiroga AC, Dunne C, Manino LA, van der Linden T, Mecrow T, Bierens J. Resuscitation of Drowned Persons During the COVID-19 Pandemic: A Consensus Statement. JAMA Netw Open. 2022;5(2):e2147078. Published 2022 Feb 1. doi:10.1001/jamanetworkopen.2021.47078

Couper K, Taylor-Phillips S, Grove A, Freeman K, Osokogu O, Court R, Mehrabian A, Morley PT, Nolan JP, Soar J, Perkins GD. COVID-19 in cardiac arrest and infection risk to rescuers: A systematic review. Resuscitation. 2020 Jun;151:59-66. doi: 10.1016/j.resuscitation.2020.04.022. Epub 2020 Apr 20.

Barcala-Furelos R, Szpilman D, Abelairas-Gómez C, Alonso-Calvete A, Domínguez-Graña M, Martínez-Isasi S, Palacios-Aguilar J, Rodríguez-Núñez A. Plastic blanket drowning kit: A protection barrier to immediate resuscitation at the beach in the Covid-19 era. A pilot study. Am J Emerg Med. 2020 Nov;38(11):2395-2399. doi: 10.1016/j.ajem.2020.08.101. Epub 2020 Sep 16.

Adelborg K, Bjørnshave K, Mortensen MB, Espeseth E, Wolff A, Løfgren B. A randomised crossover comparison of mouth-to-face-shield ventilation and mouth-to-pocket-mask ventilation by surf lifeguards in a manikin. Anaesthesia. 2014 Jul;69(7):712-6. doi: 10.1111/anae.12669. Epub 2014 Apr 28.

Adelborg K, Dalgas C, Grove EL, Jørgensen C, Al-Mashhadi RH, Løfgren B. Mouth-to-mouth ventilation is superior to mouth-to-pocket mask and bag-valve-mask ventilation during lifeguard CPR: a randomized study.
Resuscitation. 2011 May;82(5):618-22. doi: 10.1016/j.resuscitation.2011.01.009. Epub 2011 Feb 16.

Evidence Update Worksheet

BLS 343 Chest Compression Rate, Depth, and Recoil During CPR

Worksheet author(s): Mike Smyth
Task Force: BLS
Date Submitted to SAC rep for peer review and approval: 18 Jan 2023
SAC rep: Theresa Olasveengen

PICOST:

Population: Adults in any setting (in-hospital or out-of-hospital) with (cardiac arrest)
Intervention: Different chest compression rate, depth and incomplete chest wall recoil during CPR,
Comparators: Standard chest compression rate, depth and incomplete chest wall recoil during CPR
Outcomes: Survival to hospital discharge with good neurological outcome and survival to hospital discharge were ranked as critical outcomes. Return of spontaneous circulation (ROSC) and physiological measures (e.g., blood pressure and end-tidal PCO2) were ranked as a important outcomes.
Study Designs: Randomized controlled trials (RCTs) and non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies) are eligible for inclusion.
Timeframe: All years and all languages were included as long as there was an English abstract; unpublished studies (e.g., conference abstracts, trial protocols) were excluded.
Year of last full review: 2019

Current ILCOR Consensus on Science and Treatment Recommendation for this PICOST:

A scoping review was undertaken as part of the 2021 COSTR cycle. No changes were suggetsed to the 2015 recommendations.

Chest compression depth (2015 recommendation)
We recommend a chest compression depth of approximately 5 cm (2 in.) (strong recommendation, low-quality evidence) while avoiding excessive chest compression depths (greater than 6 cm [greater than 2.4 in.] in an average adult) (weak recommendation, low-quality evidence) during manual CPR.

Chest compression rate (2015 recommendation)
We recommend a manual chest compression rate of 100–120/min (strong recommendation, very-low-quality evidence).

Chest recoil (2015 recommendation)
We suggest that rescuers performing manual CPR avoid leaning on the chest between compressions to allow full chest wall recoil (weak recommendation, very-low-quality evidence).

Current Search Strategy (for an existing PICOST) included in the attached approved PICOST

1. PUBMED
Chest compression depth
(((("Resuscitation" [Mesh] OR resuscitation[TIAB] OR "Cardiopulmonary Resuscitation"[MeSH] OR CPR[TI] OR "Heart Massage"[MeSH] OR compression*[TIAB] OR "heart massage"[TIAB] OR "cardiac massage"[TIAB] OR "Advanced Cardiac Life Support"[TIAB] OR "high-quality CPR"[TIAB] OR "high quality CPR"[TIAB] OR "CPR metrics"[TIAB] OR "CPR quality"[TIAB] OR "compression quality"[TIAB]) AND (lean*[TIAB] OR "chest recoil"[TIAB] OR recoil*[TIAB] OR (("Thoracic Wall"[Mesh] OR "thoracic wall"[TIAB] OR "chest wall"[TIAB] OR mm/s[TIAB]) AND (Recoil*[TIAB] OR decompress*[TIAB] OR release*[TIAB]))) NOT

(animals[Mesh] NOT humans[Mesh]) NOT ("letter"[Publication Type] OR "comment"[Publication Type] OR "editorial"[Publication Type] or Case Reports[Publication Type])))
OR

Chest compression rate

((((((((((((((((((((Heart Arrest[MeSH Terms]) OR Ventricular Fibrillation[MeSH Terms]) OR heart arrest[Title/Abstract]) OR cardiac arrest[Title/Abstract]) OR asystole[Title/Abstract]) OR cardiopulmonary arrest[Title/Abstract]) OR cardiovascular arrest[Title/Abstract]) OR Cardiopulmonary Resuscitation[MeSH Terms]) OR resuscitation[Title/Abstract]) OR CPR[Title/Abstract]) OR "advanced cardiac life support"[Title/Abstract]) OR ACLS[Title/Abstract]) OR Heart Massage[MeSH Terms]) OR heart massage*[Title/Abstract]) OR cardiac massage*[Title/Abstract] OR Basic Life Support[Title/Abstract] OR BLS[Title/Abstract])) AND (((((((((((((((((((compression rate*[Title/Abstract]) OR cc rate*[Title/Abstract]) OR fast compression[Title/Abstract]) OR slow compression[Title/Abstract]) OR compression ratio[Title/Abstract]) OR compression ratios[Title/Abstract]) OR "compression-decompression ratio"[Title/Abstract]) OR "compression-to-ventilation ratio"[Title/Abstract]) OR "compression-to ventilation ratios"[Title/Abstract]) OR compression-ventilation ratio[Title/Abstract]) OR compression ventilation ratios[Title/Abstract]) OR compression fraction[Title/Abstract]) OR rate directed[Title/Abstract]) OR high impulse[Title/Abstract]) OR CPR rate*[Title/Abstract]) OR fast rate*[Title/Abstract]) OR time dependent[Title/Abstract]) OR interruption*[Title/Abstract]) OR pause*[Title/Abstract]) OR hands off[Title/Abstract]) OR per minute[Title/Abstract]) OR rest[Title/Abstract]))) NOT ((animals[mh] NOT humans[mh])))) NOT (("letter"[pt] OR "comment"[pt] OR "editorial"[pt] or Case Reports[ptyp]))))
OR

Leaning and recoil

(((((((((((((((((((Heart Arrest[MeSH Terms]) OR heart arrest[Title/Abstract]) OR cardiac arrest[Title/Abstract]) OR asystole*[Title/Abstract]) OR cardiopulmonary arrest[Title/Abstract]) OR cardiovascular arrest[Title/Abstract]) OR Ventricular Fibrillation[MeSH Terms]) OR Cardiopulmonary Resuscitation[MeSH Terms]) OR resuscitation[Title/Abstract]) OR CPR[Title/Abstract]) OR pulseless electrical activity[Title/Abstract]) OR advanced cardiac life support[Title/Abstract]) OR ACLS[Title/Abstract]) OR Heart Massage[MeSH Terms]) OR heart massage*[Title/Abstract]) OR cardiac massage*[Title/Abstract]) OR chest compression*[Title/Abstract]) OR cardiac compression*[Title/Abstract])) AND ((((((((((((depth[Title/Abstract]) OR recoil[Title/Abstract]) OR decompression[Title/Abstract]) OR elasticity[Title/Abstract]) OR inches[Title/Abstract]) OR centimetres[Title/Abstract]) OR centimeters[Title/Abstract]) OR depress[Title/Abstract]) OR relaxation[Title/Abstract]) OR chest wall compression[Title/Abstract]) OR chest compression quality[Title/Abstract]) OR compression force[Title/Abstract]))

2. EMBASE

Chest compression depth

('resuscitation'/exp OR resuscitation:ti,ab OR CPR:ti OR 'heart massage'/exp OR compression*:ti,ab OR "heart massage":ti,ab OR "cardiac massage":ti,ab OR "Advanced Cardiac Life Support":ti,ab OR "high-quality CPR":ti,ab OR "high quality CPR":ti,ab OR "CPR metrics":ti,ab OR "CPR quality":ti,ab OR "compression quality":ti,ab) AND (lean*:ti,ab OR "chest recoil":ti,ab OR recoil*:ti,ab OR (('thorax wall'/exp OR "thoracic wall":ti,ab OR "chest wall":ti,ab OR "mm/s":ti,ab) AND (Recoil*:ti,ab OR decompress*:ti,ab OR release*:ti,ab))) NOT ('animal'/exp NOT 'human'/exp) NOT ([editorial]/lim OR [letter]/lim OR 'case report'/de) AND [embase]/lim
OR

Chest compression rate

'heart arrest'/exp OR 'heart ventricular fibrillation'/de OR 'heart arrest':ab,ti OR 'cardiac arrest':ab,ti OR asystole:ab,ti OR 'cardiopulmonary arrest':ab,ti OR 'cardiovascular arrest':ab,ti OR 'cardiopulmonary resuscitation':ab,ti OR cpr:ab,ti OR 'advanced cardiac life support':ab,ti OR acls:ab,ti OR 'basic life support':ab,ti OR bls:ab,ti OR 'heart massage'/de OR 'heart massage':ab,ti OR 'cardiac massage':ab,ti AND ((compression NEAR/3 rate*):ab,ti OR 'cc rate':ab,ti OR 'cc rates':ab,ti OR 'fast compression':ab,ti OR 'slow compression':ab,ti OR (compression NEAR/3 ratio):ab,ti OR (compression NEAR/3 ratios):ab,ti OR 'compression fraction':ab,ti OR 'rate directed':ab,ti OR 'high impulse':ab,ti OR 'per minute':ab,ti OR 'per min':ab,ti OR 'cpr rate':ab,ti OR 'cpr rates':ab,ti OR 'fast rate':ab,ti OR 'fast rates':ab,ti OR 'time+dependent':ab,ti OR interruption*:ab,ti OR pause*:ab,ti OR 'hands+off':ab,ti OR rest:ab,ti) NOT ('animal'/exp NOT 'human'/exp) NOT ([editorial]/lim OR [letter]/lim OR 'case report'/de) AND [embase]/lim
OR

Leaning and recoil

('Heart Arrest'/exp OR 'heart arrest':ab,ti OR 'cardiac arrest':ab,ti OR asystole*:ab,ti OR 'cardiopulmonary arrest':ab,ti OR 'cardiovascular arrest':ab,ti OR 'Heart Ventricular Fibrillation'/de OR 'cardiopulmonary resuscitation':ab,ti OR CPR:ab,ti OR 'pulseless electrical activity':ab,ti OR 'advanced cardiac life support':ab,ti OR ACLS:ab,ti OR 'Heart Massage'/de OR 'heart massage':ab,ti OR 'cardiac massage':ab,ti OR 'chest compression':ab,ti OR 'cardiac compression':ab,ti) AND (depth:ab,ti OR recoil:ab,ti OR decompression:ab,ti OR elasticity:ab,ti OR inches:ab,ti OR centimetres:ab,ti OR centimeters:ab,ti OR depress:ab,ti OR relaxation:ab,ti OR 'chest wall compression':ab,ti OR 'chest compression quality':ab,ti OR 'compression force':ab,ti) AND [Embase]/lim

3. COCHRANE

Chest compression depth

([mh ^Resuscitation] OR resuscitation:ab,ti OR [mh "Cardiopulmonary Resuscitation"] OR CPR:ab,ti OR [mh "Heart Massage"] OR compression*:ab,ti OR "heart massage":ab,ti OR "cardiac massage":ab,ti OR "Advanced Cardiac Life Support":ab,ti OR "high-quality CPR":ab,ti OR "high quality CPR":ab,ti OR "CPR metrics":ab,ti OR "CPR quality":ab,ti OR "compression quality":ab,ti) AND ((lean*:ab,ti OR "chest recoil":ab,ti OR recoil*:ab,ti) OR ([mh "Thoracic Wall"] OR "thoracic wall":ab,ti OR "chest wall":ab,ti) AND (Recoil*:ab,ti OR decompress*:ab,ti OR release*:ab,ti)) NOT ([mh animals] NOT [mh humans])

OR

Chest compression rate

([mh "Heart Arrest"] OR [mh "Ventricular Fibrillation"] OR "heart arrest":ab,ti OR "cardiac arrest":ab,ti OR asystole:ab,ti OR "cardiopulmonary arrest":ab,ti OR "cardiovascular arrest":ab,ti OR [mh "Cardiopulmonary Resuscitation"] OR resuscitation:ab,ti OR CPR:ab,ti OR "advanced cardiac life support":ab,ti OR ACLS:ab,ti OR "basic life support":ab,ti OR BLS:ab,ti OR [mh "Heart Massage"] OR "heart massage*":ab,ti OR "cardiac massage*":ab,ti) AND ((compression near/3 rate*):ab,ti or "cc rate*":ab,ti or "fast compression":ab,ti or "slow compression":ab,ti or (compression near/3 ratio):ab,ti or (compression near/3 ratios):ab,ti or "compression fraction":ab,ti or "rate directed":ab,ti or "high impulse":ab,ti or "per min*":ab,ti or "CPR rate*":ab,ti or "fast rate*":ab,ti or "time dependent":ab,ti or interruption*:ab,ti or pause*:ab,ti or "hands-off":ab,ti or rest:ab,ti)

OR

Leaning and recoil

([mh "Heart Arrest"] or "heart arrest":ab,ti or "cardiac arrest":ab,ti or Asystole*:ab,ti or "cardiopulmonary arrest":ab,ti or "cardiovascular arrest":ab,ti or [mh "Ventricular Fibrillation"] or [mh "Cardiopulmonary Resuscitation"] or resuscitation:ab,ti or CPR:ab,ti or "pulseless electrical activity":ab,ti or "advanced cardiac life support":ab,ti or ACLS:ab,ti or [mh "Heart Massage"] or "heart massage":ab,ti or "cardiac massage":ab,ti or "chest compression":ab,ti or "cardiac compression":ab,ti) AND (depth:ab,ti or recoil:ab,ti or decompression:ab,ti or elasticity:ab,ti or inches:ab,ti)

Database searched: PubMed & Cochrane (EMBASE and MEDLINE searches did not work in EBSCO)
Date Search Completed: 19/12/2022
Search Results (Number of articles identified and number identified as relevant): 618 titles retrieved of which 89 were duplicates. 22 potentially relevant titles were identified and 6 were ultimately included

Summary of Evidence Update:

Chest compression depth
Relevant Guidelines or Systematic Reviews

Organization (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations
ILCOR; Ramachandran, 2022,	SR	Neonatal CC in the delivery room including: (1) heart rate thresholds to start CC, (2) compression to ventilation ratio (C:V), (3) CC technique, (4) oxygen use	74 studies included (n=46 simulation, n=24 animal and n=4 clinical studies)	Two human studies with potentially relevant findings Jang, 2018, 36 – in 7 infants there was no difference between 2 thumb vs 1 hand techniques with respect to CC depth	Evidence suggests more studies concerning compression depths in newborn infants are needed.

				Maher, 2009, 662 – in 6 infants CC depth 1/2 AP diameter vs 1/3 AP diameter achieved better blood pressures	

Nonrandomized Trials, Observational Studies

Study Acronym; Author; Year Published	Study Type/Design; Study Size (N)	Patient Population	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/Conclusion Comment(s)
Loza-Gomez, 2022, e35	Prospective observational study (n=120)	Non-trauma, adult OOHCA receiving >3min CPR	Average Compression Depth, median (IQR) inches 2.1 (1.9–2.5) Range 1.3–3.3 Compression Too Shallow, median (IQR) percent 35 (12–62) Range 1–99 Compression Too Deep, median (IQR) percent 18 (3–56) Range 0–94 Compression at Target Depth, median (IQR) percent 30 (16–41) Range 1–90 Events with < 10% of Compressions at Target Depth, n (%) 20 (16.7) Events with > 50% of Compressions at Target Depth, n (%) 13 (10.4)	Achieving a CCF target does not necessarily equate to delivering high quality chest compressions
Gutiérrez, 2022, 225	Retrospective analysis (n=221)	Adult OOHCA monitor recordings having concurrent EtCO2. Cases must have at least 1000 compressions.	median depth 50.4 (43.2–57.0). After fitting a linear model, the coefficient for explaining the effect of varying compression rate was 0.04 (95% CI: 0.01–0.07). The trend of ETCO2 with depth was significant (p< 0:001).	Depth of compressions is associated with EtCO2
Lee SG, 2022, 180	Cross-sectional observational study (n=788)	Adult OOHCA receiving >4 min CPR on scene AND during transport. 462 cases deployed mCPR	Mean depth (cm) 5.1 (0.9); pre-feedback device 5.4 (1.3); on scene 5.2 (1.0); extrication 4.7 (1.2); transport 4.9 (1.3); p <0.01 Proportion of adequate depth (%) 26.4 (14.5); pre-feedback 29.2 (28.2); on scene 30.5 (21.6); extrication 20.9 (20.9);	Inadequate CC depth was most likely to occur during the extrication phase

			transport 19.1 (13.2); p <0.01	
De Roos, 2022, 75	Prospective observational study (n=47)	Adult OOHCA receiving >1 min CPR and concurrent EtCO2.	CC depth (mm), mean (SD) ALL 57.5 (10.3); ROSC (n=19) 57.5 (11.7); No ROSC (n=28) 57.5 (9.20); p=0.997	CC depth was not associated with ROSC
Falco, 2022, 521	Retrospective analysis (n=23)	Paediatric IHCA (ED) receiving >1 min CPR.	Proportion of cases compliant with AHA: Depth too shallow 80.36%, Depth too deep 6.25%, Compliant 13.39%.	Majority of cases were not compliant with AHA recommendations (too shallow)

Chest compression rate

Relevant Guidelines or Systematic Reviews

Organization (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations
ILCOR; Ramachandran, 2022,	SR	Neonatal CC in the delivery room including: (1) heart rate thresholds to start CC, (2) compression to ventilation ratio (C:V), (3) CC technique, (4) oxygen use	74 studies included (n=46 simulation, n=24 animal and n=4 clinical studies)	One human study with potentially relevant findings Jang, 2018, 36 – in 7 infants 2 thumb technique was associated with better compliance with CC rate than I hand technique.	No recommendation regarding CC rate is made

Nonrandomized Trials, Observational Studies

Study Acronym; Author; Year Published	Study Type/Design; Study Size (N)	Patient Population	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/Conclusion Comment(s)
Loza-Gomez, 2022, e35	Prospective observational study (n=120)	Non-trauma, adult OOHCA receiving >3min CPR	Average Compression Rate, median (IQR) 118.5 (111–124) Range 101–156 Compression Rate Too Slow, median (IQR) percent 4 (2–7) Range 0–33 Compression Rate Too Fast, median (IQR) percent 41 (16–63) Range 1–99 Compression at Target Rate,	Achieving a CCF target does not necessarily equate to delivering high quality chest compressions

			median (IQR) percent 52.5 (32.5–74) Events with < 10% of Compressions at Target Rate, n (%) 8 (6.7)∗ Events with > 50% of Compressions at Target Rate, n (%) 69 (57.5)∗	
Gutiérrez, 2022, 225	Retrospective analysis (n=221)	Adult OOHCA monitor recordings having concurrent EtCO2. Cases must have at least 1000 compressions.	median rate (min-1) 111.1 (106.5–116.1). After fitting a linear model the coefficient explaining the effect of varying compression depth was 0.95 (95% CI: 0.93–0.98). No trend of ETCO2 with compression rate was observed	Rate of compressions is not associated with EtCO2
Lee SG, 2022, 180	Cross-sectional observational study (n=788)	Adult OOHCA receiving >4 min CPR on scene AND during transport. 462 cases deployed mCPR	Mean rate (/min) 104.8 (7.7); pre-feedback 111.0 (8.8); on scene 107.6 (6.7); extrication 97.6 (15.4); transport 96.7 (14.3); p<0.01 Proportion of adequate rate (%) 58.8 (18.9); pre-feedback 74.7 (27.0); on scene 72.8 (19.9); extrication 34.0 (35.0); transport 31.7 (33.8); p <0.01	Inadequate CC rate was most likely to occur during the extrication phase
De Roos, 2022, 75	Prospective observational study (n=47)	Adult OOHCA receiving >1 min CPR and concurrent EtCO2.	CC rate (min-1), mean (SD) ALL 115.6 (8.8); ROSC (n=19) 117.7 (9.2); No ROSC (n=28) 113.8 (8.3) p=0.118	CC rate was not associated with ROSC
Falco, 2022, 521	Retrospective analysis (n=23)	Paediatric IHCA (ED) receiving >1 min CPR.	Proportion of cases compliant with AHA: Rate too low 13.39%, Rate too high 17.86%, Compliant 68.75%.	Majority of cases achieved a rate compliant with AHA recommendations

Chest recoil
Nonrandomized Trials, Observational Studies

Study Acronym; Author; Year Published	Study Type/Design; Study Size (N)	Patient Population	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/Conclusion Comment(s)
De Roos, 2022, 75	Prospective observational study (n=47)	Adult OOHCA receiving >1 min CPR and concurrent EtCO2.	CC release velocity (mm/s), mean (SD) ALL 405.2 (79.6); ROSC (n=19) 410.1 (79.3); No ROSC (n=28) 401.0 (81.2); p=0.703	Release velocity was not associated with ROSC

Falco, 2022, 521	Retrospective analysis (n=23)	Paediatric IHCA (ED) receiving >1 min CPR.	Maximum release velocity (IQR)(mm/s) 185 (122.75)	No conclusion

Reviewer Comments: *(including whether this PICOST should have a systematic or scoping review***)**
No new evidence that would warrant a change to current recommendations dating from 2015.

Reference list: *(List by ILCOR ref standard (last name first author, year of publication, first page number) and insert hyperlink to all articles identified as relevant (if available on PubMed)*

1. Loza-Gomez A, Johnson M, Newby M, LeGassick T, Larmon B. Chest Compression Fraction Alone Does Not Adequately Measure Cardiopulmonary Resuscitation Quality in Out-of-Hospital Cardiac Arrest. The Journal of Emergency Medicine. 2022 Mar 1;62(3):e35-43. https://pubmed.ncbi.nlm.nih.gov/35058094/
2. Gutiérrez JJ, Sandoval CL, Leturiondo M, Russell JK, Redondo K, Daya MR, de Gauna SR. Contribution of chest compressions to end-tidal carbon dioxide levels generated during out-of-hospital cardiopulmonary resuscitation. Resuscitation. 2022 Oct 1;179:225-32. https://pubmed.ncbi.nlm.nih.gov/35835250/
3. Lee SG, Hong KJ, Kim TH, Choi S, Do Shin S, Song KJ, Ro YS, Jeong J, Park YJ, Park JH. Quality of chest compressions during prehospital resuscitation phase from scene arrival to ambulance transport in out-of-hospital cardiac arrest. Resuscitation. 2022 Nov 1;180:1-7. https://pubmed.ncbi.nlm.nih.gov/36087637/
4. De Roos E, Vanwulpen M, Hachimi-Idrissi S. Chest compression release velocity: An independent determinant of end-tidal carbon dioxide in out-of-hospital cardiac arrest. The American Journal of Emergency Medicine. 2022 Apr 1;54:71-5. https://pubmed.ncbi.nlm.nih.gov/35124336/
5. Falco L, Timmons Z, Swing T, Luciano W, Bulloch B. Measuring the Quality of Cardiopulmonary Resuscitation in the Emergency Department at a Quaternary Children's Hospital. Pediatric Emergency Care. 2022 Oct 1;38(10):521-5. https://pubmed.ncbi.nlm.nih.gov/36173429/
6. Ramachandran S, Bruckner M, Wyckoff MH, Schmölzer GM. Chest compressions in newborn infants: a scoping review. Archives of Disease in Childhood-Fetal and Neonatal Edition. 2022 Dec 1. https://pubmed.ncbi.nlm.nih.gov/36456175/
7. Jang HY, Wolfe H, Hsieh TC, Abbadessa MK, Myers S, Nadkarni V, Donoghue A. Infant chest compression quality: a video-based comparison of two-thumb versus one-hand technique in the emergency department. Resuscitation. 2018 Jan 1;122:36-40. https://pubmed.ncbi.nlm.nih.gov/29158035/
8. Maher KO, Berg RA, Lindsey CW, Simsic J, Mahle WT. Depth of sternal compression and intra-arterial blood pressure during CPR in infants following cardiac surgery. Resuscitation. 2009 Jun 1;80(6):662-4. https://pubmed.ncbi.nlm.nih.gov/19403232/

Evidence Update Worksheet

BLS 345 Rhythm Check Timing

Worksheet author(s): Tatsuya Norii
Task Force: BLS
Date Submitted to SAC rep for peer review and approval: Dec 2023
SAC rep:

PICOST / Research Question: *(Attach SAC representative approved completed PICOST template)*:
BLS 345 Rhythm check timing

Population: Adults and children who are in cardiac arrest in any setting

Intervention: Checking the cardiac rhythm immediately after defibrillation

Comparator: Immediate resumption of chest compressions with delayed check of the cardiac rhythm

Outcomes: Survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year; ROSC; recurrence of VF, CPR quality parameters (i.e. compression fraction).

Study Designs: Randomized controlled trials (RCTs) and non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies), case series (≥5 cases) are eligible for inclusion.

Timeframe: January 1st, 2022, to December 31st, 2022. All languages were included as long as there was an English abstract. Unpublished studies (e.g., conference abstracts, trial protocols), animal studies, manikin studies, cadaver studies were excluded.

Year of last full review:
2020 ILCOR CoSTR
(The last evidence update was conducted at the end of 2021.)

Current ILCOR Consensus on Science and Treatment Recommendation for this PICOST:
We suggest immediate resumption of chest compressions after shock delivery for adults in cardiac arrest in any setting (weak recommendation, very low–certainty evidence).

Current Search Strategy (for an existing PICOST) included in the attached approved PICOST:
("Pulse"[Mesh] OR "heart rate"[Mesh] OR "rhythm check"[TIAB] OR "heart rhythm"[TIAB] OR "cardiac rhythm"[TIAB] OR "pulse check"[TIAB] OR "pulse checks"[TIAB] OR "pulse checking"[TIAB] OR "pulse assessment"[TIAB] OR "rhythm analysis"[TIAB] OR "Monitoring, Physiologic"[Mesh] OR "pulse palpation"[TIAB]) AND (early[TIAB] OR earlie*[TIAB] OR late[TIAB] OR later[TIAB] OR resum*[TIAB] OR length[TIAB] OR minute*[TIAB] OR second*[TIAB] OR time[TIAB] OR timing[TIAB] OR "Time Factors"[Mesh] OR paus*[TIAB] OR delay*[TIAB]) AND ("Out-of-Hospital Cardiac Arrest"[Mesh] OR "Out of Hospital Cardiac Arrest"[TIAB] OR "Out-of-Hospital Cardiac Arrest"[TIAB] OR "Heart Arrest"[Mesh] OR "cardiac arrest"[TIAB] OR "cardiac arrests"[TIAB] OR "cardiovascular arrest"[TIAB] OR "cardiovascular arrests"[TIAB] OR "heart arrest"[TIAB] OR "heart arrests"[TIAB] OR "asystole"[TIAB] OR "pulseless electrical activity"[TIAB] OR "cardiopulmonary arrest"[TIAB] OR "cardiopulmonary arrests"[TIAB] OR "Heart Failure"[Mesh] OR "heart failure"[TIAB] OR "Myocardial Infarction"[Mesh] OR "myocardial infarction"[TIAB] OR "myocardial infarctions"[TIAB] OR "AMI"[TIAB] OR "Ventricular Fibrillation"[Mesh]) AND (("Resuscitation"[Mesh] OR resuscitat*[TIAB] OR "Advanced Cardiac Life Support"[Mesh] OR "Advanced Cardiac Life Support"[TIAB] OR "ACLS"[TIAB] OR "return of spontaneous circulation"[TIAB] OR ROSC[TIAB] OR "cardiopulmonary resuscitation"[Mesh] OR "cardiopulmonary resuscitation"[TIAB] OR CPR[TIAB] OR "Electric

Countershock"[Mesh] OR Countershock*[TIAB] OR Cardioversion*[TIAB] OR Electroversion*[TIAB] OR "Defibrillators"[Mesh] OR defibrillator*[TIAB] defibrillation*[TIAB] OR "automatic external defibrillator"[TIAB] OR "automatic external defibrillators"[TIAB] OR "automated external defibrillator"[TIAB] OR "automated external defibrillators"[TIAB] OR AED*[TIAB] OR "automatic external defibrillation"[TIAB] OR "chest compression"[TIAB] OR "chest compressions"[TIAB] OR "heart massage"[TIAB] OR "cardiac massage"[TIAB] OR "cardiac compression"[TIAB] OR "cardiac compressions"[TIAB] OR "thoracic compression"[TIAB] OR "thoracic compressions"[TIAB]) AND ("methods" [Subheading] OR method*[TIAB] OR technique*[TIAB])) NOT ((animals[mesh] NOT humans[mesh])) NOT ("letter"[Publication Type] OR "comment"[Publication Type] OR "editorial"[Publication Type] or Case Reports[Publication Type])

New Search strategy: (for a new PICOST should be outlined here as per Evidence Update Process): NA

Database searched: Pubmed

Time Frame: (existing PICOST) – updated from end of last search (please specify): January 1st, 2022, to December 31st, 2022

Time Frame: (new PICOST) – at the discretion of the Task Force (please specify): NA

Date Search Completed: December 31st, 2022

Search Results (Number of articles identified and number identified as relevant):

Since last above search: 12 articles / 1 reviewed / 0 relevant

Summary of Evidence Update: No new studies identified.

Relevant Guidelines or Systematic Reviews

Organization (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations

RCT:

Study Acronym; Author; Year Published	Aim of Study; Study Type; Study Size (N)	Patient Population	Study Intervention (# patients) / Study Comparator (# patients)	Endpoint Results (Absolute Event Rates, P value; OR or RR; & 95% CI)	Relevant 2° Endpoint (if any); Study Limitations; Adverse Events
	Study Aim: Study Type:	Inclusion Criteria:	Intervention: Comparison:	1° endpoint:	Study Limitations:

Nonrandomized Trials, Observational Studies

Study Acronym; Author; Year Published	Study Type/Design; Study Size (N)	Patient Population	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/Conclusion Comment(s)

	Study Type:	Inclusion Criteria:	1° endpoint:	

Reviewer Comments: *(including whether this PICOST should have a systematic or scoping review)*
Insufficient new evidence to warrant updating current systematic review and CoSTR.

Reference list: *(List by ILCOR ref standard (last name first author, year of publication, first page number) and insert hyperlink to all articles identified as relevant (if available on PubMed):* NA

Evidence Update Worksheet

BLS 346 Timing of CPR Cycles

Worksheet author(s): Tatsuya Norii
Task Force: BLS
Date Submitted to SAC rep for peer review and approval: December 2022
SAC rep:

PICOST / Research Question: *(Attach SAC representative approved completed PICOST template)*:
BLS 346 Timing of CPR cycles (2 min vs other)

Population: Adults and children with cardiac arrest

Intervention: Pausing chest compressions at another interval

Comparator: Pausing chest compressions every 2 minutes to assess the cardiac rhythm

Outcomes: Survival with favorable neurological/functional outcome at discharge, 30 days, 60 days, 180 days AND/OR 1 year; Survival only at discharge, 30 days, 60 days, 180 days AND/OR 1 year; Return of spontaneous circulation (ROSC); Coronary perfusion pressure; Cardiac output.

Study Designs: Randomized controlled trials (RCTs) and non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies), case series (≥5 cases) are eligible for inclusion.

Timeframe: January 1st, 2022, to December 31st, 2022. All languages were included as long as there was an English abstract. Unpublished studies (e.g., conference abstracts, trial protocols), animal studies, manikin studies, cadaver studies were excluded.

Year of last full review:
2020 ILCOR CoSTR
(The last evidence update was conducted at the end of 2021.)

Current ILCOR Consensus on Science and Treatment Recommendation for this PICOST:
We suggest pausing chest compressions every 2 min to assess the cardiac rhythm (weak recommendation, low-certainty evidence).

Current Search Strategy (for an existing PICOST) included in the attached approved PICOST
("CPR cycle"[TIAB] OR "CPR cycles"[TIAB] OR "CPR sequences"[TIAB] OR "CPR sequence"[TIAB] OR "cycle duration"[TIAB] OR "loop duration"[TIAB] OR "loop durations"[TIAB] OR "Pulse"[Mesh] OR "pulse check"[TIAB] OR "pulse checks"[TIAB] OR "pulse checking"[TIAB] OR "pulse assessment"[TIAB] OR "heart rate"[Mesh] OR "heart rhythm"[TIAB] OR "cardiac rhythm"[TIAB] OR "rhythm check"[TIAB] OR "rhythm analysis"[TIAB] OR "analysis of rhythm"[TIAB] OR "rhythm assessment"[TIAB] OR "rhythm assessments"[TIAB] OR "compression interruption"[TIAB] OR "compression interruptions"[TIAB] OR "compression delay"[TIAB] OR "compression pause"[TIAB] OR "compression pauses"[TIAB] OR "No flow time"[TIAB] OR "Hands off time"[TIAB]) AND (minute*[TIAB] OR min[TIAB] OR "1 min"[TIAB] OR "1-min"[TIAB] OR "1min"[TIAB] OR "2 minute"[TIAB] OR "2 minutes"[TIAB] OR "two minute"[TIAB] OR "two minutes"[TIAB] OR "2-minute"[TIAB] OR "2-minutes"[TIAB] OR "two-minute"[TIAB] OR "2 min"[TIAB] OR "2-min"[TIAB] OR "2min"[TIAB] OR "3 min"[TIAB] OR "3-min"[TIAB] OR "3min"[TIAB] OR "4 min"[TIAB] OR "4-min"[TIAB] OR "4min"[TIAB] OR "5 min"[TIAB] OR "5-min"[TIAB] OR "5min"[TIAB] OR timing[TI] OR "Time Factors"[Mesh] OR resum*[TIAB] OR length[TIAB] OR last*[TIAB] OR seconds[TIAB] OR paus*[TIAB] OR delay*[TIAB] OR interval*[TIAB]) AND ("Resuscitation"[Mesh] OR resuscitat*[TIAB] OR "cardiopulmonary resuscitation"[Mesh] OR "cardiopulmonary resuscitation"[TIAB] OR CPR[TIAB] OR "heart massage"[Mesh] OR "heart massage"[TIAB] OR "chest compression"[TIAB] OR "chest compressions"[TIAB] OR "cardiac massage"[TIAB] OR "cardiac compression"[TIAB] OR "cardiac compressions"[TIAB] OR "thoracic compression"[TIAB] OR "thoracic

compressions"[TIAB]) AND ("Out-of-Hospital Cardiac Arrest"[Mesh] OR "Out of Hospital Cardiac Arrest"[TIAB] OR "Out-of-Hospital Cardiac Arrest"[TIAB] OR "Out of Hospital Cardiac Arrests"[TIAB] OR "Out-of-Hospital Cardiac Arrests"[TIAB] OR "Heart Arrest"[Mesh] OR "heart arrest"[TIAB] OR "heart arrests"[TIAB] OR "asystole"[TIAB] OR "pulseless electrical activity"[TIAB] OR "cardiac arrest"[TIAB] OR "cardiac arrests"[TIAB] OR "cardiovascular arrest"[TIAB] OR "cardiovascular arrests"[TIAB] OR "cardiopulmonary arrest"[TIAB] OR "cardiopulmonary arrests"[TIAB] OR "cardio-pulmonary arrest"[TIAB] OR "cardio-pulmonary arrests"[TIAB] OR "Ventricular Fibrillation"[Mesh] OR "Ventricular Fibrillation"[TIAB] OR "Tachycardia, Ventricular"[Mesh]) NOT (animal[mesh] NOT humans[mesh]) NOT ("letter"[Publication Type] OR "comment"[Publication Type] OR "editorial"[Publication Type] or Case Reports[Publication Type])

New Search strategy: (for a new PICOST should be outlined here as per Evidence Update Process): NA

Database searched: Pubmed

Time Frame: (existing PICOST) – updated from end of last search (please specify): January 1st, 2022, to December 31st, 2022

Time Frame: (new PICOST) – at the discretion of the Task Force (please specify): NA

Date Search Completed: December 31st, 2022

Search Results (Number of articles identified and number identified as relevant):

Since last above search: 41 articles / 3 reviewed / 0 relevant

Summary of Evidence Update: No new studies identified.

Relevant Guidelines or Systematic Reviews

Organization (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations

RCT:

Study Acronym; Author; Year Published	Aim of Study; Study Type; Study Size (N)	Patient Population	Study Intervention (# patients) / Study Comparator (# patients)	Endpoint Results (Absolute Event Rates, P value; OR or RR; & 95% CI)	Relevant 2° Endpoint (if any); Study Limitations; Adverse Events
	<u>Study Aim:</u> <u>Study Type:</u>	<u>Inclusion Criteria:</u>	<u>Intervention:</u> <u>Comparison:</u>	<u>1° endpoint:</u>	<u>Study Limitations:</u>

Nonrandomized Trials, Observational Studies

Study Acronym; Author; Year Published	Study Type/Design; Study Size (N)	Patient Population	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/Conclusion Comment(s)

	Study Type:	Inclusion Criteria:	1° endpoint:	

Reviewer Comments: *(including whether this PICOST should have a systematic or scoping review*)
Insufficient new evidence to warrant updating current systematic review and CoSTR.

Reference list: *(List by ILCOR ref standard (last name first author, year of publication, first page number) and insert hyperlink to all articles identified as relevant (if available on PubMed):* NA

Evidence Update Worksheet

BLS 347 PAD Programs

Worksheet author(s): Katie Dainty
Task Force: BLS
Date Submitted to SAC rep for peer review and approval: December 2022
SAC rep:

PICOST / Research Question: *(Attach SAC representative approved completed PICOST template)*
Among adults and children who are in cardiac arrest outside of a hospital (P), does implementation of a public access AED program (I), compared with traditional EMS response (C), improve any clinical outcome?
Outcomes: Survival with favorable neurologic outcome, Survival only at discharge, 30 days, 60 days, 180 days AND/OR 1 year, ROSC, bystander CPR rates, time to first compressions, time to first shock, CPR quality
Type (intervention, diagnosis, prognosis): Intervention

Year of last full review: *2021*

Current ILCOR Consensus on Science and Treatment Recommendation for this PICOST:
We recommend the implementation of public-access defibrillation programs for patients with OHCAs.
(Strong recommendation, low-certainty evidence)

Current Search Strategy (for an existing PICOST) included in the attached approved PICOST:
("Out-of-Hospital Cardiac Arrest"[Mesh] OR "Out of Hospital Cardiac Arrest" [TIAB] OR "Out-of-Hospital Cardiac Arrest" [TIAB] OR "Out of Hospital Cardiac Arrests" [TIAB] OR "Out-of-Hospital Cardiac Arrests" [TIAB] OR (("out-of-hospital"[TIAB] OR "out of hospital"[TIAB] OR "outside of hospital"[TIAB]) AND cardiac[TIAB] AND arrest*[TIAB]) OR "Heart Arrest"[Mesh:NoExp] OR "heart arrest"[TIAB] OR "heart arrests"[TIAB] OR "cardiac arrest"[TIAB] OR "cardiac arrests"[TIAB] OR "cardiovascular arrest"[TIAB] OR "cardiovascular arrests"[TIAB] OR "asystole"[TIAB] OR "Heart Failure"[Mesh] OR "heart failure"[TIAB] OR "cardiopulmonary arrest"[TIAB] OR "cardiopulmonary arrests"[TIAB] OR "cardio-pulmonary arrest"[TIAB] OR "cardio-pulmonary arrests"[TIAB] OR "Ventricular Fibrillation"[Mesh] OR "Ventricular Fibrillation"[TIAB] OR "Tachycardia, Ventricular"[Mesh] OR "pulseless ventricular tachycardia"[TIAB] OR (Pulseless[TIAB] AND (V-tach[TIAB] OR VT[TIAB])) OR "Cardiopulmonary Resuscitation"[Mesh] OR "cardiopulmonary resuscitation"[TIAB] OR CPR[TIAB] OR "Resuscitation"[Mesh] OR resuscitat*[TIAB]) AND ("early defibrillation"[TIAB] OR "automatic external defibrillator"[TIAB] OR "automatic external defibrillators"[TIAB] OR "automated external defibrillator"[TIAB] OR "automated external defibrillators"[TIAB] OR AED[TIAB] OR AEDs[TIAB] OR "automatic external defibrillation"[TIAB] OR "public access defibrillation program"[TIAB] OR "public access defibrillation programs"[TIAB] OR (("Electric Countershock"[Mesh] OR "electric countershock"[TIAB] OR countershock*[TIAB] OR electroversion*[TIAB] OR cardioversion*[TIAB] OR "Defibrillators"[Mesh] OR defibrillator*[TIAB] OR defibrillation*[TIAB]) AND (public[TIAB] OR bystander*[TIAB] OR "first responder"[TIAB] OR "first responders"[TIAB] OR "firstresponder"[TIAB] OR "first-responders"[TIAB] OR Layperson*[TIAB] OR "lay people"[TIAB] OR "lay rescuer"[TIAB] OR "lay rescuers"[TIAB] OR witness*[TIAB] OR Firefighter*[TIAB] OR "fire fighter" OR "fire fighters" OR "Firefighters"[Mesh] OR "Police"[Mesh] OR Police[TIAB] OR "non-healthcare professionals"[TIAB] OR "non-healthcare professional"[TIAB] OR "Emergency Medical Technicians"[Mesh] OR "emergency medic"[TIAB] OR "emergency medical"[TIAB] OR "EMS"[TIAB] OR "EMT"[TIAB] OR paramedic*[TIAB]))) NOT (animals[Mesh] NOT humans[Mesh]) NOT ("letter"[Publication Type] OR "comment"[Publication Type]OR "editorial"[Publication Type] or Case Reports[Publication Type] OR "case series"[TIAB])

Database searched: PubMed
Time Frame: (existing PICOST) – December 17 2021 to December 17 2022
Date Search Completed: December 17 2022
Search Results (Number of articles identified and number identified as relevant):
PubMed: 216 articles identified/24 selected for full text review/3 identified as relevant

Summary of Evidence Update: Two studies were identified as somewhat relevant to this PICOST. None of the outcomes reported warrant a change to the current treatment recommendation.

Relevant Guidelines or Systematic Reviews

Organization (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings
Brooks et al for ILCOR; 2022	ILCOR Scientific Statement	Optimizing Outcomes After Out-of-Hospital Cardiac Arrest with Innovative Approaches to Public-Access Defibrillation: A Scientific Statement from the International Liaison Committee on Resuscitation	N/A	Despite imperfect implementation, public-access defibrillation has saved countless lives. AEDs remain underused so that many salvageable individuals die without the benefit of having an AED available to them. There are multiple barriers to more consistent AED use; however, there are also multiple opportunities to address those barriers with new approaches to PAD program implementation, including changing the behavior of potential users; improving availability; improving integration with existing emergency dispatch; enhancing AED housing, signage, and device technology; and exploring novel AED delivery vectors. Specific policy suggestions made in Table 1. Knowledge gaps identified for future research in Table 2. Continued evolution of the approach to PAD with increased early CPR, rhythm detection, and defibrillation will improve cardiac safety in our communities and ultimately increase survival after OHCA.

RCT: None

Nonrandomized Trials, Observational Studies

Study Acronym; Author; Year Published	Study Type/Design; Study Size (N)	Patient Population	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/Conclusion Comment(s)
Ishii 2022	<u>Study Type:</u> Interrupted time series analysis of the official Japanese Government Statistics database	<u>Inclusion Criteria:</u> People aged five years and older in the Japanese demographic statistics (1995–2015)	<u>1° endpoint:</u> Interrupted time series data stratified by age and sex to evaluate changes in trends of rates of annual SCDs after the introduction of a PAD program in Japan.	After the PAD introduction in 2004, a significant decrease in trends of annual SCD rates was observed for those aged 5–19 years (the ratio of trends between pre and post PAD introduction (RT) = 0.886, 95%CI: 0.801 to 0.980), 20–34 years (RT = 0.932; 95%CI: 0.906, 0.958), 35–49 years (RT = 0.953; 95%CI: 0.929, 0.977) and 50–64 years (RT = 0.971; 95%CI: 0.971, 0.991). However, the decrease was not observed for those aged 65 years and older. In the age and sex stratified analysis, there was a significant decrease in RT among males aged 5–64 years, and among females 35–49 years.
Heidet 2022	International, multicenter, retrospective cohort study	OHCA cases from Metro Vancover, Canada included in the CanROC Registry (CanROC) and from Rhone County, France in the Registre Électronique des Arrêts Cardiaques (RéAC)	<u>2° endpoint:</u> In Metro Vancouver, Canada univariate models demonstrated that AED access time of ≥ 3 minutes was associated with a lower probability of ROSC at hospital arrival (OR 0.39, 95 % CI [0.24, 0.64]) and survival at hospital discharge (OR 0.19, 95 % CI [0.10, 0.36]) (all p < 0.001). In multivariate models, 1-way access time of ≥ 3 minutes was associated with lower survival at hospital discharge (OR 0.41, 95 % CI [0.23, 0.74], p = 0.003)	These findings emphasize the need for rapid and efficient access to public AEDs. Nevertheless, these associations warrant cautious interpretation as outcomes depend on a complex chain of survival in which the organization and efficiency of EMS systems and in-hospital practices play important roles.

			but not with ROSC (Table 3 and Supp. Table 2).	

Reviewer Comments: *(including whether this PICOST should have a systematic or scoping review*)

The evidence on this PICOST remains largely observational and geographically specific. No changes to current recommendations or further systematic review is warranted at this time.

Reference list: *(List by ILCOR ref standard (last name first author, year of publication, first page number) and insert hyperlink to all articles identified as relevant (if available on PubMed)*

1. Ishii T, Nawa N, Morio T, Fujiwara T. Association between nationwide introduction of public-access defibrillation and sudden cardiac death in Japan: An interrupted time-series analysis. Int J Cardiol. 2022 Mar 15;351:100-106. doi: 10.1016/j.ijcard.2021.12.016.
https://pubmed.ncbi.nlm.nih.gov/34929250/

2. Heidet M, Freyssenge J, Claustre C, Deakin J, Helmer J, Thomas-Lamotte B, Wohl M, Danny Liang L, Hubert H, Baert V, Vilhelm C, Fraticelli L, Mermet É, Benhamed A, Revaux F, Lecarpentier É, Debaty G, Tazarourte K, Cheskes S, Christenson J, El Khoury C, Grunau B; RéAC, CanROC, ReACanROC investigators. Association between location of out-of-hospital cardiac arrest, on-scene socioeconomic status, and accessibility to public automated defibrillators in two large metropolitan areas in Canada and France. Resuscitation. 2022 Oct 26;181:97-109. doi: 10.1016/j.resuscitation.2022.10.016.
https://www-sciencedirect-com.myaccess.library.utoronto.ca/science/article/pii/S0300957222006955?via%3Dihub

Evidence Update Worksheet

BLS 348 Check for Circulation During BLS

Worksheet author(s): Bridget Dicker
Task Force: BLS
Date Submitted to SAC rep for peer review and approval:
SAC rep:

PICOST / Research Question: *(Attach SAC representative approved completed PICOST template)*
The PICOST (Population, Intervention, Comparator, Outcome, Study Designs and Timeframe)

Population: Adults and children who are in cardiac arrest in any setting

Intervention: Interruption of CPR to check circulation

Comparators: No interruption of CPR

Outcomes: Survival with Favorable neurological/functional outcome at discharge, 30 days, 60 days, 180 days AND/OR 1 year, Survival only at discharge, 30 days, 60 days, 180 days AND/OR 1 year, ROSC, chest compression fraction.

Study Designs: Randomized controlled trials (RCTs) and non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies) are eligible for inclusion.

Timeframe: All years and all languages were included as long as there was an English abstract; unpublished studies (e.g., conference abstracts, trial protocols) were excluded. Literature search completed on 21 December 2022.

Year of last full review: (*insert year where this PICOST was most recently reviewed*) *2021*

Current ILCOR Consensus on Science and Treatment Recommendation for this PICOST:
Outside of the ALS environment where invasive monitoring is available, there is insufficient data around the value of a pulse check while performing CPR. We therefore do not make a treatment recommendation regarding the value of a pulse check.

Current Search Strategy (for an existing PICOST) included in the attached approved PICOST : Used in 2022 evidence update
(Heart Arrest[MeSH Terms]) OR (Ventricular Fibrillation[MeSH Terms]) OR (Cardiopulmonary Resuscitation[MeSH Terms]) OR (Heart Massage[MeSH Terms]) OR (heart arrest[Title/Abstract]) OR (cardiac arrest[Title/Abstract]) OR (asystole[Title/Abstract]) OR (ventricular fibrillation[Title/Abstract]) OR (cardiopulmonary arrest[Title/Abstract]) OR (cardiovascular arrest[Title/Abstract]) OR (resuscitation[Title/Abstract]) OR (CPR[Title/Abstract]) OR (heart massage[Title/Abstract]) OR (cardiac massage[Title/Abstract]) OR (chest compression*[Title/Abstract]) OR (cardiac compression*[Title/Abstract]) OR (Basic Life Support[Title/Abstract]) OR (BLS[Title/Abstract]))) AND ((Coronary Circulation[MeSH Terms]) OR (Pulse[MeSH Terms]) OR (Heart Rate[MeSH Terms]) OR (circulation[Title/Abstract]) OR (pulse[Title/Abstract]) OR (heart rate[Title/Abstract]) OR (rhythm[Title/Abstract])) AND ((interrupt*[Title/Abstract]) OR (check*[Title/Abstract]) OR (pause*[Title/Abstract]))) NOT

(animals[mh] NOT humans[mh])) NOT ("letter"[pt] OR "comment"[pt] OR "editorial"[pt] OR Case Reports[ptyp])))

New Search strategy: (for a new PICOST should be outlined here as per Evidence Update Process) Same as above

Database searched: Pubmed

Time Frame: (existing PICOST) – updated from end of last search (please specify) 31 Dec 2021

Time Frame: (new PICOST) – at the discretion of the Task Force (please specify) 1 Jan 2022 to 31 December 2022.

Date Search Completed: 21 Dec 2022

Search Results (Number of articles identified and number identified as relevant):

30 results

Title screening: 0 identified as relevant

Summary of Evidence Update: No new articles identified

Relevant Guidelines or Systematic Reviews

Organization (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations

RCT:

Study Acronym; Author; Year Published	Aim of Study; Study Type; Study Size (N)	Patient Population	Study Intervention (# patients) / Study Comparator (# patients)	Endpoint Results (Absolute Event Rates, P value; OR or RR; & 95% CI)	Relevant 2° Endpoint (if any); Study Limitations; Adverse Events
	Study Aim: Study Type:	Inclusion Criteria:	Intervention: Comparison:	1° endpoint:	Study Limitations:

Nonrandomized Trials, Observational Studies

Study Acronym; Author; Year Published	Study Type/Design; Study Size (N)	Patient Population	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/Conclusion Comment(s)
	Study Type:	Inclusion Criteria:	1° endpoint:	

Reviewer Comments: *(including whether this PICOST should have a systematic or scoping review)*

Reference list: *(List by ILCOR ref standard (last name first author, year of publication, first page number) and insert hyperlink to all articles identified as relevant (if available on PubMed)*

Evidence Update Worksheet

BLS 349 Rescuer Fatigue in CC Only CPR

Worksheet author(s): Anthony Lagina
Task Force: BLS
Date Submitted to SAC rep for peer review and approval:
SAC rep:

PICOST / Research Question: *(Attach SAC representative approved completed PICOST template)*
The PICOST (Population, Intervention, Comparator, Outcome, Study Designs and Timeframe)

Population: In rescuers performing CPR on adult or paediatric patients

Intervention: compression only CPR

Comparators: traditional CPR

Outcomes: increase in rescuer fatigue with resulting decrease in CPR quality

Study Designs: Randomized controlled trials (RCTs) and non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies) were eligible for inclusion.

Timeframe: All years and all languages were included as long as there was an English abstract; unpublished studies (e.g., conference abstracts, trial protocols) were excluded. Literature search updated to January 4, 2023 .

Year of last full review: (*insert year where this PICOST was most recently reviewed*)
Additional Evidence Reviewer(s):
Conflicts of Interest (financial/intellectual, specific to this question): None

Year of last full review: 2010 / 2015 / New question:
ERC/TF scoping Review 24.11.2020

Last ILCOR Consensus on Science and Treatment Recommendation:
2010/2015 Search Strategy:
Cardiopulmonary resuscitation OR CPR AND fatigue
Cardiopulmonary resuscitation OR CPR AND quality
Chest compression AND fatigue
Chest compression AND quality
Chest compression AND continuous
2020 Search Strategy:
Cardiopulmonary resuscitation OR CPR AND fatigue
Cardiopulmonary resuscitation OR CPR AND quality
Chest compression AND fatigue
Chest compression AND quality
Chest compression AND continuous
2021 Search Strategy:
Cardiopulmonary resuscitation OR CPR AND fatigue
Cardiopulmonary resuscitation OR CPR AND quality
Chest compression AND fatigue
Chest compression AND quality
Chest compression AND continuous

Database searched: Pubmed, Embase

Date Search Completed: 04.01.2023
Search Results (Number of articles identified / number identified as relevant): 0/73
Pubmed (73 records)

(((((((((((((("compress"[All Fields] OR "compressed"[All Fields]) OR "compresses"[All Fields]) OR "compressibilities"[All Fields]) OR "compressibility"[All Fields]) OR "compressible"[All Fields]) OR "compressing"[All Fields]) OR "compression"[All Fields]) OR "compression s"[All Fields]) OR "compressions"[All Fields]) OR "compressive"[All Fields]) OR "compressively"[All Fields]) AND "only"[All Fields]) OR (((("hand"[MeSH Terms] OR "hand"[All Fields]) OR "hands"[All Fields]) OR "hand s"[All Fields]) AND "only"[All Fields])) AND ((((((((((("resuscitability"[All Fields] OR "resuscitate"[All Fields]) OR "resuscitated"[All Fields]) OR "resuscitates"[All Fields]) OR "resuscitating"[All Fields]) OR "resuscitation"[MeSH Terms]) OR "resuscitation"[All Fields]) OR "resuscitations"[All Fields]) OR "resuscitative"[All Fields]) OR "resuscitator"[All Fields]) OR "resuscitators"[All Fields])) AND (((((((((((("depth"[All Fields] OR "depths"[All Fields]) OR ("j rehabil assist technol eng"[Journal] OR "rate"[All Fields])) OR ((("recoil"[All Fields] OR "recoiled"[All Fields]) OR "recoiling"[All Fields]) OR "recoils"[All Fields])) OR (((((((((((((((((("dose fractionation, radiation"[MeSH Terms] OR (("dose"[All Fields] AND "fractionation"[All Fields]) AND "radiation"[All Fields])) OR "radiation dose fractionation"[All Fields]) OR "fractionation"[All Fields]) OR "chemical fractionation"[MeSH Terms]) OR ("chemical"[All Fields] AND "fractionation"[All Fields])) OR "chemical fractionation"[All Fields]) OR "fraction"[All Fields]) OR "fraction s"[All Fields]) OR "fractionate"[All Fields]) OR "fractionated"[All Fields]) OR "fractionates"[All Fields]) OR "fractionating"[All Fields]) OR "fractionationed"[All Fields]) OR "fractionations"[All Fields]) OR "fractionator"[All Fields]) OR "fractionators"[All Fields]) OR "fractioned"[All Fields]) OR "fractioning"[All Fields]) OR "fractionized"[All Fields]) OR "fractions"[All Fields])) OR (("qualities"[All Fields] OR "quality"[All Fields]) OR "quality s"[All Fields])) OR (((((((((("effect"[All Fields] OR "effecting"[All Fields]) OR "effective"[All Fields]) OR "effectively"[All Fields]) OR "effectiveness"[All Fields]) OR "effectivenesses"[All Fields]) OR "effectives"[All Fields]) OR "effectivities"[All Fields]) OR "effectivity"[All Fields]) OR "effects"[All Fields])) OR "willingness"[All Fields]) OR ((((((("fatiguability"[All Fields] OR "fatiguable"[All Fields]) OR "fatigue"[MeSH Terms]) OR "fatigue"[All Fields]) OR "fatigued"[All Fields]) OR "fatigues"[All Fields]) OR "fatiguing"[All Fields]) OR "fatigueability"[All Fields])) OR (((("change"[All Fields] OR "changed"[All Fields]) OR "changes"[All Fields]) OR "changing"[All Fields]) OR "changings"[All Fields])) OR ((("bystander"[All Fields] OR "bystander s"[All Fields]) OR "bystanders"[All Fields]) OR "bystanding"[All Fields])) OR (("rescuer"[All Fields] OR "rescuer s"[All Fields]) OR "rescuers"[All Fields]))

Embase (5 records)
Search Results (Number of articles identified / number identified as relevant) 0/5
Cardiopulmonary resuscitation OR CPR AND fatigue
Cardiopulmonary resuscitation OR CPR AND quality
Chest compression AND fatigue
Chest compression AND quality
Chest compression AND continuous

Inclusion/Exclusion Criteria:
Inclusion Criteria: human and manikin studies.

Exclusion Criteria: animal studies or those that did not have a comparator group of 30:2 or 15:2 CPR.

Current ILCOR Consensus on Science and Treatment Recommendation for this PICOST:
Current ILCOR recommendations for rescuer fatigue remain consistent with current CO-CPR guidelines.

Summary of Evidence Update:
1. This evidence update process is only applicable to PICOs which are *not* being reviewed as ILCOR systematic and scoping reviews.

Relevant Guidelines or Systematic Reviews: None

RCT: None

Nonrandomized Trials, Observational Studies: None

Reviewer Comments: *(including whether this PICOST should have a systematic or scoping review)*

No clinical studies were identified that addressed the criteria set out in the PICOST (fatigue in rescuers providing standard CPR vs compression only CPR). Simulation studies on pediatric and infant manikins were identified investigation variations of chest compression techniques, but the Basic Life Support Task Force did not find the results of these studies sufficient to challenge current guidelines and warrant a full review. Secondarily, a PICOST addressing fatigue with PPE and PPE is currently being undertaken.

Reference list: *(List by ILCOR ref standard (last name first author, year of publication, first page number) and insert hyperlink to all articles identified as relevant (if available on PubMed)*

Evidence Update Worksheet

BLS 353 Harm From CPR to Victims not in Arrest

Worksheet author(s): Anthony Lagina
Task Force: BLS
Date Submitted to SAC rep for peer review and approval: December 2022
SAC rep:

PICOST / Research Question: *(Attach SAC representative approved completed PICOST template)*
The PICOST (Population, Intervention, Comparator, Outcome, Study Designs and Timeframe)

Population: Among adults and children who are not in cardiac arrest (CA) out-side of a hospital (OHCA)

Intervention: Does provision of chest compressions from lay rescuers

Comparators: Compared with no use of chest compressions.

Outcomes: Change survival with favorable neurological / functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; harm (e.g. rib fracture); complications; major bleeding; risk of complications (e.g. aspiration); survival only at discharge, 30 days, 60 days, 180 days and/or 1 year; survival to admission

Study Designs: Randomized controlled trials (RCTs) and non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies) are eligible for inclusion. Unpublished studies (e.g., conference abstracts, trial protocols) are excluded. It is anticipated that there will be insufficient studies from which to draw a conclusion; case series and case reports will also be included in the initial search.

Year of last full review: (*insert year where this PICOST was most recently reviewed*)
 Type (intervention, diagnosis, prognosis): Intervention

Additional Evidence Reviewer(s): None
Conflicts of Interest (financial/intellectual, specific to this question): None

Year of last full review: 2010 / 2015 / New question: 2020

Last ILCOR Consensus on Science and Treatment Recommendation:
We recommend that lay persons initiate CPR for presumed cardiac arrest without concerns of harm to patients not in cardiac arrest (strong recommendation, very low certainty evidence).

2010/2015/2020 Search Strategy:
((((("Cardiopulmonary Resuscitation/adverse effects"[Mesh:NoExp]) OR (((("Cardiopulmonary Resuscitation"[Mesh:NoExp] OR "cardiopulmonary resuscitation"[TIAB] OR "cardio-pulmonary resuscitation"[TIAB] OR CPR[TIAB] OR "thorax compressions"[TIAB] or "chest compressions"[TIAB] OR "chest compression"[TIAB] OR "basic life support"[TIAB] OR "Basic Cardiac Life Support"[TIAB]))) AND (("Thoracic Injuries"[Mesh] OR "Wounds and Injuries"[Mesh:NoExp] OR "Abdominal Injuries"[Mesh] OR "Rupture"[Mesh] OR "Pneumothorax"[Mesh] OR "Respiratory Aspiration"[Mesh] OR "Pain"[Mesh] OR Complications[TIAB])))))) AND (bystander[TIAB] OR bystanders[TIAB] OR "lay rescuer"[TIAB] OR "lay rescuers"[TIAB] OR "first responder"[TIAB] OR "first responders"[TIAB] OR "layperson"[TIAB] OR "lay people"[TIAB] OR "lay person"[TIAB]))

2023 Search Strategy: Pubmed search as above.

Database searched: Pubmed
Date Search Completed: 04.01.2023
Search Results (Number of articles identified / number identified as relevant): 3/10

Inclusion/Exclusion Criteria: Animal studies, conference abstracts, trial protocols
Link to Article Titles and Abstracts (if available on PubMed):
No new studies

Link to Article Titles and Abstracts (if available on PubMed):
https://pubmed.ncbi.nlm.nih.gov/34995685/
https://pubmed.ncbi.nlm.nih.gov/35043689/
https://pubmed.ncbi.nlm.nih.gov/36057213/
https://pubmed.ncbi.nlm.nih.gov/35812719/

Summary of Evidence Update:
Significant injuries occur during CPR, although very few found to be life threatening. No data suggests the absence of CPR is beneficial over CPR in terms of overall harm to patient. No papers directly addressed the question of CPR on persons not in arrest.

Relevant Guidelines or Systematic Reviews:
None

RCT:
None

Nonrandomized Trials, Observational Studies

Study Acronym; Author; Year Published	Study Type/Design; Study Size (N)	Patient Population	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/Conclusion Comment(s)
Karasek, 2022 (Resusication)	<u>Study Type:</u> Retrospective multicenter study	<u>Inclusion Criteria:</u> 859 patients with OHCA with CPR Admitted to ICU: 231 (ICU group) Unsuccessful resus: 628 (Dead Group)	<u>1° endpoint:</u> Injuries resulting from the application of CPR (ICU vs. Dead) RR and CI Thoracic Skeletal 0.08 (0.04-0.15) Rib Fracture 0.1 (0.06-0.2) Sternum 0.11 (0.05-0.26) Liver 4.3 (1.6-9.9)	547 (87%) of Dead group had CPR related injury 30(13%) of ICU group had CPR related injury Patients who died had more CPR related trauma than those to survive to ICU. Multifactorial reasons for results
Karatasakis 2022	Prospective, observational study	104 OHCA with ROSC and Head to Pelvis CT within 6 hours of ROSC	Injuries from CPR 81% (72-87%)	This study did not directly address PICOST but did show that significant injures occur with CPR and CT can identify potential injuries requiring intervention
Karasek, 2022 (AJEM)	multicenter, retrospective study	628 OHCA with unsuccessful resus	Injury in 594 (94.6%) 3% of which life threatening	Shared data set from first reference to characterize DEAD group. Showing frequent but often not life-threatening injuries associated with CPR

Reviewer Comments: *(including whether this PICOST should have a systematic or scoping review*)

The Basic Life Support Task Force did not find the results of the published observational and retrospective studies to challenge current guidelines and warrant a full review.

Reference list: *(List by ILCOR ref standard (last name first author, year of publication, first page number) and insert hyperlink to all articles identified as relevant (if available on PubMed)*

Karasek J, Slezak J, Stefela R, Topinka M, Blankova A, Doubková A, Pitasova T, Nahalka D, Bartes T, Hladik J, Adamek T, Jirasek T, Polasek R, Ostadal P. CPR-related injuries after non-traumatic out-of-hospital cardiac arrest: Survivors versus non-survivors. Resuscitation. 2022 Feb;171:90-95. doi: 10.1016/j.resuscitation.2021.12.036. Epub 2022 Jan 5. PMID: 34995685.

Karatasakis A, Sarikaya B, Liu L, Gunn ML, Kudenchuk PJ, Gatewood MO, Maynard C, Sayre MR, Counts CR, Carlbom DJ, Edwards RM, Branch KRH. Prevalence and Patterns of Resuscitation-Associated Injury Detected by Head-to-Pelvis Computed Tomography After Successful Out-of-Hospital Cardiac Arrest Resuscitation. J Am Heart Assoc. 2022 Feb;11(3):e023949. doi: 10.1161/JAHA.121.023949. Epub 2022 Jan 19. PMID: 35043689; PMCID: PMC9238478.

Karasek J, Blankova A, Doubková A, Pitasova T, Nahalka D, Bartes T, Hladik J, Adamek T, Strycek M, Jirasek T, Polasek R, Ostadal P. Trauma associated with cardiopulmonary resuscitation based on autopsy reports after the 2015 ERC guidelines. Am J Emerg Med. 2022 Nov;61:81-86. doi: 10.1016/j.ajem.2022.08.034. Epub 2022 Aug 18. PMID: 36057213.

Kawai Y, Takano K, Miyazaki K, Yamamoto K, Tada Y, Asai H, Maegawa N, Urisono Y, Saeki K, Fukushima H. Association of multiple rib fractures with the frequency of pneumonia in the post-resuscitation period. Resusc Plus. 2022 Jul 1;11:100267. doi: 10.1016/j.resplu.2022.100267. PMID: 35812719; PMCID: PMC9256829.

Evidence Update Worksheet

BLS 354 Harm to Rescuers from CPR

Worksheet author(s): Anthony Lagina
Task Force: BLS
Date Submitted to SAC rep for peer review and approval:
SAC rep:

PICOST / Research Question: *(Attach SAC representative approved completed PICOST template)*
The PICOST (Population, Intervention, Comparator, Outcome, Study Designs and Timeframe)

Population: Rescuers providing CPR to unconscious persons not breathing normally in any setting

Intervention: Performing resuscitation (ventilations, compressions, defibrillation, etc)

Comparators: Not performing resuscitation

Outcomes: Harm to rescuer (eg. Infection, exhaustion, stress, physical harm etc.)?

Study Designs: Randomized controlled trials (RCTs) and non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies) were eligible for inclusion.

Timeframe: *All years and all languages were included as long as there was an English abstract; unpublished studies (e.g., conference abstracts, trial protocols) were excluded. Literature search updated to January 4,2023.*

Year of last full review: 2010 / 2015 / New question: 2010

Additional Evidence Reviewer(s): None
Conflicts of Interest (financial/intellectual, specific to this question): None

Current ILCOR Consensus on Science and Treatment Recommendation for this PICOST:
Treatment Recommendation
Evidence supporting rescuer safety during CPR is limited. The few isolated reports of adverse effects resulting from the widespread and frequent use of CPR suggest that performing CPR is relatively safe. Delivery of defibrillator shock with an AED during BLS is also safe. The incidence and morbidity of defibrillator-related injuries in the rescuers are low.

Current Search Strategy (for an existing PICOST) included in the attached approved PICOST
2010/2015/2020 Search Strategy:
Pubmed (89 records; 2021)
((Rescuer OR "Single rescuer" OR "single-rescuer" OR saviour* OR savior* OR deliverer) AND ("Heart Arrest"[Mesh] OR "heart arrest*"[TIAB] OR "cardiac arrest*"[TIAB] OR "cardiovascular arrest*"[TIAB] OR "cardiopulmonary arrest*"[TIAB] OR "cardio-pulmonary arrest*"[TIAB] OR "Out-of-Hospital Cardiac Arrest*"[Mesh] OR OHCA OR "Out of Hospital Cardiac Arrest*"[TIAB] OR "Out-of-Hospital Cardiac Arrest*"[TIAB] OR "Outside-of-Hospital Cardiac Arrest"[TIAB] OR resuscitation [Mesh] OR resuscitation* [TIAB] OR "cardiopulmonary resuscitation"[Mesh] OR "cardiopulmonary resuscitation"[TIAB] OR "Cardio-Pulmonary Resuscitation" OR "Cardio Pulmonary Resuscitation" OR CPR [TIAB] OR "Life Support Care"[Mesh] OR "Basic Cardiac Life Support" OR "basic life support" OR "Cardiac Life Support" [TIAB] OR "cardiorespiratory resuscitation"[TIAB] OR "Heart Massage*"[Mesh] OR "heart massage*"[TIAB] OR "cardiac massage*" [TIAB] OR "chest compression*"[TIAB] OR "cardiac compression*"[TIAB] OR ventilation OR defibrillation OR "Electric countershock" [MeSH Terms] OR "Electric Defibrillation" OR "Automated External Defibrillator*" OR AED)) AND (harm OR harms OR danger* OR injur* OR trauma OR damage OR hurt OR "adverse effects" OR safety OR hazard OR "disease transmission" OR infection [MeSH Terms] OR infection* OR "patient-to-professional" OR stress OR psychological OR exhaustion OR fatigue OR collapse OR burnout))

New Search strategy: same as 2022
Database searched: Medline
Time Frame: (existing PICOST) – updated from end of last search articles included 1 year prior to search date
Date Search Completed: 04.01.2023
Search Results (Number of articles identified and number identified as relevant): 2/29
Inclusion/Exclusion Criteria: Inclusion Criteria: human studies. Exclusion Criteria: animal studies or those that did not describe risk or adverse effects in CPR performers. Abstract only studies and studies not peer reviewed or not answer question.
Papers addressing risk for covid-19 infection and risk during aquatic rescue were considered out of scope as they are addressed in separate PICOSTs.

Link to Article Titles and Abstracts (if available on PubMed):
https://pubmed.ncbi.nlm.nih.gov/35065602/
https://pubmed.ncbi.nlm.nih.gov/34922232/
https://pubmed.ncbi.nlm.nih.gov/35942482/

Summary of Evidence Update:
The limited number of studies focused mostly on either modifying pediatric chest compression technique or safety associated with hands on defibrillation. These subjects are not directly related to the PICOST and covered more thoroughly researched in other PICOST and PLS task force.

Relevant Guidelines or Systematic Reviews:
None

RCT:

Study Acronym; Author; Year Published	Aim of Study; Study Type; Study Size (N)	Patient Population	Study Intervention (# patients) / Study Comparator (# patients)	Endpoint Results (Absolute Event Rates, P value; OR or RR; & 95% CI)	Relevant 2° Endpoint (if any); Study Limitations; Adverse Events
Tsou JY, 2022	<u>Study Aim:</u> One handed vs two handed CC for Children <u>Study Type:</u> Randomized crossover observational study	<u>Inclusion Criteria:</u> 35 emergency department nurses	<u>Intervention:</u> 2 handed CC <u>Comparison:</u> 1 handed CC	<u>1° endpoint:</u> Perceived pain and fatigue differences The compression discomfort when performing TH and OH ECC, measured using the NRS, was 4 and 5, respectively (p = 0.003)	<u>Study Limitations:</u> No noted injuries but slight but significant difference in perceived pain with 2 handed chest compressions. Outcomes are self-reported, manikin study

Nonrandomized Trials, Observational Studies

Study Acronym; Author; Year Published	Study Type/Design; Study Size (N)	Patient Population	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/Conclusion Comment(s)
	<u>Study Type:</u>	<u>Inclusion Criteria:</u>	<u>1° endpoint:</u>	

Reviewer Comments: *(including whether this PICOST should have a systematic or scoping review*)

The Basic Life Support Task Force did not find the results of the single qualitative study sufficient to challenge current guidelines and warrant a full review. The safety of hands-on defibrillation is an evolving concept with limited initial data although does appear safe and can be addressed in a secondary PICOST. Secondarily, articles addressing modifying pediatric and infant chest compression techniques are evaluated in PLS.

Reference list: *(List by ILCOR ref standard (last name first author, year of publication, first page number) and insert hyperlink to all articles identified as relevant (if available on PubMed)*

Tsou JY, Kao CL, Tu YF, Hong MY, Su FC, Chi CH. Biomechanical analysis of force distribution in one-handed and two-handed child chest compression- a randomized crossover observational study. BMC Emerg Med. 2022 Jan 22;22(1):13. doi: 10.1186/s12873-022-00566-z. Erratum in: BMC Emerg Med. 2022 Sep 1;22(1):151. PMID: 35065602; PMCID: PMC8783411.

Stephens AF, Šeman M, Nehme Z, Voskoboinik A, Smith K, Gregory SD, Stub D. *Ex vivo* evaluation of personal protective equipment in hands-on defibrillation. Resusc Plus. 2022 Aug 3;11:100284. doi: 10.1016/j.resplu.2022.100284. PMID: 35942482; PMCID: PMC9356271.

Evidence Update Worksheet

BLS 357 Hand Position During Compressions

Worksheet author(s): Bridget Dicker
Task Force: BLS
Date Submitted to SAC rep for peer review and approval: December 2022
SAC rep:

PICOST / Research Question: *(Attach SAC representative approved completed PICOST template)*
The PICOST (Population, Intervention, Comparator, Outcome, Study Designs and Timeframe)

Population: Adults and children in any setting (in-hospital or out-of-hospital) with cardiac arrest

Intervention: Any other location for chest compressions

Comparators: Delivery of chest compressions on the lower half of the sternum

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 EtCO2 were also considered important outcomes.

Study Designs: Randomized controlled trials (RCTs) and non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies) reporting clinical outcomes are eligible for inclusion.

Timeframe: All years and all languages were included as long as there was an English abstract. Mannikin studies and unpublished studies (e.g., conference abstracts, trial protocols) were excluded. Literature search conducted 21 December 2022.

Year of last full review: (*insert year where this PICOST was most recently reviewed***)** *2021*

Current ILCOR Consensus on Science and Treatment Recommendation for this PICOST:
There were no studies reporting the critical outcomes of favorable neurological outcome, survival, or the important outcome of ROSC. For the important outcome of physiological end points, we identified 3 very-low certainty studies (downgraded for bias, indirectness, and imprecision). One crossover study in 17 adults with prolonged resuscitation from nontraumatic cardiac arrest observed improved peak arterial pressure during compression systole (114±51 mm Hg compared with 95±42 mm Hg) and ETCO2 (11.0±6.7 mm Hg compared with 9.6±6.9 mm Hg) when compressions were performed over the lower third of the sternum compared with the center of the chest, but arterial pressure during compression recoil, peak right atrial pressure, and coronary perfusion pressure did not differ. A second crossover study in 30 adults with cardiac arrest observed no difference in ETCO2 values resulting from changes in hand placement. A third crossover study in 10 children observed higher peak systolic pressure and higher mean arterial pressure when compressions were performed on the lower third of the sternum compared with the middle of the sternum.

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

Current Search Strategy (for an existing PICOST) included in the attached approved PICOST :
("hand"[Mesh] OR "Hand placement"[TIAB] OR "hand position"[TIAB] OR "hand positioning"[TIAB] OR "finger placement"[TIAB] OR "finger position"[TIAB] OR "finger positioning"[TIAB] OR "alternative position" OR "alternative compression") AND ("Resuscitation"[Mesh] OR resuscitat*[TIAB] OR "cardiopulmonary resuscitation"[Mesh] OR "heart massage"[Mesh] OR "cardiopulmonary resuscitation"[TIAB] OR CPR[TIAB] OR "chest compression"[TIAB] OR "chest compressions"[TIAB] OR "heart massage"[TIAB] OR "cardiac massage"[TIAB] OR "cardiac compression"[TIAB] OR "cardiac compressions"[TIAB] OR "thoracic compression"[TIAB] OR "thoracic compressions"[TIAB]) NOT (animal[Mesh] NOT humans[Mesh]) NOT ("News" [Publication Type] OR "letter"[Publication Type] OR "comment"[Publication Type] OR "editorial"[Publication Type] or Case Reports[Publication Type])

New Search strategy: (for a new PICOST should be outlined here as per Evidence Update Process)

Database searched: Pubmed

Time Frame: (existing PICOST) – updated from end of last search (please specify) 31 Dec 2021

Time Frame: (new PICOST) – at the discretion of the Task Force (please specify) 1 Jan 2022 to 31 December 2022.

Date Search Completed: 21 Dec 2022

Search Results (Number of articles identified and number identified as relevant):

12 results

Title screening: 0 identified as relevant

Summary of Evidence Update: No new articles identified

Relevant Guidelines or Systematic Reviews

Organization (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations

RCT: mannequin only

Study Acronym; Author; Year Published	Aim of Study; Study Type; Study Size (N)	Patient Population	Study Intervention (# patients) / Study Comparator (# patients)	Endpoint Results (Absolute Event Rates, P value; OR or RR; & 95% CI)	Relevant 2° Endpoint (if any); Study Limitations; Adverse Events
	Study Aim: **Study Type:**	**Inclusion Criteria:**	**Intervention:** **Comparison:**	**1° endpoint:**	**Study Limitations:**

Nonrandomized Trials, Observational Studies

Study Acronym; Author; Year Published	Study Type/Design; Study Size (N)	Patient Population	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/Conclusion Comment(s)
	Study Type:	**Inclusion Criteria:**	**1° endpoint:**	

Reviewer Comments: *No new studies identified.*

Reference list: *n/a*

Evidence Update Worksheet

BLS 360 EMS CCO vs C-CPR

Worksheet author(s): Chika Nishiyama
Task Force: BLS
Date Submitted to SAC rep for peer review and approval: December 2022
SAC rep:

PICOST / Research Question: Among adults who are in cardiac arrest outside of a hospital (population), does provision of chest compressions with delayed ventilation by Emergency Medical Services (EMS) (intervention) compared with chest compressions with early ventilations by EMS (comparison) change outcome (outcome)?

Year of last full review: 2018, updated 2022

Current ILCOR Consensus on Science and Treatment Recommendation for this PICOST:
- We recommend that EMS providers perform CPR with 30 compressions to 2 breaths (30:2 ratio) or continuous chest compressions with PPV delivered without pausing chest compressions until a tracheal tube or supraglottic device has been placed (strong recommendation, high-certainty evidence).
- We suggest that when EMS systems have adopted minimally interrupted cardiac resuscitation, this strategy is a reasonable alternative to conventional CPR for witnessed shockable OHCA (weak recommendation, very low–certainty evidence).

Current Search Strategy (for an existing PICOST) included in the attached approved PICOST
1 exp Cardiopulmonary Resuscitation/
2 (cardiopulmonary respiratory resuscitation$ or cardiopulmonary resuscitation$ or cardio pulmonary resuscitation$ or cardio-pulmonary resuscitation$ or CPR or Advanced Cardiac Life Support or basic cardiac life support or code blue or resuscitation$ mouth-to-mouth or mouth-to-mouth resuscitation$ or mouth to mouth resuscitation$).tw.
3 Resuscitation/
4 limit 3 to yr=1978-1991
5 1 or 2 or 4
6 mt.fs.
7 method$.tw.
8 6 or 7
9 5 and 8
10 randomized controlled trial.pt.
11 (randomized or placebo).mp.
12 clinical trial.pt.
13 Comparative Study.pt.
14 cross-over studies/
15 controlled clinical trial.pt.
16 (time adj series).tw.
17 (pre test or pretest or (posttest or post test)).tw.
18 random allocation/
19 (controlled adj before).tw.
20 exp epidemiologic studies/
21 ((case* adj3 control*) or (case adj3 comparison*) or control group*).tw.
22 or/10-21
23 9 and 22
24 (control$ or compar$ or random$).tw.
25 9 and 24
26 23 or 25
27 animals/ not humans/
28 26 not 27

29 (editorial or letter).pt.
30 28 not 29
31 ("18334691" or "19660833" or "16564776" or "18374452" or "20370759" or "26550795").ui.
32 30 or 31
33 comment.pt.
34 32 not 33
35 remove duplicates from 34

New Search strategy: (for a new PICOST should be outlined here as per Evidence Update Process)

Database searched: Medline

Time Frame: (existing PICOST) – updated from 1/Jan/2022 through 28/Dec/2022

Time Frame: (new PICOST) – at the discretion of the Task Force (please specify)

Date Search Completed: 28/Dec/2022

Search Results (Number of articles identified and number identified as relevant): 1,466 articles retrieved from search and 626 articles were duplicated. 820 articles were identified but no article was related.

Summary of Evidence Update: None

Relevant Guidelines or Systematic Reviews

Organization (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations

RCT:

Study Acronym; Author; Year Published	Aim of Study; Study Type; Study Size (N)	Patient Population	Study Intervention (# patients) / Study Comparator (# patients)	Endpoint Results (Absolute Event Rates, P value; OR or RR; & 95% CI)	Relevant 2° Endpoint (if any); Study Limitations; Adverse Events
	Study Aim: Study Type:	Inclusion Criteria:	Intervention: Comparison:	1° endpoint:	Study Limitations:

Nonrandomized Trials, Observational Studies

Study Acronym; Author; Year Published	Study Type/Design; Study Size (N)	Patient Population	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/Conclusion Comment(s)
	Study Type:	Inclusion Criteria:	1° endpoint:	

Reviewer Comments: There is no new research to suggest the need for scoping reviews or systematic reviews.

Reference list: *(List by ILCOR ref standard (last name first author, year of publication, first page number) and insert hyperlink to all articles identified as relevant (if available on PubMed)*

Evidence Update Worksheet

BLS 362 Compression Ventilation Ratio

Worksheet author(s): Ziad Nehme
Task Force: BLS
Date Submitted to SAC rep for peer review and approval: 20/12/2022
SAC rep: Olasveengen

PICOST / Research Question: *(Attach SAC representative approved completed PICOST template)*

The PICOST (Population, Intervention, Comparator, Outcome, Study Designs and Timeframe)

Population: Patients of all ages (i.e., neonates, children, adults) with cardiac arrest from any cause and across all settings (in-hospital and out-of-hospital). Studies that included animals were not eligible.

Intervention: All manual CPR methods including Compression-only CPR (CO-CPR), Continuous Compression CPR (CC-CPR), and CPR with different compression-to-ventilation ratios. CO-CPR included compression with no ventilations, while CC-CPR included compression with asynchronous ventilations or minimally interrupted cardiac resuscitation (MICR) Studies that mentioned the use of a mechanical device during CPR were only considered if the same device was used across all relevant intervention arms and would therefore not confound the observed effect.

Comparators: Studies had to compare at least two different CPR methods from the eligible interventions; studies without a comparator were excluded.

Outcomes: The primary outcome was favorable neurological outcomes, measured by cerebral performance or a modified Rankin Score. Secondary outcomes were survival, ROSC, and quality of life.

Study Designs: Randomised controlled trials (RCTs) and non-randomised studies (non-randomised controlled trials, interrupted time series, controlled before-and-after studies, cohort studies) were eligible for inclusion. Study designs without a comparator group (e.g., case series, cross-sectional studies), reviews, and pooled analyses were excluded.

Timeframe: All years and all languages were included as long as there was an English abstract; unpublished studies (e.g., conference abstracts, trial protocols) were excluded. Literature search updated to 20 December 2022.

Year of last full review: 2017

Current ILCOR Consensus on Science and Treatment Recommendation for this PICOST:
1. We suggest a compression–ventilation ratio of 30:2 compared with any other compression–ventilation ratio in patients with cardiac arrest (weak recommendation, very low-quality evidence).

Current Search Strategy (for an existing PICOST) included in the attached approved PICOST
Ovid MEDLINE(R) and Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations
1   exp Cardiopulmonary Resuscitation/
2   (cardiopulmonary respiratory resuscitation$ or cardiopulmonary resuscitation$ or cardio pulmonary resuscitation$ or cardio-pulmonary resuscitation$ or CPR or Advanced Cardiac Life Support or basic cardiac life support or code blue or resuscitation$ mouth-to-mouth or mouth-to-mouth resuscitation$ or mouth to mouth resuscitation$).tw.
3   Resuscitation/
4   limit 3 to yr=1978-1991
5   1 or 2 or 4
6   mt.fs.
7   method$.tw.
8   6 or 7

9   5 and 8
10   randomized controlled trial.pt.
11   (randomized or placebo).mp.
12   clinical trial.pt.
13   Comparative Study.pt.
14   cross-over studies/
15   controlled clinical trial.pt.
16   (time adj series).tw.
17   (pre test or pretest or (posttest or post test)).tw.
18   random allocation/
19   (controlled adj before).tw.
20   exp epidemiologic studies/
21   ((case* adj3 control*) or (case adj3 comparison*) or control group*).tw.
22   or/10-21
23   9 and 22
24   (control$ or compar$ or random$).tw.
25   9 and 24
26   23 or 25
27   animals/ not humans/
28   26 not 27
29   (editorial or letter).pt.
30   28 not 29
31   com
32   30 or 31
33   comment.pt.
34   32 not 33

New Search strategy: (for a new PICOST should be outlined here as per Evidence Update Process) Same as above, including 'limit 34 to yr="2022"'

Database searched: Medline

Time Frame: (existing PICOST) – updated from end of last search (please specify) Literature search updated to 20 December 2022

Time Frame: (new PICOST) – at the discretion of the Task Force (please specify)

Date Search Completed: 20/12/2022

Search Results (Number of articles identified and number identified as relevant): 780 identified. Of these, none met the inclusion criteria.

Summary of Evidence Update: None

Relevant Guidelines or Systematic Reviews

Organization (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations
None					

RCT:

Study Acronym; Author; Year Published	Aim of Study; Study Type; Study Size (N)	Patient Population	Study Intervention (# patients) / Study Comparator	Endpoint Results (Absolute Event Rates, P value; OR or RR; & 95% CI)	Relevant 2° Endpoint (if any); Study Limitations;

			(# patients)		Adverse Events
None	**Study Aim:** **Study Type:**	**Inclusion Criteria:**	**Intervention:** **Comparison:**	**1° endpoint:**	**Study Limitations:**

Nonrandomized Trials, Observational Studies

Study Acronym; Author; Year Published	Study Type/Design; Study Size (N)	Patient Population	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/Conclusion Comment(s)
	Study Type:	**Inclusion Criteria:**	**1° endpoint:**	

Reviewer Comments: *(including whether this PICOST should have a systematic or scoping review)*
No new articles met the inclusion criteria for 2022.

Reference list: *(List by ILCOR ref standard (last name first author, year of publication, first page number) and insert hyperlink to all articles identified as relevant (if available on PubMed)*

Evidence Update Worksheet

BLS 363 CPR Prior to Defibrillation

Worksheet author(s): Bridget Dicker
Task Force: BLS
Date Submitted to SAC rep for peer review and approval: December 2022
SAC rep:

PICOST / Research Question: *(Attach SAC representative approved completed PICOST template)*

The PICOST (Population, Intervention, Comparator, Outcome, Study Designs and Timeframe)

Population: Adults and children in any setting (in-hospital or out-of-hospital) with cardiac arrest and a shockable rhythm at initiation of cardiopulmonary resuscitation (CPR)

Intervention: A prolonged period of chest compressions before defibrillation

Comparators: A short period of chest compressions before defibrillation

Outcomes: 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.

Study Designs: Randomized controlled trials (RCTs) and non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies) are eligible for inclusion.

Timeframe: All years and all languages were included as long as there was an English abstract; unpublished studies (e.g., conference abstracts, trial protocols) were excluded. Literature was conducted on 21 Dec 2022.

Year of last full review: (*insert year where this PICOST was most recently reviewed*) 2021

Current ILCOR Consensus on Science and Treatment Recommendation for this PICOST:
We suggest a short period of CPR until the defibrillator is ready for analysis and/or defibrillation in unmonitored cardiac arrest. (weak recommendation, low-certainty evidence).

Current Search Strategy (for an existing PICOST) included in the attached approved PICOST : Used in 2022 evidence update
("Ventricular Fibrillation"[Mesh] OR "Ventricular Fibrillation"[TW] OR "pulseless VT"[TW] OR "pulseless ventricular tachycardia"[TW] OR "Electrocardiography"[Mesh:NoExp]) AND (("Cardiopulmonary Resuscitation"[Mesh] OR "chest compressions"[TW] OR "chest compression"[TW] OR "thorax compression"[TW] OR "Heart Massage"[Mesh] OR "cardiopulmonary resuscitation"[TW] OR "cardio-pulmonary resuscitation"[TW] OR CPR[TW]) AND ("Electric Countershock"[Mesh] OR "Defibrillators"[Mesh:NoExp] OR "electric countershock"[TW] OR "cardiac electroversion"[TW] OR defibrillator*[TW] OR defibrillation*[TW])))) NOT ("Defibrillators, Implantable"[Mesh])) NOT "Atrial Fibrillation"[Mesh])))) AND (("Time Factors"[Mesh] OR "Emergencies"[Mesh] OR "Emergency Medical Services"[Mesh:NoExp] OR "Emergency Medical Technicians"[Mesh] OR "Treatment Outcome"[Mesh] OR "Fatal Outcome"[Mesh] OR "Outcome Assessment (Health Care)"[Mesh] OR "Outcome and Process Assessment (Health Care)"[Mesh] OR "Survival"[Mesh] OR "Mortality"[Mesh] OR "mortality"[Subheading] OR "Disease-Free Survival"[Mesh] OR "Survival Analysis"[Mesh] OR "Survival Rate"[Mesh] OR "Outcome"[All Fields] OR "outcomes"[All Fields] OR "Survivors"[Mesh] OR "return of spontaneous circulation"[TIAB] OR "ROSC"[TIAB])))) NOT (((animals[mh] NOT humans[mh]) NOT ("letter"[pt] OR "comment"[pt] OR "editorial"[pt] or Case Reports[ptyp]))))

New Search strategy: (for a new PICOST should be outlined here as per Evidence Update Process) Same as above

Database searched: Pubmed
Time Frame: (existing PICOST) – updated from end of last search (please specify) 14 Feb 2021
Time Frame: (new PICOST) – at the discretion of the Task Force (please specify) 14 Feb 2021 to 31 Dec 2022
Date Search Completed: 21 Dec 2022
Search Results (Number of articles identified and number identified as relevant):
67 results
Title screening: 0 identified as relevant

Summary of Evidence Update: No new articles identified

Relevant Guidelines or Systematic Reviews

Organization (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations

RCT:

Study Acronym; Author; Year Published	Aim of Study; Study Type; Study Size (N)	Patient Population	Study Intervention (# patients) / Study Comparator (# patients)	Endpoint Results (Absolute Event Rates, P value; OR or RR; & 95% CI)	Relevant 2° Endpoint (if any); Study Limitations; Adverse Events
	<u>Study Aim:</u> <u>Study Type:</u>	<u>Inclusion Criteria:</u>	<u>Intervention:</u> <u>Comparison:</u>	<u>1° endpoint:</u>	<u>Study Limitations:</u>

Nonrandomized Trials, Observational Studies

Study Acronym; Author; Year Published	Study Type/Design; Study Size (N)	Patient Population	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/Conclusion Comment(s)
	<u>Study Type:</u>	<u>Inclusion Criteria:</u>	<u>1° endpoint:</u>	

Reviewer Comments: *No studies found.*

Reference list: *n/a*

Evidence Update Worksheet

BLS 368 FBAO

Worksheet author(s): Vihara Dassanayake

Task Force: Basic Life Support

Date Submitted to SAC rep for peer review and approval: December 2022

SAC rep:

PICOST / Research Question: *(Attach SAC representative approved completed PICOST template)*

The PICOST (Population, Intervention, Comparator, Outcome, Study Designs and Timeframe)

Population: Adults and children with foreign body airway obstruction in any setting.

Intervention: Interventions to remove foreign body airway obstruction, such as finger sweep, back slaps, abdominal thrusts, chest thrusts, and suction-based airway clearance devices.

Comparators: No action.

Outcomes: Survival with good neurological outcome, survival, return of spontaneous circulation, relief of airway obstruction, harms/ complications.

Study Designs: Randomized controlled trials (RCTs) and non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies), case series (≥5 cases) are eligible for inclusion. Case reports of injuries/ complications will be eligible.

Timeframe: All years and all languages were included as long as there was an English abstract. Unpublished studies (e.g., conference abstracts, trial protocols), animal studies, manikin studies, cadaver studies were excluded. Literature searched to January 2022.

Year of last full review: (*insert year where this PICOST was most recently reviewed***)**
2022 (05th January 2022)

Current ILCOR Consensus on Science and Treatment Recommendation for this PICOST:
We suggest that back slaps are used initially in adults and children with an FBAO and an ineffective cough (weak recommendation, very-low certainty evidence).

We suggest that abdominal thrusts are used in adults and children (older than 1 year) with an FBAO and an ineffective cough when back slaps are ineffective (weak recommendation, very-low-certainty evidence).

We suggest that rescuers consider the manual extraction of visible items in the mouth (weak recommendation, very-low-certainty evidence).

We suggest against the use of blind finger sweeps in patients with an FBAO (weak recommendation, very-low-certainty evidence).

We suggest that appropriately skilled healthcare providers use Magill forceps to remove an FBAO in patients with OHCA from FBAO

(weak recommendation, very-low-certainty evidence).

We suggest that chest thrusts be used in unconscious adults and children with an FBAO (weak recommendation, very-low-certainty evidence).
We suggest that bystanders undertake interventions to support FBAO removal as soon as possible after recognition (weak recommendation, very-low-certainty evidence).

We suggest against the routine use of suction-based airway clearance devices (weak recommendation, very-low-certainty evidence).

Current Search Strategy (for an existing PICOST) included in the attached approved PICOST
Not indicated

New Search strategy: (for a new PICOST should be outlined here as per Evidence Update Process)

Database searched: eg Medline Embase Cochrane
Ovid MEDLINE

Time Frame: (existing PICOST) – updated from end of last search (please specify)
27th January 2021 to 05th January 2022

Time Frame: (new PICOST) – at the discretion of the Task Force (please specify)

Date Search Completed: 20th December 2022
Search Results (Number of articles identified and number identified as relevant): 6 articles. None relevant.

Summary of Evidence Update: This evidence update process is only applicable to PICO s which are not being reviewed as ILCOR systematic and scoping reviews.

Relevant Guidelines or Systematic Reviews

Organization (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations

RCT:

Study Acronym; Author; Year Published	Aim of Study; Study Type; Study Size (N)	Patient Population	Study Intervention (# patients) / Study Comparator (# patients)	Endpoint Results (Absolute Event Rates, P value; OR or RR; & 95% CI)	Relevant 2° Endpoint (if any); Study Limitations; Adverse Events
	Study Aim: Study Type:	Inclusion Criteria:	Intervention: Comparison:	1° endpoint:	Study Limitations:

Nonrandomized Trials, Observational Studies

Study Acronym; Author; Year Published	Study Type/Design; Study Size (N)	Patient Population	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/Conclusion Comment(s)
	Study Type:	**Inclusion Criteria:**	**1° endpoint:**	

Reviewer Comments: *(including whether this PICOST should have a systematic or scoping review)*
Insufficient new evidence to warrant updating current systematic review and CoSTR

Reference list: *(List by ILCOR ref standard (last name first author, year of publication, first page number) and insert hyperlink to all articles identified as relevant (if available on PubMed)*

Evidence Update Worksheet

BLS 370 Firm Surface for CPR

Worksheet author(s): Janet Bray
Task Force: BLS
Date Submitted to SAC rep for peer review and approval: 7th December 2022
SAC rep: Theresa Olasveengen

PICOST / Research Question:

Population: Adults or children in cardiac arrest on a bed (out-of-hospital and in-hospital),

Intervention: CPR on a hard surface e.g. backboard, floor, deflatable or specialist mattress

Comparators: CPR on a regular mattress

Outcomes: Any clinical outcome.

Study Designs: Randomized controlled trials (RCTs) and non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies), case series with ≥ 5 patients, simulation studies are eligible for inclusion. Unpublished studies (e.g., conference abstracts, trial protocols) are excluded.

Year of last full review: 2020

Current ILCOR Consensus on Science and Treatment Recommendation for this PICOST:

We suggest performing chest compressions on a firm surface when possible (weak recommendation, very low certainty evidence)

During in-hospital cardiac arrest, we suggest, where a bed has a CPR mode which increases mattress stiffness, it should be activated (weak recommendation, very low certainty of evidence).

During in-hospital cardiac arrest, we suggest against moving a patient from a bed to floor, to improve chest compression depth (weak recommendation, very low certainty of evidence).

During in-hospital cardiac arrest, we suggest in favour of either a backboard or no-backboard strategy, to improve chest compression depth, (Conditional recommendation, very low certainty of evidence).

Current Search Strategy (for an existing PICOST) included in the attached approved PICOST
1 exp Death, sudden, cardiac/ (14796)
2 cardiopulmonary resuscitation.ti,ab. or exp Cardiopulmonary Resuscitation/ (21251)
3 cpr.ti,ab. (10043)
4 exp heart massage/ (3068)
5 chest compression*.ti,ab. (3078)
6 resuscitat*.ti,ab. (53080)
7 or/2-6 (63712)
8 exp Beds/ (4295)
9 (bed not capacity).ti,ab. (72378)
10 mattress*.ti,ab. (3342)
11 (backboard* or back-board* or back board*).ti,ab. (150)
12 exp stretchers/ or stretcher*.ti,ab. (726)

13 8 or 9 or 10 or 11 or 12 (78057)
14 7 and 13 (672)
15 limit 14 to yr="2009 -Current" (305)
16 exp animals/ not humans.sh. (4612957)
17 15 not 16 (298)

Database searched: OVID Embase
Time Frame: 2022
Date Search Completed: 7th December 2022
Search Results (Number of articles identified and number identified as relevant): 1 title, duplicate of 2021 review study. No eligible studies. One additional study reported differences in the force required to achieve adequate compression depth on different surfaces (de Azevedo Vianna 2023).

Summary of Evidence Update:

Relevant Guidelines or Systematic Reviews

Organization (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations

RCT:

Study Acronym; Author; Year Published	Aim of Study; Study Type; Study Size (N)	Patient Population	Study Intervention (# patients) / Study Comparator (# patients)	Endpoint Results (Absolute Event Rates, P value; OR or RR; & 95% CI)	Relevant 2° Endpoint (if any); Study Limitations; Adverse Events
	Study Aim: **Study Type:**	**Inclusion Criteria:**	**Intervention:** **Comparison:**	**1° endpoint:**	**Study Limitations:**

Nonrandomized Trials, Observational Studies

Study Acronym; Author; Year Published	Study Type/Design; Study Size (N)	Patient Population	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/Conclusion Comment(s)
	Study Type:	**Inclusion Criteria:**	**1° endpoint:**	

Reviewer Comments: *(including whether this PICOST should have a systematic or scoping review)*
No new evidence.

Reference list: *(List by ILCOR ref standard (last name first author, year of publication, first page number) and insert hyperlink to all articles identified as relevant (if available on PubMed)*

Evidence Update

BLS 372 Alternative Chest Compression Techniques

Worksheet author(s): Nicholas J Johnson
Task Force: BLS
Date Submitted to SAC rep for peer review and approval: 12/20/2022
SAC rep:

PICOST / Research Question: *(Attach SAC representative approved completed PICOST template)*
In adults or children in cardiac arrest (out-of-hospital and in-hospital) [P] does the use of alternative methods of manual CPR (cough CPR, percussion pacing, precordial thump) [I], compared with standard CPR [C], improve outcomes (restoration of cardiac output/circulation, return of spontaneous circulation (ROSC), survival to 30 days or hospital discharge, survival with favorable neurological outcome) [O].

The original search was conducted as a systematic review. We registered the protocol with the International Prospective Register of Systematic Reviews (PROSPERO) (CRD42019152925)

Link to published study: https://doi.org/10.1016/j.resuscitation.2021.01.027

Year of last full review: 2021

Current ILCOR Consensus on Science and Treatment Recommendation for this PICOST:

Cough CPR
We recommend against the routine use of cough CPR for cardiac arrest (strong recommendation, very-low-certainty evidence).

We suggest that cough CPR may be considered only as a temporizing measure in exceptional circumstance of a witnessed, monitored IHCA (eg, in a cardiac catheterization laboratory) if a nonperfusing rhythm is recognized promptly before loss of consciousness (weak recommendation, very-low-certainty evidence).

Percussion (fist) pacing
We recommend against fist pacing for cardiac arrest (strong recommendation, very-low-certainty evidence).

We suggest that fist pacing may be considered only as a temporizing measure in the exceptional circumstance of a witnessed, monitored, IHCA (eg, in a cardiac catheterization laboratory) due to bradyasystole if such a nonperfusing rhythm is recognized promptly before loss of consciousness (weak recommendation, very-low-certainty evidence).

Precordial thump
We recommend against the use of a precordial thump for cardiac arrest (strong recommendation, very-low-certainty evidence).

Original Search Strategy (for an existing PICOST) included in the attached approved PICOST:
MEDLINE

1.	exp Cardiopulmonary Resuscitation/exp Cardiopulmonary Resuscitation/	18149
2.	cardiopulmonary resuscitation.ab,ti.	12620
3.	CPR.ab,ti	10687
4.	exp Heart Massage/	3126
5.	"chest compression*".ab,ti.	3306
6.	"resus*".ab,ti.	60545
7.	1 or 2 or 3 or 4 or 5 or 6	71754

8.	cough CPR.mp	16
9.	cicpr.mp	1
10.	exp Cough/	15920
11.	"cough*".ab,ti.	43491
12.	10 or 11	47654
13.	7 and 12	184
14.	"precordial thump*".ab,ti.	65
15.	(chest and thump*).ab,ti.	95
16.	fist pacing.ab,ti.	5
17.	percussion pacing.ab,ti.	9
18.	(percussion and (pace or pacing or paced)).ab,ti.	11
19.	(precordial and thump*).ab,ti.	69
20.	8 or 9 or 13 or 14 or 15 or 16 or 17 or 18 or 19	342
21.	manual.ab,ti.	80160
22.	7 and 21	1026
23.	20 or 22	1349
24.	exp animals/ not humans.sh.	4725507
25.	23 not 24	1142

EMBASE

1.	exp resuscitation/	110974
2.	"resus*".ab,ti.	96827
3.	cardiopulmonary resuscitation.ab,ti.	20236
4.	cpr.ab,ti.	21926
5.	exp heart massage/	2231
6.	chest compression*".ab,ti.	6283
7.	1 or 2 or 3 or 4 or 5 or 6	157044
8.	cough CPR.ab,ti.	17
9.	cicpr.ab,ti.	1
10.	exp coughing/	122722
11.	"cough*".ab,ti.	83105
12.	10 or 11	145717
13.	7 and 12	1143
14.	"precordial thump*".ab,ti.	77
15.	(chest and thump*).ab,ti.	125
16.	fist pacing.ab,ti.	5
17.	percussion pacing.ab,ti.	11
18.	(percussion and (pace or pacing or paced)).ab,ti.	18
19.	(precordial and thump*).ab,ti.	80
20.	8 or 9 or 13 or 14 or 15 or 16 or 17 or 18 or 19	1341
21.	manual.ab,ti.	132177
22.	7 and 21	1995
23.	20 or 22	3289
24.	exp animals/ not human.sh.	4811515
25.	23 not 24	3074
26.	limit 25 to (article or article in press or "review")	1856

COCHRANE LIBRARY

#1	MeSH descriptor: [Cardiopulmonary Resuscitation] explode all trees	1050
#2	(cardiopulmonary resuscitation):ti,ab,kw	2069
#3	("CPR"):ti,ab,kw	2174
#4	MeSH descriptor: [Heart Massage] explode all trees	153
#5	(chest compression*):ti,ab,kw	1338
#6	(resus*):ti,ab,kw	7860
#7	(manual):ti,ab,kw	18082
#8	#1 or #2 or #3 or #4 or #5 or #6 or #7	9244

#9	(cough cpr):ti,ab,kw	1
#10	(cicpr):ti,ab,kw	0
#11	MeSH descriptor: [Cough] explode all trees	1346
#12	(cough*):ti,ab,kw	1325
#13	(precordial thump*):ti,ab,kw	0
#14	(chest thump*):ti,ab,kw	2
#15	(fist pac*):ti,ab,kw	11
#16	(percussion pac*):ti,ab,kw	20
#17	#9 or #10 or #11 or #12 or #13 or #14 or #15 or #16	13361
#18	#8 and #17	436

Database searched: MEDLINE, PubMed, Cochrane
Time Frame: January 1 2022 – December 20, 2022
Date Search Completed: December 20, 2022
Search Results (Number of articles identified and number identified as relevant):

MEDLINE:	15 articles /1 full text reviewed/no studies relevant
PubMed:	28 articles/2 full text reviewed/no studies relevant
Cochrane:	2 articles/0 full text review/no studies relevant

Summary of Evidence Update:

Searches were updated on 9 December 2022. For **current** update MEDLINE, PubMed, and Cochrane library searches were limited 2022-current. There were no new articles for consideration after title and abstract review.

Relevant Guidelines or Systematic Reviews

Organization (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations
N/A					

RCT:

Study Acronym; Author; Year Published	Aim of Study; Study Type; Study Size (N)	Patient Population	Study Intervention (# patients) / Study Comparator (# patients)	Endpoint Results (Absolute Event Rates, P value; OR or RR; & 95% CI)	Relevant 2° Endpoint (if any); Study Limitations; Adverse Events
N/A	**Study Aim:** **Study Type:**	**Inclusion Criteria:**	**Intervention:** **Comparison:**	**1° endpoint:**	**Study Limitations:**

Nonrandomized Trials, Observational Studies

Study Acronym; Author; Year Published	Study Type/Design; Study Size (N)	Patient Population	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/Conclusion Comment(s)
N/A	**Study Type:**	**Inclusion Criteria:**	**1° endpoint:**	

Reviewer Comments: *(including whether this PICOST should have a systematic or scoping review)*
The searches together identified a total of 45 citations, which were screened initially on title and abstract. 3 papers were retrieved for review of the full-text, and all were assessed as not meeting the inclusion/exclusion criteria. This review therefore concludes that there is no new science that would change or initiate a revision of the current CoSTR recommendations.

There were no new relevant articles identified in this search. This does NOT meet criteria for systematic or scoping review at this point.

Reference list: *(List by ILCOR ref standard (last name first author, year of publication, first page number) and insert hyperlink to all articles identified as relevant (if available on PubMed):* n/a

Evidence Update Worksheet

BLS 372 (In-hospital CCO-CPR vs conventional CPR)

Worksheet author(s): Chika Nishiyama
Task Force: BLS
Date Submitted to SAC rep for peer review and approval: December 2022
SAC rep:

PICOST / Research Question: Among adults who are in cardiac arrest inside of a hospital (population), does provision of chest compressions without ventilation by trained/untrained laypersons (intervention) compared with chest compressions with ventilations (comparison)

Year of last full review: 2018, updated 2022

Current ILCOR Consensus on Science and Treatment Recommendation for this PICOST:
•   Whenever tracheal intubation or an SGA is achieved during in-hospital CPR, we suggest that providers perform continuous compressions with PPV delivered without pausing chest compressions (weak recommendation, very low–certainty evidence).

Current Search Strategy (for an existing PICOST) included in the attached approved PICOST
1 exp Cardiopulmonary Resuscitation/
2 (cardiopulmonary respiratory resuscitation$ or cardiopulmonary resuscitation$ or cardio pulmonary resuscitation$ or cardio-pulmonary resuscitation$ or CPR or Advanced Cardiac Life Support or basic cardiac life support or code blue or resuscitation$ mouth-to-mouth or mouth-to-mouth resuscitation$ or mouth to mouth resuscitation$).tw.
3 Resuscitation/
4 limit 3 to yr=1978-1991
5 1 or 2 or 4
6 mt.fs.
7 method$.tw.
8 6 or 7
9 5 and 8
10 randomized controlled trial.pt.
11 (randomized or placebo).mp.
12 clinical trial.pt.
13 Comparative Study.pt.
14 cross-over studies/
15 controlled clinical trial.pt.
16 (time adj series).tw.
17 (pre test or pretest or (posttest or post test)).tw.
18 random allocation/
19 (controlled adj before).tw.
20 exp epidemiologic studies/
21 ((case* adj3 control*) or (case adj3 comparison*) or control group*).tw.
22 or/10-21
23 9 and 22
24 (control$ or compar$ or random$).tw.
25 9 and 24
26 23 or 25
27 animals/ not humans/
28 26 not 27
29 (editorial or letter).pt.

30 28 not 29
31 ("18334691" or "19660833" or "16564776" or "18374452" or "20370759" or "26550795").ui.
32 30 or 31
33 comment.pt.
34 32 not 33
35 remove duplicates from 34

New Search strategy: (for a new PICOST should be outlined here as per Evidence Update Process)

Database searched: Medline

Time Frame: (existing PICOST) – updated from 1/Jan/2022 through 28/Dec/2022

Time Frame: (new PICOST) – at the discretion of the Task Force (please specify)

Date Search Completed: 3/Jan/2022

Search Results (Number of articles identified and number identified as relevant): 1,743 articles retrieved from search, but no article was related.

Summary of Evidence Update: None

Relevant Guidelines or Systematic Reviews

Organization (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations

RCT:

Study Acronym; Author; Year Published	Aim of Study; Study Type; Study Size (N)	Patient Population	Study Intervention (# patients) / Study Comparator (# patients)	Endpoint Results (Absolute Event Rates, P value; OR or RR; & 95% CI)	Relevant 2° Endpoint (if any); Study Limitations; Adverse Events
	<u>Study Aim:</u> <u>Study Type:</u>	<u>Inclusion Criteria:</u>	<u>Intervention:</u> <u>Comparison:</u>	<u>1° endpoint:</u>	<u>Study Limitations:</u>

Nonrandomized Trials, Observational Studies

Study Acronym; Author; Year Published	Study Type/Design; Study Size (N)	Patient Population	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/Conclusion Comment(s)
	<u>Study Type:</u>	<u>Inclusion Criteria:</u>	<u>1° endpoint:</u>	

Reviewer Comments: There is no new research to suggest the need for scoping reviews or systematic reviews.

Reference list: *(List by ILCOR ref standard (last name first author, year of publication, first page number) and insert hyperlink to all articles identified as relevant (if available on PubMed)*

Evidence Update Worksheet

BLS 372 Lay Rescuer CCO vs Standard CPR

Worksheet author(s): Takanari Ikeyama
Task Force: BLS
Date Submitted to SAC rep for peer review and approval: December 2022
SAC rep:

PICOST / Research Question: *(Attach SAC representative approved completed PICOST template)*

Among adults who are in cardiac arrest outside of a hospital (population), does provision of chest compressions without ventilation by trained/untrained laypersons (intervention) compared with chest compressions with ventilations (comparison)
          change outcome (outcome) [BLS372]?
          change survival with favorable neurological/functional outcome at discharge, 30 days, 60 days, 180 days and/or 1 year; survival only at discharge, 30 days, 60 days, 180 days and/or 1 year; ROSC, bystander CPR performance, CPR quality (outcome) [BLS 547]?
Outcomes: BLS371 addressed outcome in a generic sense (not specified); BLS 547 specifically addressed short-term and long-term outcomes, as well as CPR performance and quality measures.

Year of last full review: 2015

Current ILCOR Consensus on Science and Treatment Recommendation for this PICOST:
2020
- **We continue to recommend that bystanders perform chest compressions for all adult patients in cardiac arrest (good practice statement)**
- **We suggest that bystanders who are trained, able and willing to give rescue breaths and chest compressions do so for all adults in cardiac arrest (weak recommendation, very-low-certainty evidence)**

Current Search Strategy (for an existing PICOST) included in the attached approved PICOST:
same terms and database as for 2020 Guidelines provided by Ms. Janet Bray
Database searched: Ovid Medline
Time Frame: (existing PICOST) – updated from end of last search (please specify)
Time Frame: (new PICOST) – at the discretion of the Task Force (please specify)
Date Search Completed:
Search Results (Number of articles identified and number identified as relevant): The search strategy produced 1466 articles, but no relevant article identified through initial title screening, abstract screening for 26 selected articles, and full-text screening for 2 articles

Summary of Evidence Update: No new study identified.

Relevant Guidelines or Systematic Reviews: No.

Organization (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations

RCT: No study identified.

Study Acronym; Author; Year Published	Aim of Study; Study Type; Study Size (N)	Patient Population	Study Intervention (# patients) / Study Comparator (# patients)	Endpoint Results (Absolute Event Rates, P value; OR or RR; & 95% CI)	Relevant 2° Endpoint (if any); Study Limitations; Adverse Events
	Study Aim: **Study Type:**	**Inclusion Criteria:**	**Intervention:** **Comparison:**	**1° endpoint:**	**Study Limitations:**

Nonrandomized Trials, Observational Studies: No study identified

Study Acronym; Author; Year Published	Study Type/Design; Study Size (N)	Patient Population	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/Conclusion Comment(s)
	Study Type:	**Inclusion Criteria:**	**1° endpoint:**	

Reviewer Comments: *(including whether this PICOST should have a systematic or scoping review)*

No new study has been identified. For now, continuing evidence update regularly is recommended.

Reference list: none

Evidence Update Worksheet

BLS 373 Rhythm Check in CPR

Worksheet author(s): Ziad Nehme
Task Force: BLS
Date Submitted to SAC rep for peer review and approval: 20/12/2022
SAC rep: Olasveengen

PICOST / Research Question: *(Attach SAC representative approved completed PICOST template)*

The PICOST (Population, Intervention, Comparator, Outcome, Study Designs and Timeframe)

Population: Adults in any setting (in-hospital or out-of-hospital) with cardiac arrest

Intervention: Analysis of cardiac rhythm during chest compressions

Comparators: Standard care (analysis of cardiac rhythm during pauses in chest compressions).

Outcomes: 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. CPR quality metrics such time chest compression fraction, pauses in compressions, compressions per minute, time to commencing CPR, or time to first shock etc. were included as important outcomes.

Study Designs: Randomized controlled trials (RCTs) and non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies) are eligible for inclusion. Unpublished studies (e.g., conference abstracts, trial protocols) are excluded.

It is anticipated that there will be insufficient studies from which to draw a conclusion; case series will be included in the initial search and included as long as they contain ≥ 5 cases.

Timeframe: All years and all languages were included as long as there was an English abstract; unpublished studies (e.g., conference abstracts, trial protocols) were excluded. Literature search updated to 20 December 2022.

Year of last full review: 2020

Current ILCOR Consensus on Science and Treatment Recommendation for this PICOST:
1. We suggest against the routine use of artifact-filtering algorithms for analysis of electrocardiographic rhythm during CPR (weak recommendation, very-low-certainty evidence).
2. We suggest that the usefulness of artifact-filtering algorithms for analysis of electrocardiographic rhythm during CPR be assessed in clinical trials or research initiatives (weak recommendation, very-low-certainty evidence).

Current Search Strategy (for an existing PICOST) included in the attached approved PICOST
((((((((((("continuous compressions"[TIAB] OR "Continuous chest compression"[TIAB] OR "Continuous chest-compressions"[TIAB] OR "uninterrupted compressions"[TIAB] OR "uninterrupted chest compression"[TIAB] OR "uninterrupted chest-compressions"[TIAB] OR "ongoing compressions"[TIAB] OR "ongoing chest compression"[TIAB] OR "ongoing chest-compressions"[TIAB] OR "instantaneous chest compression"[TIAB] OR "instantaneous chest compression"[TIAB])) OR ((("Heart Arrest"[Mesh] OR "cardiac arrest"[TIAB] OR "cardiovascular arrest"[TIAB] OR "heart arrest"[TIAB] OR "asystole"[TIAB] OR "pulseless electrical activity"[TIAB] OR "Ventricular Fibrillation"[Mesh:noexp] OR "cardiopulmonary arrest"[TIAB]) AND ("cardiopulmonary resuscitation"[TIAB] OR "Advanced Cardiac Life Support"[TIAB] OR "ACLS"[TIAB] OR "cardiopulmonary resuscitation"[Mesh] OR "advanced cardiac life support"[Mesh] OR "Heart Massage"[Mesh] OR cardiac massage[ti] OR CPR[ti] OR "basic life support"[ti] OR chest compression[TIAB] OR chest compressions[TIAB])))) AND (("Electrocardiography/instrumentation"[Mesh:NoExp] OR

"Electrocardiography/methods"[Mesh:NoExp] OR "Artifacts"[Mesh] OR "Continuous ECG monitoring"[TIAB] OR "ECG analysis"[TIAB] OR "ECG rhythm analysis"[TIAB] OR "Electrocardiogram analysis"[TIAB] OR "rhythm analyses"[TIAB] OR "rhythm analysis"[TIAB] OR "rhythm assessment"[TIAB] OR "rhythm check"[TIAB] OR "rhythm evaluation"[TIAB] OR "rhythm monitoring"[TIAB] OR "shock advisory system"[TIAB] OR"nonshockable rhythm"[TIAB] OR "non-shockable rhythms"[TIAB] OR "non-shockable rhythm"[TIAB] OR "shockable rhythm"[TIAB] OR "nonshockable rhythms"[TIAB] OR "shockable rhythms"[TIAB]))) OR (("rhythm analysis"[TIAB] AND algorithm[TIAB]))))) NOT ((((animals[mh] NOT humans[mh]) NOT ("letter"[pt] OR "comment"[pt] OR "editorial"[pt] or Case Reports[ptyp]))))

New Search strategy: (for a new PICOST should be outlined here as per Evidence Update Process) Same as above
Database searched: Pubmed
Time Frame: (existing PICOST) – updated from end of last search (please specify) Literature search updated to 20 December 2022
Time Frame: (new PICOST) – at the discretion of the Task Force (please specify)
Date Search Completed: 20/12/2022
Search Results (Number of articles identified and number identified as relevant): 158 identified between 2021 and 2022 meeting the search criteria. Of these, 1 met the inclusion criteria.

Summary of Evidence Update: None

Relevant Guidelines or Systematic Reviews

Organization (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations
None					

RCT:

Study Acronym; Author; Year Published	Aim of Study; Study Type; Study Size (N)	Patient Population	Study Intervention (# patients) / Study Comparator (# patients)	Endpoint Results (Absolute Event Rates, P value; OR or RR; & 95% CI)	Relevant 2° Endpoint (if any); Study Limitations; Adverse Events
None	**Study Aim:** **Study Type:**	**Inclusion Criteria:**	**Intervention:** **Comparison:**	**1° endpoint:**	**Study Limitations:**

Nonrandomized Trials, Observational Studies

Study Acronym; Author; Year Published	Study Type/Design; Study Size (N)	Patient Population	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/Conclusion Comment(s)
De Graaf 2021	**Study Type:** Observational (before	**Inclusion Criteria:** Cardiac arrest victims treated by Amsterdam	**1° endpoint:** Sensitivity of the intervention AED was 96%,	CONCLUSION: Compared to conventional AEDs, cprINSIGHT leads to a significantly shorter pre-

	and after) (n=890)	Police and Fire Fighters between 2016-2017 (control) and 2018-2019 (intervention).	(LCPL 93%) and specificity was 98% (LCL 97%), both not significantly different from control. Intervention cases had a shorter median pre-shock pause compared to control cases (8 s vs 22 s, $p < 0.001$) and higher median CCF (86% vs 80%, $P < 0.001$).	shock pause and a significant increase in CCF.
Didon 2021	**Study Type:** Observational (n=2916)	**Inclusion Criteria:** Out-of-hospital cardiac arrest (OHCA) patients treated with AEDs (DEFIGARD TOUCH7, Schiller Médical, France) were subjected patient-wise to Analyze Whilst Compressing (AWC) training (8559 strips, 1604 patients) and validation (7498 strips, 1312 patients).	**1° endpoint:** "Standard Analysis Stage" presented ventricular fibrillation (VF) sensitivity Se = 98.3% and non-shockable rhythm specificity Sp>99%; "AWC Stage" decision after Step2 reconfirmation achieved Se = 92.1%, Sp>99%. AWC required hands-off reconfirmation in 34.4% of cases	AWC presented similar performances to other AED algorithms during CPR, fulfilling performance goals recommended by standards. AWC provided advances in the challenge for
Kwok 2022	**Study Type:** Observational (n=432)	**Inclusion Criteria:** Out-of-hospital cardiac arrest (OHCA) patients treated by EMS. Patients were included if they received at least one defibrillation attempt and the defibrillator recording with ECG and transthoracic impedance signals was available.	**1° endpoint:** Accuracy of rhythm interpretation. Compared to manual review during period with an without CPR, the algorithm correctly classified 0.88 (95% CI 0.85–0.91) for asystole, 0.98 (95% CI 0.98–0.99) for organised rhythm, and 0.97 (95% CI 0.96–0.97) for ventricular fibrillation.	A novel algorithm continuously classified resuscitation rhythms with 88–98% accuracy, enabling accurate shock advisory guidance during most two-minute CPR cycles. Note: 43% of rhythms were classified as Inconclusive and could not be assessed by the algorithm.

Reviewer Comments: *(including whether this PICOST should have a systematic or scoping review)*
The last title screening performed early 2022 identified two observational studies (De Graaf and Didon) evaluating analysis during compressions in clinical settings. This evidence update identified one further observational study (Kwok). None of the studies report on critical outcomes and only one considers the important outcome of CPR quality (chest compression fraction). The topic should be considered for full systematic review.

Reference list: *(List by ILCOR ref standard (last name first author, year of publication, first page number) and insert hyperlink to all articles identified as relevant (if available on PubMed)*

1. de Graaf C, Beesems SG, Oud S, Stickney RE, Piraino DW, Chapman FW, Koster RW. Analyzing the heart rhythm during chest compressions: Performance and clinical value of a new AED algorithm. Resuscitation. 2021 Jan 16:S0300-9572(21)00009-5. doi: 10.1016/j.resuscitation.2021.01.003. Online ahead of print.

2. Didon JP, Ménétré S, Jekova I, Stoyanov T, Krasteva V. Analyze Whilst Compressing algorithm for detection of ventricular fibrillation during CPR: A comparative performance evaluation for automated external defibrillators. Resuscitation. 2021 Jan 30;160:94-102. doi: 10.1016/j.resuscitation.2021.01.018. Online ahead of print.

3. Kwok H, Coult J, Blackwood J, Sotoodehnia N, Kudenchuk P, Rea T. A method for continuous rhythm classification and early detection of ventricular fibrillation during CPR. Resuscitation. 2022;176:90-7.

Evidence Update Worksheet

BLS 546 Tidal Volumes and Ventilation rates

Worksheet author: Nicholas J Johnson
Task Force: ILCOR – Basic Life Support Task Force
Date Submitted to SAC rep for peer review and approval: December 15, 2022
SAC rep:

PICO / Research Question:
(NB This is the PICO from C2010 – BLS052)

Population: In adult and paediatric patients in cardiac arrest (both out-of-hospital and in-hospital) who are NOT endotracheally intubated
Intervention: does providing ventilation with a 1 second inspiratory time and a tidal volume of approximately 600ml
Comparison: compared with any other combination of inspiratory time and tidal volume
Outcomes: clinical outcomes (return of spontaneous circulation, survival to discharge from hospital, oxygenation status, ventilation status, incidence of aspiration).
Type (intervention, diagnosis, prognosis): Intervention

Conflicts of Interest (financial/intellectual, specific to this question): None
Year of last full review: 2010

Current ILCOR Consensus on Science and Treatment Recommendation:
This question was last reviewed in C2010 "Tidal Volumes and Ventilation Rates"; however, was entitled BLS052, and did not comment on ventilation rates (reported on inspiratory time instead).

C2010
Tidal Volumes and Ventilation Rates (BLS-052)
<u>Consensus on Science</u>
In 3 human studies (LOE 5174–176), tidal volumes of 600 mL using room air were sufficient to maintain oxygenation and normocarbia in apneic patients. When tidal volumes less than 500 mL were used, supplementary oxygen was needed to achieve satisfactory oxygenation. Three studies of mechanical
models (LOE 5177–179) found no clinically important difference in tidal volumes when a 1- or 2-second inspiratory time was used. In 1 human study with 8 subjects (LOE 4180), expired air resuscitation using tidal volumes of 500 to 600ml
<u>Treatment Recommendation</u>
For mouth-to-mouth ventilation for adult victims using exhaled air or bag-mask ventilation with room air or oxygen, it is reasonable to give each breath within a 1-second inspiratory time and with an approximate volume of 600 mL to achieve chest rise. It is reasonable to use the same initial tidal volume and rate in patients regardless of the cause of the cardiac arrest.

<u>**Current Search Strategy**</u>

Tidal Volume search (5 January 2022– 7 December 2022)
(tidal volume [MeSH Terms] OR tidal volume[TIAB]) AND (((((((((((life support care[MeSH Terms]) OR "life support"[Title/Abstract]) OR cardiopulmonary resuscitation[MeSH Terms]) OR "cardiopulmonary resuscitation"[Title/Abstract]) OR "CPR"[Title/Abstract]) OR "return of spontaneous circulation"[Title/Abstract]) OR "ROSC"[Title/Abstract]) OR heart arrest[MeSH Terms]) OR "cardiac arrest"[Title/Abstract]) NOT ((animals[MH] NOT humans[MH])))
N=12

Ventilation rate search (5 January 2022– 7 December 2022)

(Noninvasive Ventilation [MeSH Terms] OR ventilation [TI]) AND ((((((((((life support care[MeSH Terms]) OR "life support"[Title/Abstract]) OR cardiopulmonary resuscitation[MeSH Terms]) OR "cardiopulmonary resuscitation"[Title/Abstract]) OR "CPR"[Title/Abstract]) OR "return of spontaneous circulation"[Title/Abstract]) OR "ROSC"[Title/Abstract]) OR heart arrest[MeSH Terms]) OR "cardiac arrest"[Title/Abstract])) NOT ((animals[MH] NOT humans[MH])))
N=36

Database searched: PubMed (5 January 2022– 7 December 2022)

Date Search Completed: 7 December 2022

Search Results (Number of articles identified / number identified as relevant):
Tidal volume: 12 retrieved / 4 full-text retrieved and reviewed / no studies relevant
Ventilation rate: 36 retrieved / 4 full-text retrieved and reviewed / no studies relevant

Inclusion/Exclusion Criteria (C2010):
Inclusion:
Include all studies where there was a comparison of 600mL [~500-700mL] tidal volumes (with approximately one second inspiratory time) with any other ventilation mode during cardiopulmonary resuscitation AND an identifiable result showing that reported clinical outcomes (return of spontaneous circulation, survival to discharge from hospital, oxygenation status, ventilation status, incidence of aspiration).
Exclusion:
Exclude all neonatal and infant studies and those studies involving patients or animals that were intubated. Exclude studies where no clinically relevant outcomes were reported. Exclude review articles.

Link to Article Titles and Abstracts (if available on PubMed): n/a

Tidal volume search (PubMed link): here
Ventilation rate search (PubMed link): here

Summary of Evidence Update:

Evidence Update Process for topics not covered by ILCOR Task Forces
This evidence update process is only applicable to PICOs which are *not* being reviewed as ILCOR systematic and scoping reviews.

TIDAL VOLUME
12 studies identified, 4 full texts reviewed, none were found to be relevant (3 invasive mechanical ventilation/intubated, 1 post-arrest, 3 also had no clinical outcomes)

NO RELEVANT STUDIES

VENTILATION RATE
36 studies identified, 4 full texts reviewed, 1 was found to be relevant (1 pediatric, 1 advanced airway, 2 no clinical outcomes)

NO RELEVANT STUDIES

Relevant Guidelines or Systematic Reviews

Organization (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations
N/A	N/A	N/A	N/A	N/A	N/A

RCT:

Study Acronym; Author; Year Published	Aim of Study; Study Type; Study Size (N)	Patient Population	Study Intervention (# patients) / Study Comparator (# patients)	Endpoint Results (Absolute Event Rates, P value; OR or RR; & 95% CI)	Relevant 2° Endpoint (if any); Study Limitations; Adverse Events
N/A	Study Aim: Study Type:	Inclusion Criteria:	Intervention: Comparison:	1° endpoint:	Study Limitations:

Nonrandomized Trials, Observational Studies

Study Acronym; Author; Year Published	Study Type/Design; Study Size (N)	Patient Population	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/Conclusion Comment(s)
N/A	Study Type:	Inclusion Criteria:	1° endpoint:	

Reviewer Comments: *(including whether this PICOST should have a systematic or scoping review)*

This BLS PICOST question was addressed with two separate PubMed searches, one for 'tidal volumes' during CPR and a second for 'ventilation rates'. The searches together identified a total of 48 citations, which were screened initially on title and abstract. 4 papers were retrieved for review of the full-text, and all were assessed as not meeting the inclusion/exclusion criteria. This review therefore concludes that there is no new science that would change or initiate a revision of the 20100 CoSTR recommendations, and therefore a systematic or scoping review is not recommended.

Reference list: *(List by ILCOR ref standard (last name first author, year of publication, first page number) and insert hyperlink to all articles identified as relevant (if available on PubMed)*

Evidence Update Worksheet

BLS 661 CPR CAB vs ABC

Worksheet author(s): Vihara Dassanayake
Task Force: Basic Life Support
Date Submitted to SAC rep for peer review and approval: December 2022
SAC rep:

PICOST / Research Question: *(Attach SAC representative approved completed PICOST template)*
Population: Among adults and children who are in cardiac arrest in any setting

Intervention: does commencing CPR beginning with compressions first (30:2)

Comparison: compared with starting CPR beginning with ventilation first (2:30)

Outcomes:
- Survival with favourable neurological / functional outcome at discharge, 30 days, 60 days, 180 days AND/OR 1 year
- Survival only at discharge, 30 days, 60 days, 180 days AND/OR 1 year
- ROSC

Study types: Randomised controlled trials (RCTs) and non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies)

Year of last full review: (*insert year where this PICOST was most recently reviewed***)**
2022 (06th January 2022)

Current ILCOR Consensus on Science and Treatment Recommendation for this PICOST:
We suggest commencing CPR with compressions rather than ventilations (weak recommendation, very-low-quality evidence). Values, Preferences, and Task Force Insights In making this recommendation in the absence of human data, we placed a high value on time to specific elements of CPR (chest compressions, rescue breathing, completion of first CPR cycle). In making this recommendation in the absence of human data, given that most cardiac arrests in adults are cardiac in cause, we placed a high value on reducing time to specific elements of CPR (chest compressions and completion of first CPR cycle). We refer the reader to the systematic review Peds 709 (see "Part 6: Pediatric Basic Life Support and Pediatric Advanced Life Support") for recommendations in children**.**

Current Search Strategy (for an existing PICOST) included in the attached approved PICOST
(((((compression:ventilation[Title/Abstract] OR "chest compression fraction"[TIAB]))) OR ((((Heart Massage[MeSH Terms] OR heart massage*[Title/Abstract] OR cardiac massage*[Title/Abstract] OR compression*[Title/Abstract])) AND ("Respiration, Artificial"[Mesh:NoExp] OR ventilation*[Title/Abstract])) AND (ratio[Title/Abstract] OR ratios[Title/Abstract])))) NOT ((animals[mh] NOT humans[mh]) NOT ("letter"[pt] OR "comment"[pt] OR "editorial"[pt] or Case Reports[ptyp]))

New Search strategy: (for a new PICOST should be outlined here as per Evidence Update Process)

Database searched: eg Medline Embase Cochrane
PubMed

Time Frame: (existing PICOST) – updated from end of last search (please specify)

07th January 2022 to 13th December 2022

Time Frame: (new PICOST) – at the discretion of the Task Force (please specify)

Date Search Completed: 13th December 2022

Search Results (Number of articles identified and number identified as relevant): 37/0

Summary of Evidence Update: This evidence update process is only applicable to PICO s which are not being reviewed as ILCOR systematic and scoping reviews**.**
No relevant guidelines, systematic reviews, RCT s, non-randomized trials or observational studies were identified.

Relevant Guidelines or Systematic Reviews

Organization (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations

RCT:

Study Acronym; Author; Year Published	Aim of Study; Study Type; Study Size (N)	Patient Population	Study Intervention (# patients) / Study Comparator (# patients)	Endpoint Results (Absolute Event Rates, P value; OR or RR; & 95% CI)	Relevant 2° Endpoint (if any); Study Limitations; Adverse Events
	Study Aim: **Study Type:**	**Inclusion Criteria:**	**Intervention:** **Comparison:**	**1° endpoint:**	**Study Limitations:**

Nonrandomized Trials, Observational Studies

Study Acronym; Author; Year Published	Study Type/Design; Study Size (N)	Patient Population	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/Conclusion Comment(s)
	Study Type:	**Inclusion Criteria:**	**1° endpoint:**	

Reviewer Comments: *(including whether this PICOST should have a systematic or scoping review)*
No new evidence was identified for this question.

Reference list: *(List by ILCOR ref standard (last name first author, year of publication, first page number) and insert hyperlink to all articles identified as relevant (if available on PubMed)*

Evidence Update Worksheet

1527 CPR Prior to Call for Help

Worksheet author(s): Christopher Smith
Task Force: Basic Life Support
Date Submitted to SAC rep for peer review and approval: 16-01-2023
SAC rep:

PICOST / Research Question:
BLS 1527

In adults sustaining out-of-hospital cardiac arrest (P), does an immediate call for help to EMS dispatch centre by a lone rescuer with a mobile phone (I), compared to a call after one minute of CPR (C), improve ROSC, survival to discharge or 30 days, survival with favourable neurological recovery (O)

Outcomes: ROSC, survival to discharge or 30 days, survival with favourable neurological recovery

Type (intervention, diagnosis, prognosis): Intervention

Year of last full review:

2022 (11th January)

Current ILCOR Consensus on Science and Treatment Recommendation for this PICOST

We recommend that a lone bystander with a mobile phone should dial EMS, activate the speaker or other hands-free option on the mobile phone, and immediately begin CPR with dispatcher assistance, if required (strong recommendation, very-low-certainty evidence).

Current Search Strategy (for an existing PICOST) included in the attached approved PICOST:

(Original searches conducted on 23rd October 2019.)

MEDLINE

Evidence Update Worksheet – 9 Jan 2021

My Account Ask A Librarian Support & Training Ovid® Search Builder

| ch | Journals | Books | Multimedia | My Workspace |

Search History (16)

# ▲	Searches	Results
1	exp Death, Sudden, Cardiac/	14849
2	cardiopulmonary resuscitation.mp. or exp Cardiopulmonary Resuscitation/	23422
3	CPR.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	11686
4	out of hospital cardiac arrest.mp. or exp Out-of-Hospital Cardiac Arrest/	6395
5	exp Heart Massage/	3068
6	chest compression*.mp.	3572
7	resuscitat*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	76315
8	1 or 2 or 3 or 4 or 5 or 6 or 7	97196
9	call first.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	13
10	CPR first.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	27
11	resuscitation first.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	19
12	emergency call*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	819
13	exp Emergency Medical Service Communication Systems/ or exp Emergency Medical Dispatch/	1820
14	9 or 10 or 11 or 12 or 13	2571
15	8 and 14	427
16	limit 15 to humans	399

Remove Combine with: AND OR

EMBASE

My Account Ask A Librarian Support & Training Ovid® Search Builder

| ch | Journals | Books | Multimedia | My Workspace |

Search History (17)

# ▲	Searches	Results
1	exp sudden cardiac death/	14404
2	cardiopulmonary resuscitation.mp. or exp resuscitation/	108141
3	exp "out of hospital cardiac arrest"/	8962
4	out of hospital cardiac arrest.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]	11361
5	exp heart massage/	2198
6	chest compression*.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]	6056
7	resuscitat*.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]	141248
8	CPR.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]	21291
9	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8	164617
10	call first.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]	22
11	CPR first.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]	61
12	emergency call*.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]	1382
13	exp emergency medical dispatch/	141
14	resuscitation first.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]	26
15	10 or 11 or 12 or 13 or 14	1597
16	9 and 15	471
17	limit 16 to human	425

Remove Combine with: AND OR

All Edit Create RSS View Saved

Cochrane Library

−	+	#1	MeSH descriptor: [Death, Sudden, Cardiac] explode all trees	MeSH ▼	592
−	+	#2	MeSH descriptor: [Cardiopulmonary Resuscitation] explode all trees	MeSH ▼	990
−	+	#3	cardiopulmonary resuscitation	Limits	2169
−	+	#4	CPR	Limits	2093
−	+	#5	MeSH descriptor: [Out-of-Hospital Cardiac Arrest] explode all trees	MeSH ▼	314
−	+	#6	out of hospital cardiac arrest	Limits	1414
−	+	#7	MeSH descriptor: [Heart Massage] explode all trees	MeSH ▼	144
−	+	#8	chest compression*	Limits	1394
−	+	#9	resuscitat*	Limits	8553
−	+	#10	#1 or #2 or #3 or #4 or #5 or #6 or #7 or #8 or #9	Limits	10665
−	+	#11	"call first"	Limits	4
−	+	#12	"CPR first"	Limits	15
−	+	#13	"resuscitation first"	Limits	9
−	+	#14	emergency call*	Limits	2359
−	+	#15	MeSH descriptor: [Emergency Medical Service Communication Systems] explode all trees	MeSH ▼	50
−	+	#16	MeSH descriptor: [Emergency Medical Dispatch] in all MeSH products	MeSH ▼	2
−	+	#17	#11 or #12 or #13 or #14 or #15 or #16	Limits	2403
−	+	#18	#10 and #17	Limits	367

Database searched:

Medline, Embase and Cochrane Library

Time Frame (existing PICOST):

"2022-present"

Date Search Completed

16 January 2023

Search Results (Number of articles identified and number identified as relevant):

Medline: 28
Embase: 48
Cochrane: 41

None of these articles deemed relevant for full-text retrieval after title/abstract review

Summary of Evidence Update:

No new relevant papers identified.

Relevant Guidelines or Systematic Reviews

Evidence Update Worksheet – 9 Jan 2021

Organization (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations

RCT:

Study Acronym; Author; Year Published	Aim of Study; Study Type; Study Size (N)	Patient Population	Study Intervention (# patients) / Study Comparator (# patients)	Endpoint Results (Absolute Event Rates, P value; OR or RR; & 95% CI)	Relevant 2° Endpoint (if any); Study Limitations; Adverse Events
	Study Aim: Study Type:	Inclusion Criteria:	Intervention: Comparison:	1° endpoint:	Study Limitations:

Nonrandomized Trials, Observational Studies

Study Acronym; Author; Year Published	Study Type/Design; Study Size (N)	Patient Population	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/Conclusion Comment(s)
	Study Type:	Inclusion Criteria:	1° endpoint:	

Reviewer Comments: *(including whether this PICOST should have a systematic or scoping review)*

This does not meet the criteria for further formal review

Reference list: *(List by ILCOR ref standard (last name first author, year of publication, first page number) and insert hyperlink to all articles identified as relevant (if available on PubMed)*

N/A

Evidence Update Worksheet

BLS XXX Heads Up CPR

Worksheet author(s): Janet Bray
Task Force: BLS
Date Submitted to SAC rep for peer review and approval: December 2022
SAC rep:

PICOST / Research Question: *(Attach SAC representative approved completed PICOST template)*

Population: Adults in any setting (in-hospital or out-of-hospital) with cardiac arrest

Intervention: Heads-up CPR

Comparators: Standard or compression-only CPR in supine position

Outcomes: Any clinical outcome.

Study Designs: Randomized controlled trials (RCTs) and non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies), case series with ≥ 5 patients are eligible for inclusion. Unpublished studies (e.g., conference abstracts, trial protocols) are excluded.

Timeframe: All years and all languages are included as long as there is an English abstract.

Year of last full review: 2021

Current ILCOR Consensus on Science and Treatment Recommendation for this PICOST:
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).

Current Search Strategy (for an existing PICOST) included in the attached approved PICOST
(("field"[All Fields] OR "field s"[All Fields] OR "fields"[All Fields] OR "heads-up"[All Fields] OR "head up"[All Fields] OR "head-up"[All Fields]OR "tilt"[All Fields]) AND (("life support care"[MeSH Terms] OR "life support"[Title/Abstract] OR "cardiopulmonary resuscitation"[MeSH Terms] OR "cardiopulmonary resuscitation"[Title/Abstract] OR "CPR"[Title/Abstract] OR "return of spontaneous circulation"[Title/Abstract] OR "ROSC"[Title/Abstract] OR "heart arrest"[MeSH Terms] OR "cardiac arrest"[Title/Abstract]) NOT ("animals"[MeSH Terms] NOT "humans"[MeSH Terms])))
Database searched: PubMed
Time Frame: 1/1/2022-7/12/2022
Date Search Completed: 7th December 2022
Search Results (Number of articles identified and number identified as relevant): 159 titles, 2 relevant systematic reviews and 1 observational study

Summary of Evidence Update:

Relevant Guidelines or Systematic Reviews

Organization (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations
Tan 2022 515	Systematic review	Search to May 2021 Whether head-up CPR (HU-CPR) improved survival and surrogate outcomes as compared to standard CPR (S-CPR).	13 (11 animal, 1 cadaver, 1 human)	The human study (n=2,322) reported increased return of spontaneous circulation with HU-CPR in OHCA (17.9% versus 34.2%, P<0.0001).	Human study included in 2021 ILCOR SR.
Varney 2022 e644	Systematic review	Search to Feb 2021 investigate the safety and efficacy of heads-up CPR versus supine CPR.	7 animal studies	No human studies	n/a

Nonrandomized Trials, Observational Studies

Study Acronym; Author; Year Published	Study Type/Design; Study Size (N)	Patient Population	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/Conclusion Comment(s)
Moore 2022 159	**Study Type:** Prospective observational. Intervention group bundle: (1) active compression-decompression CPR and/or automated CPR, (2) an impedance threshold device, and (3) automated controlled elevation of the head and thorax (ACE)	**Inclusion Criteria:** Adults in OHCA. Comparator group taken from 3 RCTS in high performance CPR EMS.	**1° endpoint:** After propensity score matching overall outcomes with ACE-CPR and C-CPR were comparable for the overall probabilities of ROSC (33% [74/222] versus 33% [282/860], OR, 1.02, 95% CI, 0.75–1.49), survival to hospital discharge (9.5% [21/222] versus 6.7% [58/860], OR, 1.44, 95% CI, 0.86–2.44) and survival to hospital discharge with favorable neurological status (5.9% [13/222] versus 4.1% [35/860], OR, 1.47, 95% CI, 0.76–2.82). Rapid initiation of ACE-CPR was associated with higher adjusted odds of survival to hospital discharge with favorable neurological function compared with C-CPR patients.	High risk of bias. No different on outcomes overall.
Kim 2022 159	**Study Type:** Prospective pilot study. Intervention: alternating head-up and supine positions at 4-minute intervals while performing CPR in ED.	**Inclusion Criteria:** Adults in non-traumatic OHCA (n=28) receiving ALS care.	**1° endpoint:** The median increase in cerebral blood flow (CBF) in the prefrontal area in the head-up position was 14.6% (Interquartile range, 8.8–65.0), more than that in the supine position. An increase in CBF was observed in the head-up position compared with the supine position in 83.3% of the patients included in the analysis.	Small sample size.

Reviewer Comments: Two observational human studies since the 2021 ILCOR systematic review. Largest study showed no difference in outcomes overall. Update of the systematic review not needed.

Reference list: *(List by ILCOR ref standard (last name first author, year of publication, first page number) and insert hyperlink to all articles identified as relevant (if available on PubMed)*

Kim 2022 159 A new variant position of head-up CPR may be associated with improvement in the measurements of cranial near-infrared
spectroscopy suggestive of an increase in cerebral blood flow in non-traumatic out-of-hospital cardiac arrest patients: A prospective interventional pilot study. Resuscitation 2022:175:159-166
https://www.resuscitationjournal.com/article/S0300-9572(22)00100-9/fulltext

Moore 2022 159 Head and thorax elevation during cardiopulmonary resuscitation using circulatory adjuncts is associated with improved survival. Resuscitation 2022:175:159-166
https://www.resuscitationjournal.com/article/S0300-9572(21)00459-7/fulltext

Tan 2022 515 The role of head-up cardiopulmonary resuscitation in sudden cardiac arrest: a systematic review and meta-analysis. Ann Transl Med 2022;10(9):515
https://atm.amegroups.com/article/view/91770/html

Varney 2022 e644 Efficacy of heads-up CPR compared to supine CPR positions:Systematic review and meta-analysisHealth Sci. Rep. 2022;5:e644
https://onlinelibrary.wiley.com/doi/10.1002/hsr2.644

Evidence Update Worksheet

BLS XXX Video-based dispatch system

Worksheet author(s): Sung Phil Chung
Task Force: BLS
Date Submitted to SAC rep for peer review and approval: 2022 Dec
SAC rep:

PICOST / Research Question: *(Attach SAC representative approved completed PICOST template)*
Among adults and children with presumed cardiac arrest in out-of-hospital setting (P), does Patients/cases or EMS systems where dispatch assisted CPR is offered by video and audio communication between dispatcher center and scene (I), compared with audio-only communication (C), improve any clinical outcome?
Outcomes: Survival with favorable neurologic outcome, survival, ROSC, and CPR quality

Year of last full review: (*insert year where this PICOST was most recently reviewed***)**
2021 Systematic review, 2022 evidence update

Current ILCOR Consensus on Science and Treatment Recommendation for this PICOST:
We suggest that the usefulness of video-based dispatch systems be assessed in clinical trials or research initiatives (weak recommendation, very low-certainty evidence).

Current Search Strategy (for an existing PICOST) included in the attached approved PICOST
PubMed: (((((((((((OHCA) OR out of hospital cardiac arrest)) OR ((CPR) OR cardiopulmonary resuscitation)) OR bystander) OR layperson) OR dispatch) OR dispatcher) OR (((CPR) AND assisted) AND quality)) OR ((resuscitation) AND quality))) AND (((((((((((video) AND assisted)) OR ((video) AND instruction)) OR ((audio) AND assisted)) OR ((audio) AND instruction)) OR ((smartphone) AND assisted)) OR ((smartphone) AND instruction)) OR ((cell phone) AND assisted)) OR ((cell phone) AND instruction)) OR ((mobile) AND assisted)) OR ((mobile) AND instruction))

Embase: 'video'/exp OR video AND assisted OR ('video'/exp OR video AND instruction) OR (audio AND assisted) OR (audio AND instruction) OR ('smartphone'/exp OR smartphone AND assisted) OR ('smartphone'/exp OR smartphone AND instruction) OR ('cell'/exp OR cell AND phone AND assisted) OR ('cell'/exp OR cell AND phone AND instruction) OR (mobile AND assisted) OR (mobile AND instruction) AND ('ohca'/exp OR ohca OR cpr OR (out AND of AND ('hospital'/exp OR hospital) AND cardiac AND ('arrest'/exp OR arrest)) OR 'bystander'/exp OR bystander OR layperson OR dispatch OR dispatcher OR (cpr AND assisted AND ('quality'/exp OR quality)) OR ('resuscitation'/exp OR resuscitation AND ('quality'/exp OR quality)))

Cochrane Library: ((mh video OR video:ab,ti AND assisted) OR (mh video OR video AND instruction) OR (audio AND assisted) OR (audio AND instruction) OR (mh smartphone OR smartphone AND assisted) OR (mh smartphone OR smartphone AND instruction) OR (mh cell OR cell AND phone AND assisted) OR (mh cell OR cell AND phone AND instruction) OR (mobile AND assisted) OR (mobile AND instruction)) AND (mh ohca OR ohca OR cpr OR (out AND of AND (mh hospital OR hospital) AND cardiac AND (mh arrest OR arrest)) OR mh bystander OR bystander OR layperson OR dispatch OR dispatcher OR (cpr AND assisted AND (mh quality OR quality)) OR (mh resuscitation OR resuscitation AND (mh quality OR quality)))

Database searched: Medline

Time Frame: (existing PICOST) – updated from end of last search (please specify): Dec 1, 2021 to Dec 11, 2022

Date Search Completed: Dec 11, 2022

Search Results (Number of articles identified and number identified as relevant):
PubMed: 683 articles identified, 5 articles identified as relevant

Summary of Evidence Update:

There were 2 systematic reviews, 1 scoping review, and 2 simulated RCT studies.

Relevant Guidelines or Systematic Reviews

Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations
Bielski, 2022	Systematic review	Audio-instructed and video-instructed dispatcher-assisted CPR	2 clinical and 8 simulation trials	Video-assisted CPR significantly improved prehospital ROSC (OR=0.46; 95% CI: 0.30-0.69) and survival to hospital discharge (OR=0.46; 95% CI: 0.30-0.70).	No change (Studies were already included in previous ILCOR review)
Pan, 2022	Systematic review	Video-guided vs telephone-guided dispatcher CPR	6 simulation RCTs (no clinical study included)	Video-assisted CPR was significantly improved mean chest compression rate (OR=0.66, 95% CI: 0.49-0.82), but mean chest compression depth was not statistically different between groups.	No change
Sykora, 2022	Scoping review	Video emergency call	12 studies (5 clinical and 7 simulation studies)	Video emergency calls are feasible and appear to be a well-accepted method between dispatchers and callers.	No change

RCT:

Author; Year Published	Aim of Study; Study Type; Study Size (N)	Patient Population	Study Intervention (# patients) / Study Comparator (# patients)	Endpoint Results (Absolute Event Rates, P value; OR or RR; & 95% CI)	Relevant 2° Endpoint (if any); Study Limitations; Adverse Events
Peters, 2022	Study Aim: to evaluate the impact of adding video conferencing to dispatcher assisted telephone CPR on pediatric bystander CPR quality Study Type: prospective, randomized manikin study	Inclusion Criteria: untrained participants (18-75 years old), trained volunteers were bachelor nurses	4 groups(n=120): untrained (U) vs trained (T), telephone-guided (T) vs video-guided (V) group (n=30 each)	1° endpoint: global CPR score was highest in the U-V group compared with the U-T group, and was significantly higher in the T-V group than in the U-V group.	Study Limitations: not able to precisely measure CC depth and tidal volume of the ventilations
Igarashi, 2022	Study Aim: to determine whether video calls with dispatchers improve the quality of first aid for infants with foreign body airway obstruction Study Type: randomized manikin study	Inclusion Criteria: untrained first-year college students	Intervention: video call (n=17), Comparison: voice call (n=16)	1° endpoint: receipt of excellent or acceptable evaluation, did not differ significantly between the groups (video 41% vs. voice 50%; P=0.61)	Study Limitations: simulation study (could not investigate survival and neurological outcomes)

Reviewer Comments: *(including whether this PICOST should have a systematic or scoping review)*
This PICO included only one clinical study (Lee 2020 12) when reviewed in 2020, and was uploaded to the ILCOR website in early 2021. In 2021 evidence update, two additional clinical studies were searched but one (Lee 2021 15555) was from the same country

(Korea) with only a different period (2018-2019), and a Danish study (Linderoth 2021 35) did not report clinical outcomes. So, TF decided to wait for additional research. Now, there have been no additional clinical studies, I think that there is no need to conduct a systematic review at this point.

Reference list: *(List by ILCOR ref standard (last name first author, year of publication, first page number) and insert hyperlink to all articles identified as relevant (if available on PubMed)*

● Bielski K, Böttiger BW, Pruc M, Gasecka A, Sieminski M, Jaguszewski MJ, Smereka J, Gilis-Malinowska N, Peacock FW, Szarpak L. Outcomes of audio-instructed and video-instructed dispatcher-assisted cardiopulmonary resuscitation: a systematic review and meta-analysis. Ann Med. 2022 Dec;54(1):464-471.

● Igarashi Y, Suzuki K, Norii T, Motomura T, Yoshino Y, Kitagoya Y, Ogawa S, Yokobori S, Yokota H. Do Video Calls Improve Dispatcher-Assisted First Aid for Infants with Foreign Body Airway Obstruction? A Randomized Controlled Trial/Simulation Study. J Nippon Med Sch. 2022;89(5):526-532.

● Pan DF, Li ZJ, Ji XZ, Yang LT, Liang PF. Video-assisted bystander cardiopulmonary resuscitation improves the quality of chest compressions during simulated cardiac arrests: A systemic review and meta-analysis. World J Clin Cases. 2022 Nov 6;10(31):11442-11453.

● Peters M, Stipulante S, Cloes V, Mulder A, Lebrun F, Donneau AF, Ghuysen A. Can Video Assistance Improve the Quality of Pediatric Dispatcher-Assisted Cardiopulmonary Resuscitation? Pediatr Emerg Care. 2022 Feb 1;38(2):e451-e457.

● Sýkora R, Peřan D, Renza M, Bradna J, Smetana J, Duška F. Video Emergency Calls in Medical Dispatching: A Scoping Review. Prehosp Disaster Med. 2022 Dec;37(6):819-826.

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● Linderoth G, Rosenkrantz O, Lippert F, Østergaard D, Ersbøll AK, Meyhoff CS, Folke F, Christensen HC. Live video from bystanders' smartphones to improve cardiopulmonary resuscitation. Resuscitation. 2021 Nov;168:35-43.

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Evidence Update Worksheet

Resuscitation in Pregnancy

Worksheet author(s): Carolyn M Zelop, MD and Amir Shamshirsaz, MD
Task Force: ALS TF
Date Submitted to SAC rep for peer review and approval:
SAC rep:

PICOST / Research Question: *(Attach SAC representative approved completed PICOST template)*
Among pregnant women who are in cardiac arrest in any setting (P), does any specific intervention(s) (I), compared with standard care (usual resuscitation practice) (C), change ROSC, Survival only at discharge, 30 days, 60 days, 180 days AND/OR 1 year, Survival with Favorable neurological/functional outcome at discharge, 30 days, 60 days, 180 days AND/OR 1 year (O)?

Outcomes:

Maternal: ROSC, Survival only at discharge, 30 days, 60 days, 180 days AND/OR 1 year, Survival with Favorable neurological/functional outcome at discharge, 30 days, 60 days, 180 days AND/OR 1 year

neonatal : ROSC, Survival only at discharge, 30 days, 60 days, 180 days AND/OR 1 year, Survival with Favorable neurological/functional outcome at discharge, 30 days, 60 days, 180 days AND/OR 1 year

Year of last full review: (*insert year where this PICOST was most recently reviewed) 2020*

Current ILCOR Consensus on Science and Treatment Recommendation for this PICOST:
This treatment recommendation (below) is unchanged from 2015.1,7 We suggest delivery of the fetus by perimortem cesarean delivery for women in cardiac arrest in the second half of pregnancy (weak recommendation, very low-quality evidence). There is insufficient evidence to define a specific time interval by which delivery should begin. High-quality usual resuscitation care and therapeutic interventions that target the most likely cause(s) of cardiac arrest remain important in this population. There is insufficient evidence to make a recommendation about the use of left-lateral tilt and/or uterine displacement during CPR in the pregnant patient.

Current Search Strategy (for an existing PICOST) included in the attached approved PICOST
("Pregnancy"[Mesh:NoExp] or "Pregnant Women"[Mesh] or "Pregnancy Complications"[Mesh:NoExp] or pregnant[TI] or pregnancy[TI] OR maternal[TI] OR parturient[TIAB] OR "Anesthesia, Obstetrical"[Mesh] OR "Perinatology"[Mesh] OR "Maternal Mortality"[Mesh]) AND ("Heart Arrest"[Mesh] OR "cardiac arrest"[TIAB] OR "cardiac arrests"[TIAB] OR "cardiovascular arrest"[TIAB] OR "heart arrest"[TIAB] OR "heart arrests"[TIAB] OR "asystole"[TIAB] OR "pulseless electrical activity"[TIAB] OR "cardiopulmonary arrest"[TIAB] OR "cardiopulmonary arrests"[TIAB] OR CPR[TIAB] OR "resuscitation"[Mesh] OR resuscitat*[TIAB] OR "chest compression"[TIAB] OR "chest compressions"[TIAB] OR "heart massage"[TIAB] OR "cardiac massage"[TIAB] OR "cardiac compression"[TIAB] OR "cardiac compressions"[TIAB] OR "thoracic compression"[TIAB] OR "thoracic compressions"[TIAB] OR "maternal resuscitation"[TIAB]) AND ("perimortem cesarean section"[TIAB] OR "perimortem delivery"[TIAB] OR "left lateral"[TIAB] OR "lateral tilt"[TIAB] OR "uterine displacement"[TIAB] OR "aortocaval compression"[TIAB] OR "Patient Positioning"[Mesh] OR "Pregnancy Complications, Cardiovascular"[MeSH] OR pharmacokinetic*[TIAB] OR "Pharmacokinetics"[Mesh] OR "lipid resuscitation" OR "Thrombolytic Therapy"[Mesh] OR thrombolytic*[TIAB] OR Fibrinolytic*[TIAB] OR "Fat Emulsions, Intravenous"[Mesh] OR "fat emulsion"[TIAB] OR "fat emulsions"[TIAB] OR "lipid emulsion"[TIAB] OR "lipid emulsions"[TIAB] OR "cardiac output"[TIAB] OR "Hypothermia, Induced"[Mesh:NoExp] OR hypothermia[TIAB] OR emergenc*[TIAB] OR "Emergencies"[Mesh] OR "Emergency Medical Services"[Mesh] OR "Combined Modality Therapy"[Mesh:NoExp]) NOT ("animals"[Mesh] NOT "humans"[Mesh]) NOT ("letter"[pt] OR "comment"[pt] OR "editorial"[pt] or Case Reports[ptyp] or news[ptyp])

New Search strategy: same strategy used
Database searched: Pubmed, Embase, Cochrane
Time Frame: (existing PICOST) – updated from end of last search performed 10/26/19
Time Frame: (new PICOST) – at the discretion of the Task Force (please specify)
Date Search Completed: July 8th, 2022
Search Results (202 articles were revealed with 4 new relevant articles including 2 found by hand search):

Summary of Evidence Update:

Relevant Guidelines or Systematic Reviews

Organization (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations
Extracorporeal Life Support in Pregnancy: A Systematic Review Naoum E et al. J Am Heart Assoc. 2020 Jul 7;9(13):e016072	Systematic Review	Comprehensive research of ECLS in the pregnant and postpartum periods, to define the reported indications, maternal and fetal survival, and to identify associated complications	221 studies identified with 358 patients (all VV/ VA/ VA-VV ECMO) Since case reports were included with one or more reported outcomes, the quality of evidence was not assessed	57 patients had MCA (7 antepartum, 39 immediate postpartum, 11 postpartum from 24 hours-42 days), 41 VA, 6 VA-VV and 7 with unknown cannulation. Maternal survival rate 87.7%. Overall 30-day survival rate on ECMO 75.4% for mothers and 64.7% for fetuses. Overall neurologically intact 78.9% For women delivered on ECMO maternal survival 79.4% and fetal survival 56.3% Complications Mild to moderate bleeding 66 (18.4%), Severe bleeding requiring surgical	Cardiac arrest was the most common indication in the immediately postpartum periods with VA ECMO with favorable survival of 87.7% compared with general adult population survival with ECMO (29%). These findings support consideration of ECLS in pregnant and immediately postpartum patients given the potential for success and relative safety of this life saving intervention Prospective and detailed reporting with multicenter collaboration may help to better evaluate the use of ECLS in pregnancy including indications, complications, outcomes, and best management strategies for this unique population.

				intervention 48 (13.4%) Intracranial neurologic morbidity 19 (5.3%).	
Effect of Maternal positioning during cardiopulmonary resuscitation: a Systematic Review and Meta-analyses Enomoto N et al. BMC pregnancy and Childbirth. 2022; 2(25): 159	Systematic review and Meta-analyses	The gravid uterus causes aortocaval compression when the uterus is greater than or equal to 20 weeks gestation. Does uterine displacement and positioning of the pregnant patient alter effectiveness of cardiopulmonary resuscitation?	8 studies were included after screening 1490 studies The eight studies were simulation-based crossover trials performed on mannequins that examined the quality of chest compressions including six crossover RCT and two nonrandomized crossover studies Outcomes of interest included: ROSC, survival to discharge including neurological status, quality of chest compressions and any adverse events	No data were available about the survival of patients or neonates Depth of chest compressions and correctness of hand position were favored by the supine position (Quality of evidence was rated low according to GRADE and certainty of data was downgraded for risk of bias, indirectness, inconsistency and imprecision of results) Only one study utilized left lateral uterine displacement with the supine position and demonstrated that there was no difference in chest compression effectiveness Chest compressions	The supine position is favored for resuscitation during cardiac arrest during pregnancy. Left lateral uterine displacement is recommended to relieve aortocaval compression but not substantiated by results of this study.

			Statistical methods reveal heterogeneity and only four studies were used for meta-analysis	were easier to perform in the supine position	

RCT:

Study Acronym; Author; Year Published	Aim of Study; Study Type; Study Size (N)	Patient Population	Study Intervention (# patients) / Study Comparator (# patients)	Endpoint Results (Absolute Event Rates, P value; OR or RR; & 95% CI)	Relevant 2° Endpoint (if any); Study Limitations; Adverse Events
	Study Aim: Study Type:	Inclusion Criteria:	Intervention: Comparison:	1° endpoint:	Study Limitations:

Nonrandomized Trials, Observational Studies

Study Acronym; Author; Year Published	Study Type/Design; Study Size (N)	Patient Population	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/Conclusion Comment(s)
Analysis of prehospital perimortem caesarean deliveries performed by Helicopter Emergency Medical Services (HEMS) in the Netherlands and recommendations for the future Moors X et al. Resuscitation, 2020. 155:112	**Study Type:** Population based Retrospective cohort study of all maternal out of hospital cardiac arrest in HEMS databases in Netherlands 1995-2019. All patients with MCA requiring primary cesarean delivery (PCD) identified and questionnaires were sent to physicians who performed PCD	**Inclusion Criteria:** All MCA with primary cesarean delivery	**1° endpoint** Maternal and Neonatal survival Of 7 patients, 3 were pronounced dead on scene, 4 transferred to hospital and none of them survived. Of 7 neonates, 1 died on scene, 6 transferred to hospital of which 3 died in hospital, 3 discharged home (two cases with good neurological outcome) All pregnant patients with non-shockable rhythm (5 asystole and 2 PEA) Time from dispatch to PCD initiation was over 10 minutes with shorter time for midline skin incision (1 minute in comparison to 2-5 minutes in lower transverse abdominal incision.	Low incidence of PCDs during out-of-hospital MCA with all > recommended 5 minutes. In the prehospital resuscitation and PCD, special attention should be paid to performing intubation (with capnography), manual left uterine displacement and using midline rather than lower transverse. In case of maternal death autopsy is highly recommended to investigate the etiology (if not feasible a full body MRI or CT scan sever as an alternative)

Study Acronym; Author; Year Published	Study Type/Design; Study Size (N)	Patient Population	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/Conclusion Comment(s)
Risk factors, management, and outcomes of amniotic fluid embolism: A multi-country, population-based cohort and nested case-control study Fitzpatrick et al. PLOS Med. 2019. 12: 16(11):) e1002962.	**Study Type:** Multi-county, population-based cohort and nested case-control using INOSS. Control group were collected by UK and Australia Sample size: 218	Inclusion Criteria: Pooled data on women with AFE from each five countries based on 3 AFE definition criteria: UKOSS, INOSS and Clark	**1° endpoint** Older maternal age, multiple pregnancy, polyhydramnios, placenta previa, and induction of labor were associated with AFE Among women with AFE, irrespective of case definition, poor maternal outcome more likely to present with cardiac arrest and less likely to have platelet or a source of	This study suggested when an AFE is suspected, initial supportive obstetric care is important, but having an obstetrician and/or anesthesiologist present at the time of AFE event and use of interventions to correct coagulopathy, including administration of adequate dose of TXA , may be important to improve of maternal outcome

			fibrinogen concentrate given, and less likely to have obstetrician or anesthesiologist present at the time of AFE event/resuscitation.	

Reviewer Comments:

Overall quality of the studies is low with substantial limitations including lack of granularity, small sample size and the presence of bias and confounding. The researchers are hampered by the inability to construct large scale prospective or randomized study design.

Perimortem or resuscitative cesarean delivery at or greater than 20 weeks uterine size appears to improve outcomes of maternal cardiac arrest (MCA) when high quality resuscitative care does not result in return of spontaneous circulation (ROSC). Shorter time intervals from arrest to delivery appear to lead to improved maternal and neonatal outcomes. In order to accomplish delivery within 5 minutes from time of arrest, immediate preparation for resuscitative delivery must be initiated with initial BLS and ACLS interventions. (1,2)

The enlarging uterus leads to aortocaval compression when the uterine size is greater than or equal to 20 weeks gestation. Relief of aortocaval compression may enhance resuscitative outcomes. Enomoto et al. (3) provide only low-quality evidence for the performance of resuscitation in the supine position during pregnancy citing better depth of chest compressions and correctness of hand position compared to left lateral tilt. Although these researchers recommend left lateral uterine displacement of the uterus, their data does not corroborate this practice. Supine positioning along with left manual uterine displacement preserves the optimal vectors for high quality chest compression, the cornerstone of BLS/ACLS. Only indirect evidence extrapolated from non-arrest clinical scenarios supports this recommendation. (4)

Guidelines for management of out of hospital MCA must be developed to accommodate the unique aspects of MCA. Moors et al. (5), perhaps limited by their small sample size, demonstrated no maternal benefit for perimortem cesarean performed in the field by the resuscitation crew, while 3/7 neonates survived with 2/7 with good neurological outcomes. This study underscores the challenges of resuscitation in the field for the pregnant victim.

Although identifying a comparative control group highly limits the interpretation of the results of this study, Fitzpatrick et al. (6) propose better management of coagulopathy and hemorrhage for pregnant patients with suspected coagulopathy.

Extra-corporeal life support (ELS) may enhance maternal and neonatal outcomes when ongoing resuscitation interventions are required. Naoum et al. (7) presents a comprehensive overview of the use of ELS in a detailed systematic review. In their study, the most common indications for ECLS overall in pregnancy included acute respiratory distress syndrome 177 (49.4%), cardiac failure 67 (18.7%), and cardiac arrest 57 (15.9%). While their findings support consideration of ECLS in pregnant and immediately postpartum patients given the potential for success and relative safety of this life saving intervention, their study data is highly limited by publication bias of good outcomes. Prospective and detailed reporting with multicenter collaboration may help to better evaluate the use of ECLS in pregnancy including indications, complications, outcomes, and best management strategies for this unique population.

Overall, the limited number of studies and low evidence quality does not support the performance of a systematic review or scoping review at this time.

Reference list:

1) Beckett VA et al. The CAPS Study: incidence, management and outcomes of cardiac arrest in pregnancy in the UK: a prospective, descriptive study. BJOG. 2017; 124:1374.

2) Jeejeebhoy FM et al. Cardiac Arrest in Pregnancy: A Scientific Statement from the American Heart Association.Circulation. 2015; 132:1747.

3) Enomoto N et al. Effect of maternal positioning during cardiopulmonary resuscitation: a systematic review and meta-analyses. BMC Pregnancy Childbirth. 2022. Feb 25;22(1):159. PMID: 35216559
Effect of maternal positioning during cardiopulmonary resuscitation: a systematic review and meta-analyses - PubMed (nih.gov)

4) Kundra P et al. Manual displacement of the uterus during Caesarean section. Anaesthesia. 2007;62(5):460.

5) Moors X et al. Analysis of prehospital perimortem caesarean deliveries performed by Helicopter Emergency Medical Services in the Netherlands and recommendations for the future. Resuscitation. 2020. Oct;155:112.   PMID: 32745580.
Analysis of prehospital perimortem caesarean deliveries performed by Helicopter Emergency Medical Services in the Netherlands and recommendations for the future - Resuscitation (resuscitationjournal.com)

6) Fitzpatrick KE et al. Risk factors, management, and outcomes of amniotic fluid embolism: A multicountry, population-based cohort and nested case-control study. PLoS Med. 2019. 16(11): e1002962. PMID.1002962
Risk factors, management, and outcomes of amniotic fluid embolism: A multicountry, population-based cohort and nested case-control study - PMC (nih.gov)

7) Naoum EE et al. Extracorporeal Life Support in Pregnancy: A Systematic Review. J Am Heart Assoc. 2020. Jul 7;9(13):e016072. PMID: 32578471
Extracorporeal Life Support in Pregnancy: A Systematic Review - PMC (nih.gov)

Evidence Update Worksheet

Steroids after ROSC

Worksheet author(s): Tonia Nicholson
Task Force: ALS
Date Submitted to SAC rep for peer review and approval:
SAC rep: Peter Morely

PICOST / Research Question:
In adult patients with ROSC after cardiac arrest (prehospital or in-hospital) (P), does treatment with corticosteroids (I) as opposed to standard care (C), improve outcome (O) (eg. survival)?

Year of last full review:
2010 (but similar literature search done to address 2015 PICOST 433, and EvURs done in 2019 and 2021).

Current ILCOR Consensus on Science and Treatment Recommendation for this PICOST:
Consensus on Science : There were no human or animal studies that directly addressed the use of the estrogen, progesterone, insulin, or insulin-like growth factor in cardiac arrest. Early observational studies of the use of corticosteroids during cardiac arrest suggested possible benefit (LOE 4).[229,230] One complex randomized pilot study (LOE 1)[231] and 1 nonrandomized human study (LOE 2)[232] suggested benefit with corticosteroids, whereas 1 small, older, human prehospital controlled clinical trial suggested no benefit (LOE 1).[233] One animal study of corticosteroids suggested possible benefit (LOE 5).[234]

Treatment Recommendation : There is insufficient evidence to support or refute the use of corticosteroids alone or in combination with other drugs during cardiac arrest.

2010 Search Strategy:
Cochrane Library search:
("Heart Arrest"[Mesh] OR "Cardiopulmonary Resuscitation"[Mesh]) AND ("Pituitary-Adrenal System"[Mesh] OR "Adrenal Insufficiency"[Mesh] OR "Adrenal Cortex Hormones"[Mesh] OR "Glucocorticoids"[Mesh] OR "Hydrocortisone"[Mesh] OR "Cortisone"[Mesh] OR "Prednisolone"[Mesh] OR"Prednisone"[Mesh]OR"Methylprednisolone"[Mesh] OR"Dexamethasone"[Mesh] OR"Betamethasone"[Mesh]). 5 results.

PubMed search:
("Heart Arrest"[Mesh] OR "Cardiopulmonary Resuscitation"[Mesh]) AND ("Pituitary-Adrenal System"[Mesh] OR "Adrenal Insufficiency"[Mesh] OR "Adrenal Cortex Hormones"[Mesh] OR "Adrenal Cortex Hormones "[Pharmacological Action] OR "Glucocorticoids"[Mesh] OR "Hydrocortisone"[Mesh] OR "Cortisone"[Mesh] OR "Prednisolone"[Mesh] OR "Prednisone"[Mesh] OR "Methylprednisolone"[Mesh] OR "Dexamethasone"[Mesh] OR "Betamethasone"[Mesh]). 18 articles identified.

EMBASE search:
('heart arrest'/exp/mj OR 'resuscitation'/exp/mj) AND 'corticosteroid'/exp/mj results. 347 results.

AHA Endnote database search: ("arrest" OR "CPR") AND ("adrenal" OR "glucocorticoids" OR "steroid" OR "hydrocortisone" OR "cortisone" OR "prednisolone" OR "prednisone" OR "methylprednisolone" OR "dexamethasone" OR "betamethasone"): 379 results. Titles and abstracts (where appropriate) of all results were examined for relevance. Where doubt existed the full papers were reviewed to identify relevant papers.

The reference lists of relevant papers were searched for other relevant papers. Forward searching of relevant papers was performed using SCOPUS.

2022 Search Strategy: Table 1 (below)

Explanation of search strategy approach

This search is a re-run of the last search performed for the EvUR done on this PICO in 2021. It was time restricted (Jan 14th 2021 to Nov 14th 2022) to try and identify any relevant new articles on the topic in the past year.

#	Search string (developed for the EMBASE.com platform, which includes Medline and Embase databases)	Explanation
#1	'heart arrest'/exp 'heart arrest$':ti,ab 'cardiac arrest$':ti,ab 'cardiovascular arrest$':ti,ab 'cardiopulmonary arrest'/exp 'cardiopulmonary arrest$':ti,ab 'cardio-pulmonary arrest$':ti,ab 'resuscitation'/exp rosc:ti,ab 'post-rosc':ti,ab 'post-resuscitation':ti,ab 'return of spontaneous circulation':ti,ab resuscitat*:ti,ab	**Population – Cardiac arrest** Terms related to cardiac arrest and/or ROSC should be the focus of the article, so these terms must appear in either the title or the abstract, or the article must be tagged with EMTREE terms for cardiac arrest or ROSC. Note, general terms for life support such as 'basic life support' (as used in prior search) or ''advanced cardiac life support' were considered too generic, and terms relating to CPR techniques such as chest compressions and heart massage were considered too specifically focusing on the process of CPR rather than the post-ROSC patient.
#2	#1 NOT ('animal'/exp NOT 'human'/exp OR 'nonhuman'/exp OR 'rodent'/exp OR 'animal experiment'/exp OR 'experimental animal'/exp OR rat:ti,ab OR rats:ti,ab OR mouse:ti,ab OR mice:ti,ab OR dog$:ti,ab OR pig$:ti,ab OR porcine:ti,ab OR swine:ti,ab OR chick$:ti,ab)	**Exclude non-human studies** The search results must include citations from the newborn population string, so a 'non-human studies' filter was applied to it.
#3	#2 NOT ([conference abstract]/lim OR [conference review]/lim OR [editorial]/lim OR [erratum]/lim OR [letter]/lim OR [note]/lim OR [book]/lim OR 'case report'/de)	**Exclude publication types** Conference abstracts and other ineligible study types were removed here.
#4	#3 AND [2021-2022]/py	**Date limit** The date of the last ILCOR search was 13th Jan 2021. This search string can be combined with intervention strings or other population strings to produce a final number of records.
#5	'steroid'/de 'corticosteroid'/de 'mineralocorticoid'/de corticosteroid$:ti,ab mineralocorticoid$:ti,ab steroid$:ti,ab prednisone:ti,ab prednisolone:ti,ab methylprednisolone:ti,ab fludrocortisone:ti,ab hydrocortisone:ti,ab dexamethasone:ti,ab	**Intervention terms – steroids** To identify steroid studies. These terms must appear in the title or abstract, or the article must be tagged with EMTREE terms for steroids. Note, the EMTREE terms were not exploded as that includes a large number of irrelevant interventions. Instead, studies coded directly to the steroid EMTREE term (or the corticosteroid EMTREE term, etc.) were captured, along with studies that include these terms as free text, or include the specific drugs that were included in the search for the 2015 ILCOR CoSTR (hydrocortisone was added to this set of specific drugs as it is mentioned in the 2015 Consensus on science).
#6	#4 AND #5	**Population + intervention**
#7	(((after OR post) NEAR/4 (rosc OR spontaneous OR circulation OR resuscitation OR cardiac OR arrest)):ti,ab) OR postarrest:ti,ab OR 'post-arrest':ti,ab OR 'post-rosc':ti,ab OR (surviv* NEAR/3 (cardiac OR arrest OR resuscitation OR ohca OR 'oh ca' OR ihca OR 'ih ca'))	**Post-arrest terms** This string is useful to stratify studies according to whether they include reference to post-ROSC status. However, this string could potentially exclude relevant studies, and should not be relied upon to filter the identified studies. The search was run both with and without this string – 18 more studies were included WITHOUT the string, but none of these were relevant to the PICOST.
#8	#6 AND #7	**Population + intervention + post-arrest terms**
#9	#6 NOT #8	**Population + intervention (minus + post-arrest terms)**

Database searched: EMBASE.com platform (includes Medline and EMBASE) /Cochrane Reviews /PubMed /National Clinical Trials Database and WHO International Clinical Trials Registry

Date Search Completed: Nov 14th 2022

Search Results (Number of articles identified / number identified as relevant):
Embase/Medline 17
Cochrane   449
PubMed   18
Trials Registry   9

Inclusion/Exclusion Criteria:

Inclusion – Adults (>18yrs) with non-traumatic cardiac arrest

Exclusions - Steroids given ONLY during CPR (ie. Prior to ROSC), paediatric patients, animal studies, letters, commentaries, editorials, case series, poster presentations only, journal club reviews, interim analyses.

After screening, only 1 article relevant to the PICOST was identified – this was an RCT.

Summary of Evidence Update:

Relevant Guidelines or Systematic Reviews – *None*

Organization (if relevant);Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations

RCT: *One*

Study Acronym; Author; Year Published	Aim of Study; Study Type; Study Size (N)	Patient Population	Study Intervention (# patients) / Study Comparator (# patients)	Endpoint Results (Absolute Event Rates, P value; OR or RR; & 95% CI)	Relevant 2° Endpoint (if any); Study Limitations; Adverse Events

| CORTICA; Mentzelopoulos SD, Pappa E, Malachias S, Vrettou CS, Giannopoulos A. et al. Published 2022. | **Study Aim:** To test the hypothesis that treatment with stress- dose steroids might result in improved early post-resuscitation haemodynamics, which are associated with mortality and functional out-come.

Study Type: Prospective, two-centre, randomized, double-blind, placebo-controlled, parallel-group clinical trial. | **Inclusion Criteria:** Adult patients (>18yrs) with IHCA requiring Adrenaline

ROSC for >20 min. | **Intervention:** Administration of 40mg of methylprednisolone hydrogen succinate during the first CPR cycle post-enrolment. Then 240 mg of hydrocortisone sodium succinate daily for those with post-resuscitation shock for 7 days maximum.
Comparison: Administration of normal saline during the first CPR cycle post- enrolment. Then daily saline placebo for those with post-resuscitation shock for 7 days maximum. | **1° endpoint:** Arterial blood pressure and $ScvO_2$ at 20 min and at 4, 24, 48 & 72 hours post-ROSC. In mixed-model analyses, there was no significant effect of group (ie. steroids vs placebo) on arterial pressure and $ScvO_2$.

Though ROSC was not considered as an endpoint, it is clearly relevant to the study: Rate of ROSC for steroid group was 54/98 (55.1%) and for control group was 46/86 (53.5%) (P = 0.88) ie. There was no significant difference in the rate of ROSC between the 2 groups. | Multiple 2° endpoints were evaluated, but the only one considered pertinent to this review was survival to hospital discharge with good neurological outcome, defined as Cerebral Performance Category Score of 1 or 2. To avert potential bias due to post-randomization exclusion, data from patients with no ROSC were included in the analyses of survival/neurological outcome and of non-outcome cardiac arrest variables. There were 2/80 with good neuro outcome in the steroid group and 5/89 in the control group . The HR for poor functional outcome was non- significant (P = 0.28–0.48) ie. steroids didn't improve neurological outcome.

Study Limitations: *From the perspective of relevance to this PICOST:* 1)ROSC was not an outcome. 2) There was group cross-contamination by steroids' use in 9 controls with vasopressor-refractory hemodynamic instability. *With regards to the study in general:* 3)The prediction for a possible, steroid-related increase in MAP of 17 mmHg, though evidence-based, could have been too high. The study would only have detected a large effect size. 4)Limited sample size precluding reliable evaluation of long-term outcomes & contributing to "baseline imbalances". In conjunction with Rx individualization in small study groups might partly explain the observed |

				differences in the prescribed medication. 5) Lack of determinations of cortisol levels & glucocorticoid receptor expression 6) Missing echocardiographic and NIRS (Near infra-red spectroscopy) data from >50% of the patients of both groups. **Adverse Events** There was no significant between-group difference in adverse events. AEs considered were: Hyperglycaemia +/or hypernatraemia (1-10/7 post-ROSC); infections, bleeding peptic ulcers & paresis throughout hospital stay.

Nonrandomized Trials, Observational Studies - *None*

Study Acronym; Author; Year Published	Study Type/Design; Study Size (N)	Patient Population	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/Conclusion Comment(s)
	Study Type:	**Inclusion Criteria:**	**1° endpoint:**	

Clinical trials registry: *Three*

There are 3 trials registered with Clinical Trials.govt still actively recruiting patients, that may provide evidence relevant to this PICOST. Two of these trials involve administration of steroids with other drugs:

1) Steroids, Thiamine and Ascorbic Acid during post-resuscitation period for comatose OHCA survivors (STAR trial).

A multi-centre RCT based in Korea and lead by WY Kim. Estimated to be completed in June 2023.

2) VAsopressin and STeroids in Addition to Adrenaline in Cardiac Arrest.

A randomized, placebo controlled, double blind, superiority, multi-centre clinical trial, based in Sweden & lead by Tiohundra. Commenced enrolment in 2021, estimated completion date Jan 2027.

Since both of these involve administration of a drug cocktail, they are unlikely to provide definitive evidence for the utility of steroids post cardiac arrest. The 3rd study registered on Clinical Trials however, may be more helpful since the only drug administered in the interventional arm is methylprednisolone. This is a Danish based RCT lead by Laust, involving administration of methylprednisolone compared with saline placebo, to patients with ROSC after IHCA. Recruiting commenced in May 2020, and the estimated completion date is Dec 2022. A predicted challenge with the interpretation of the evidence

that will be provided by this study, is that the primary outcomes registered are not ones relevant to cardiac arrest (eg. survival to hospital discharge, or survival with good neurological outcome) – though these are included as secondary outcomes.

Reviewer Comments: *(including whether this PICOST should have a systematic or scoping review)*
The previous 2010 COSTR concluded – *"There is insufficient evidence to support or refute the use of corticosteroids alone or in combination with other drugs during cardiac arrest."*

A 2020 EvUp identified 1 RCT comparing the administration of hydrocortisone to patients with ROSC post-IHCA[1], 1 retrospective observational study of the use of steroids post-ROSC[2], and one RCT comparing placebo with the addition of vasopressin and steroids during cardiac arrest and steroids to those with post-ROSC shock[3]. The RCT comparing only post-ROSC steroids with placebo suggested that the addition of steroids had no beneficial effect, whilst the observational study suggested possible benefit. The RCT of vasopressin and steroids also suggested benefit. The CORTICA study was identified of interest in the 2021 EvUp, but had not at that time been published. It has now been published, and, as described above, the results did not demonstrate any improvement in outcomes for the group given steroids compared to the group given saline placebo. The study did involve administration of steroids both during and after cardiac arrest, but the lack of any overall beneficial effect from the addition of steroids both intra- & post- arrest would suggest that addition of steroids post-ROSC alone is also unlikely to improve outcomes.

Therefore, at this stage, a new systematic review on the efficacy of post-ROSC steroids after cardiac arrest is probably not warranted as studies done since the last CoSTR on the topic are generally small, of different types and with varying methodology, meaning that a meta-analysis would not be feasible. It is possible that the results of the CORTICA study might support modification of the current CoSTR to a treatment recommendation similar to *"We suggest against the (?routine) addition of corticosteroids to patients who have achieved ROSC post- cardiac arrest."* However, this wouldn't actually result in a change in practice, since steroids are not routinely given either during cardiac arrest or post-ROSC.
In addition, since there are 3 trials registered with Clinical Trials.govt still actively recruiting patients, that may provide further evidence on this topic, it may be sensible to postpone consideration of a new systematic review until these studies have been completed.

Reference list:

1) Donnino, MW, Andersen, LW, Berg, KM, Chase, M, Sherwin, R, Smithline, H, Carney, E, Ngo, L, Patel, PV, Liu, X and et al. Corticosteroid therapy in refractory shock following cardiac arrest: a randomized, double-blind, placebo-controlled, trial. Critical care (London, England). 2016; 20(1). doi: 10.1186/s13054-016-1257-x

2) Tsai, MS, Chuang, PY, Huang, CH, Tang, CH, Yu, PH, Chang, WT and Chen, WJ. (2019). Post-arrest Steroid Use May Improve Outcomes of Cardiac Arrest Survivors. Critical care medicine. 47(2):167-1. DOI: 10.1097/CCM.0000000000003468

3) Mentzelopoulos SD, Malachias S, Chamos C, et al. Vasopressin, steroids and epinephrine and neurologically favourable survival after in-hospital cardiac arrest: a randomized clinical trial. JAMA. 2013;310:270-9. DOI: 10.1001/jama.2013.7832

4) Steroid, Thiamine and Ascorbic Acid During Post-Resuscitation Period for Comatose Out-of-hospital Cardiac Arrest Survivors (STAR) Trial. https://clinicaltrials.gov/show/NCT04921189.

5) VAsopressin and STeroids in Addition to Adrenaline in Cardiac Arrest - a Randomized Clinical Trial. https://clinicaltrials.gov/show/NCT05139849.

6) Steroid Treatment as Anti-inflammatory and Neuroprotective Agent Following Out-of-Hospital Cardiac Arrest. A Randomized Trial. https://clinicaltrials.gov/show/NCT04624776.
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Evidence Update Worksheet

Pad Size, Type, and Placement for Pediatric Defibrillation (PLS 378)

Worksheet author(s): Jason Acworth, Gabrielle Nuthall, Gene Ong
Task Force: Pediatric Life Support
Date Submitted to SAC rep for peer review and approval: Dec 2022
SAC rep: Dianne Atkins, Ian Maconochie

PICOST / Research Question: Pad Size, Type, and Placement for Pediatric Defibrillation (PLS 378)

Population	Among infants and children who are in ventricular fibrillation or pulseless ventricular tachycardia after out-of-hospital or in-hospital cardiac arrest (excluding newborn children)
Intervention	does any specific pad size, type, orientation or position
Comparison	compared with a different pad size, type, orientation or position
Outcomes	Any clinical outcomes, including (not exclusive) - short-term survival and neurological outcomes (e.g. survival to hospital discharge, survival at 30-days), - long-term survival and neurological outcomes (e.g. PCPC at 6-months, and 1-year). - first shock success for cardioversion/defibrillation - number of shocks required for successful electrical cardioversion / defibrillation - time to first shock
Study Design	Randomized controlled trials (RCTs) and non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies) that directly concern the population and intervention described above are eligible for inclusion. If it is anticipated that there will be insufficient studies from which to draw a conclusion, case series may be included in the initial search. The minimum number of cases for a case series to be included was set by the taskforce at 5. Unpublished studies (e.g., conference abstracts, trial protocols) are excluded.
Timeframe	All studies published since last search (December 1, 2019) and all languages are included as long as there is an English abstract

Year of last full review: 2020

Current ILCOR Consensus on Science and Treatment Recommendation for this PICOST:
These treatment recommendations (below) are unchanged from 2010. (Kleinman 2010 S466; de Caen 2010 e215)

There is insufficient evidence to alter the current recommendations to use the largest size paddles that fit an infant's or child's chest without touching each other or to recommend one paddle or pad position or type over another.

Either self-adhesive defibrillation pads or paddles may be used in infants and children in cardiac arrest.

Database searched: Embase database and indexed journals in Medline
Time Frame: Last updated 1 December 2019. New search 1 January 2019 to 20 September 2022 to include date of previous search
Date Search Completed: 20 September 2022
Search Strategies:

SEARCH STRATEGY #1: Previously utilized strategy from 2019 EvUp

PUBMED.ncbi.nlm.nih.gov
(((("pad"[Title/Abstract] OR "placement"[Title/Abstract] OR "impedance"[Title/Abstract]) AND ("life support care"[MeSH Terms] OR "life support"[Title/Abstract] OR "cardiopulmonary resuscitation"[MeSH Terms] OR "cardiopulmonary resuscitation"[Title/Abstract] OR "ROSC"[Title/Abstract] OR "return of spontaneous circulation"[Title/Abstract] OR "heart arrest"[MeSH Terms] OR "cardiac arrest"[Title/Abstract]) AND ("infan*"[Text Word] OR "child*"[Text Word] OR "adolescen*"[Text Word] OR "pediatric*"[Text Word] OR "paediatric*"[Text Word] OR "pube*"[Text Word] OR "juvenil*"[Text Word] OR "school*"[Text Word] OR "newborn*"[Title/Abstract] OR "newborn*"[Title/Abstract] OR "neonat*"[Title/Abstract] OR "neonat*"[Title/Abstract] OR "premature*"[Title/Abstract] OR "postmature*"[Title/Abstract] OR "premature*"[Title/Abstract] OR "post mature*"[Title/Abstract] OR "preterm*"[Title/Abstract] OR "preterm*"[Title/Abstract] OR "baby"[Title/Abstract] OR "babies"[Title/Abstract] OR "toddler*"[Title/Abstract] OR "youngster*"[Title/Abstract] OR "preschool*"[Title/Abstract] OR "kindergart*"[Title/Abstract] OR "kid"[Title/Abstract] OR "kids"[Title/Abstract] OR "playgroup*"[Title/Abstract] OR "play group*"[Title/Abstract] OR "playschool*"[Title/Abstract] OR "prepube*"[Title/Abstract] OR "preadolescen*"[Title/Abstract] OR "junior high*"[Title/Abstract] OR "highschool*"[Title/Abstract] OR "senior high"[Title/Abstract] OR "young people*"[Title/Abstract] OR "minors"[Title/Abstract])) NOT ("animals"[MeSH Terms] NOT "humans"[MeSH Terms])) NOT ("Letter"[Publication Type] OR "Editorial"[Publication Type] OR "Comment"[Publication Type])) AND (2019/12/1:2022/9/20[pdat])

Search Results for Search Strategy #1 (Number of articles identified and number identified as relevant):
73 articles after limit search 2019-2022
73 articles after 0 duplicates removed
0 articles after 73 excluded upon title and abstract screening

SEARCH STRATEGY #2: Revised search strategy devised in collaboration with information specialist

EMBASE.com

#1	defibrill*:ti,ab,kw
#2	'defibrillation'/de OR 'defibrillator'/de OR 'external defibrillator'/exp OR 'low energy defibrillator'/de OR 'high energy defibrillator'/de
#3	(#1 OR #2) NOT (implant*:ti OR icd:ti OR external:ti)
#4	#3 NOT ([conference abstract]/lim OR [conference review]/lim OR [editorial]/lim OR [erratum]/lim OR [letter]/lim OR [note]/lim OR [book]/lim OR 'case report'/de) AND [2019-2022]/py
#5	((young NEAR/3 (person* OR people)):ti,ab,kw) OR adolescent$:ti,ab,kw OR boy$:ti,ab,kw OR child:ti,ab,kw OR children:ti,ab,kw OR infant$:ti,ab,kw OR girl$:ti,ab,kw OR juvenile*:ti,ab,kw OR kids:ti,ab,kw OR kinder*:ti,ab,kw OR paediatric$:ti,ab,kw OR pediatric$:ti,ab,kw OR 'preadolescen*':ti,ab,kw OR 'pre-adolescen*':ti,ab,kw OR 'preschool':ti,ab,kw OR 'pre-school':ti,ab,kw OR school$:ti,ab,kw OR schoolchild*:ti,ab,kw OR student$:ti,ab,kw OR teen$:ti,ab,kw OR teenager$:ti,ab,kw OR toddler$:ti,ab,kw OR 'young people':ti,ab,kw OR 'young person':ti,ab,kw OR youth:ti,ab,kw OR youths:ti,ab,kw

#6	'adolescent'/de OR 'adolescence'/de OR 'child'/de OR 'child health care'/de OR 'child hospitalization'/de OR 'hospitalized adolescent'/de OR 'hospitalized child'/de OR 'infant'/exp OR 'pediatrics'/de OR 'pediatric advanced life support'/de OR 'pediatric emergency medicine'/de OR 'preschool child'/de OR 'school child'/de OR 'toddler'/de OR 'boy'/de OR 'girl'/de
#7	babies:ti,ab,kw OR baby:ti,ab,kw OR birth:ti,ab,kw OR neonat*:ti,ab,kw OR 'new* born':ti,ab,kw OR newborn$:ti,ab,kw OR 'post-natal':ti,ab,kw OR postnatal:ti,ab,kw OR 'post neonatal':ti,ab,kw OR postneonatal:ti,ab,kw
#8	'baby'/de OR 'delivery room'/de OR 'neonatology'/exp OR 'newborn'/de OR 'newborn care'/exp OR 'perinatal period'/de OR 'postnatal care'/de
#9	#5 OR #6 OR #7 OR #8
#10	pad$:ti,ab,kw OR paddle$:ti,ab,kw OR electrode$:ti,ab,kw OR impedance:ti,ab,kw OR place$:ti,ab,kw OR placement$:ti,ab,kw OR position*:ti,ab,kw OR size$:ti,ab,kw OR orientation:ti,ab,kw OR location$:ti,ab,kw OR type$:ti,ab,kw OR adhesive$:ti,ab,kw OR attach*:ti,ab,kw
#11	#4 AND #9 AND #10

Cochrane Library

#1	defibrill*:ti,ab,kw
#2	[mh ^"electric countershock"] OR [mh ^defibrillators]
#3	#1 OR #2
#4	((young NEAR/3 (person* OR people)):ti,ab,kw) OR adolescent*:ti,ab,kw OR boy*:ti,ab,kw OR child:ti,ab,kw OR children:ti,ab,kw OR infant*:ti,ab,kw OR girl*:ti,ab,kw OR juvenile*:ti,ab,kw OR kids:ti,ab,kw OR kinder*:ti,ab,kw OR paediatric*:ti,ab,kw OR pediatric*:ti,ab,kw OR 'preadolescen*':ti,ab,kw OR 'pre-adolescen*':ti,ab,kw OR 'preschool':ti,ab,kw OR 'pre-school':ti,ab,kw OR school*:ti,ab,kw OR schoolchild*:ti,ab,kw OR student*:ti,ab,kw OR teen*:ti,ab,kw OR teenager*:ti,ab,kw OR toddler*:ti,ab,kw OR 'young people':ti,ab,kw OR 'young person':ti,ab,kw OR youth:ti,ab,kw OR youths:ti,ab,kw
#5	babies:ti,ab,kw OR baby:ti,ab,kw OR birth:ti,ab,kw OR neonat*:ti,ab,kw OR 'new* born':ti,ab,kw OR newborn$:ti,ab,kw OR 'post-natal':ti,ab,kw OR postnatal:ti,ab,kw OR 'post neonatal':ti,ab,kw OR postneonatal:ti,ab,kw
#6	#4 OR #5
#7	pad$:ti,ab,kw OR paddle$:ti,ab,kw OR electrode$:ti,ab,kw OR impedance:ti,ab,kw OR place$:ti,ab,kw OR placement$:ti,ab,kw OR position*:ti,ab,kw OR size$:ti,ab,kw OR orientation:ti,ab,kw OR location$:ti,ab,kw OR type$:ti,ab,kw OR adhesive$:ti,ab,kw OR attach*:ti,ab,kw
#8	#3 AND #6 AND #7

Both searches limited to 2019 onwards

Search Results (Number of articles identified and number identified as relevant):
156 articles after limit search 2019-2022
153 articles after 3 duplicates removed
4 articles after 149 excluded upon title and abstract screening
0 articles included in analysis after full text review

Summary of Evidence Update:

In the 2020 Evidence Update (Maconochie 2020 S140) on the use of various pad sizes, types and placement for pediatric defibrillation, 1 new pediatric study (Tibballs 2011) was identified since 2010 examining the use of different defibrillator pad positions in children with shockable rhythms in cardiac arrest.

Our Evidence Update in 2022 did not find any new pediatric studies on the topics of defibrillator pad size, type or placement in pediatric cardiac arrest.

Relevant Guidelines or Systematic Reviews

Organization (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations
Maconochie, 2020	Guideline		3	Identified 3 observational studies but only one pediatric study (1 animal and 1 manikin study). The prospective observational pediatric study (Tibballs 2011) compared the rate of ROSC in 48 children with VF or pulseless VT who received external shock (IHCA) with pads or paddles placed in either A-P or A-L positions. Whatever position, the prevalence of ROSC was not significantly different with pads or paddles.	There is insufficient evidence to alter the current recommendations to use the largest size paddles that fit an infant's or child's chest without touching each other or to recommend one paddle or pad position or type over another.

Either self-adhesive defibrillation pads or paddles may be used in infants and children in cardiac arrest. |

RCT:

Study Acronym; Author; Year Published	Aim of Study; Study Type; Study Size (N)	Patient Population	Study Intervention (# patients) / Study Comparator (# patients)	Endpoint Results (Absolute Event Rates, P value; OR or RR; & 95% CI)	Relevant 2° Endpoint (if any); Study Limitations; Adverse Events
No new pediatric RCTs published					

Nonrandomized Trials, Observational Studies

Study Acronym; Author; Year Published	Study Type/Design; Study Size (N)	Patient Population	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/Conclusion Comment(s)

No new pediatric studies published				

Reviewer Comments: *(including whether this PICOST should have a systematic or scoping review)*

There are few pediatric specific studies on the topics of defibrillator pad size, type or placement in pediatric cardiac arrest. Our evidence update failed to
identify any new publications since the last update in 2020. Therefore, a systematic review of pediatric cardiac arrest patients is not justified
at this time.

Therefore, the ILCOR treatment recommendations from 2020 (Maconochie 2020 S140) should remain unchanged:

There is insufficient evidence to alter the current recommendations to use the largest size paddles that fit an infant's or child's chest without touching each other or to recommend one paddle or pad position or type over another.

Either self-adhesive defibrillation pads or paddles may be used in infants and children in cardiac arrest.

Reference list:

de Caen AR, 2010, e213 [https://pubmed.ncbi.nlm.nih.gov/20956041/]

Kleinman ME, 2010, S876 [https://pubmed.ncbi.nlm.nih.gov/20956230/]

Maconochie IK, 2020, S140 [https://pubmed.ncbi.nlm.nih.gov/33084393/]

Tibballs J, 2011, 14 [https://pubmed.ncbi.nlm.nih.gov/20308928/]

Evidence Update Worksheet

PLS 389 Single or Stacked Shocks for Pediatric Defibrillation

Worksheet author(s): Jason Acworth, Gabrielle Nuthall, Gene Ong
Task Force: Pediatric Life Support
Date Submitted to SAC rep for peer review and approval: Dec 2022
SAC rep: Dianne Atkins, Ian Maconochie

PICOST / Research Question: Single or Stacked Shocks for Pediatric Defibrillation (PLS 389)

Population	Infants and children who are in ventricular fibrillation or pulseless ventricular tachycardia after out-of-hospital or in-hospital cardiac arrest (excluding newborn children)
Intervention	more than one shock for the initial or subsequent defibrillation attempt(s) within the algorithm
Comparison	a single shock for each defibrillation attempt
Outcomes	Clinical outcomes, including - short-term survival and neurological outcomes (e.g. survival to hospital discharge, survival at 30-days), - long-term survival and neurological outcomes (e.g. PCPC at 6-months, and 1-year).
Study Design	Randomized controlled trials (RCTs) and non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies) that directly concern the population and intervention described above are eligible for inclusion. If it is anticipated that there will be insufficient studies from which to draw a conclusion, case series may be included in the initial search. The minimum number of cases for a case series to be included was set by the taskforce at 5. Unpublished studies (e.g., conference abstracts, trial protocols) are excluded.
Timeframe	All studies published since last search (December 1, 2019) and all languages are included as long as there is an English abstract

Year of last full review: 2020

Current ILCOR Consensus on Science and Treatment Recommendation for this PICOST:
There are no randomized controlled studies examining a single versus sequential (stacked) shock strategy in children with ventricular fibrillation (VF) or pulseless ventricular tachycardia (pVT).

A single-shock strategy followed by immediate CPR (beginning with chest compressions) is recommended for children with out-of-hospital or in-hospital VF or pVT. (Kleinman 2010 S466; de Caen 2010 e215)

Database searched: Embase database and indexed journals in Medline

Time Frame: Last updated 1 December 2019. New search 1 January 2019 to 20 September 2022 to include date of previous search.
Date Search Completed: 20 September 2022

Search Strategies:

SEARCH STRATEGY #1: Previously utilized strategy from 2019 EvUp

PUBMED.ncbi.nlm.nih.gov
(((("stacked"[Title/Abstract] OR "shock*"[Title/Abstract] OR "three shocks"[Title/Abstract] OR "two shocks"[Title/Abstract] OR "defibrillation"[Title/Abstract] OR "successive"[Title/Abstract] OR "sequen*"[Title/Abstract] OR "charg*"[Title/Abstract]) AND 2019/12/01:2022/09/20[Date - Publication] AND ("life support care"[MeSH Terms] OR "life support"[Title/Abstract] OR "cardiopulmonary resuscitation"[MeSH Terms] OR "cardiopulmonary resuscitation"[Title/Abstract] OR "ROSC"[Title/Abstract] OR "return of spontaneous circulation"[Title/Abstract] OR "heart arrest"[MeSH Terms] OR "cardiac arrest"[Title/Abstract]) AND ("infan*"[Text Word] OR "child*"[Text Word] OR "adolescen*"[Text Word] OR "pediatric*"[Text Word] OR "paediatric*"[Text Word] OR "pube*"[Text Word] OR "juvenil*"[Text Word] OR "school*"[Text Word] OR "newborn*"[Title/Abstract] OR "newborn*"[Title/Abstract] OR "neonat*"[Title/Abstract] OR "neonat*"[Title/Abstract] OR "premature*"[Title/Abstract] OR "postmature*"[Title/Abstract] OR "premature*"[Title/Abstract] OR "post mature*"[Title/Abstract] OR "preterm*"[Title/Abstract] OR "preterm*"[Title/Abstract] OR "baby"[Title/Abstract] OR "babies"[Title/Abstract] OR "toddler*"[Title/Abstract] OR "youngster*"[Title/Abstract] OR "preschool*"[Title/Abstract] OR "kindergart*"[Title/Abstract] OR "kid"[Title/Abstract] OR "kids"[Title/Abstract] OR "playgroup*"[Title/Abstract] OR "play group*"[Title/Abstract] OR "playschool*"[Title/Abstract] OR "prepube*"[Title/Abstract] OR "preadolescen*"[Title/Abstract] OR "junior high*"[Title/Abstract] OR "highschool*"[Title/Abstract] OR "senior high"[Title/Abstract] OR "young people*"[Title/Abstract] OR "minors"[Title/Abstract]) AND 2019/12/01:2022/09/20[Date - Publication]) NOT ("animals"[MeSH Terms] NOT "humans"[MeSH Terms])) NOT ("Letter"[Publication Type] OR "Editorial"[Publication Type] OR "Comment"[Publication Type])) AND (2019/12/1:2022/9/20[pdat])

Search Results for Search Strategy #1 (Number of articles identified and number identified as relevant):
418 articles after limit search 2019-2022
417 articles after 1 duplicate removed
14 articles after 403 excluded upon title and abstract screening
0 articles included in analysis after full text review

SEARCH STRATEGY #2: Revised search strategy devised in collaboration with information specialist

EMBASE.com

#1	defibrill*:ti,ab,kw
#2	'defibrillation'/de OR 'defibrillator'/de OR 'external defibrillator'/exp OR 'low energy defibrillator'/de OR 'high energy defibrillator'/de
#3	(#1 OR #2) NOT (implant*:ti OR icd:ti OR external:ti)
#4	#3 NOT ([conference abstract]/lim OR [conference review]/lim OR [editorial]/lim OR [erratum]/lim OR [letter]/lim OR [note]/lim OR [book]/lim OR 'case report'/de) AND [2019-2022]/py
#5	((young NEAR/3 (person* OR people)):ti,ab,kw) OR adolescent$:ti,ab,kw OR boy$:ti,ab,kw OR child:ti,ab,kw OR children:ti,ab,kw OR infant$:ti,ab,kw OR girl$:ti,ab,kw OR juvenile*:ti,ab,kw OR kids:ti,ab,kw OR kinder*:ti,ab,kw OR paediatric$:ti,ab,kw OR pediatric$:ti,ab,kw OR 'preadolescen*':ti,ab,kw OR 'pre-adolescen*':ti,ab,kw OR 'preschool':ti,ab,kw OR 'pre-school':ti,ab,kw OR school$:ti,ab,kw OR schoolchild*:ti,ab,kw OR student$:ti,ab,kw

	OR teen$:ti,ab,kw OR teenager$:ti,ab,kw OR toddler$:ti,ab,kw OR 'young people':ti,ab,kw OR 'young person':ti,ab,kw OR youth:ti,ab,kw OR youths:ti,ab,kw
#6	'adolescent'/de OR 'adolescence'/de OR 'child'/de OR 'child health care'/de OR 'child hospitalization'/de OR 'hospitalized adolescent'/de OR 'hospitalized child'/de OR 'infant'/exp OR 'pediatrics'/de OR 'pediatric advanced life support'/de OR 'pediatric emergency medicine'/de OR 'preschool child'/de OR 'school child'/de OR 'toddler'/de OR 'boy'/de OR 'girl'/de
#7	babies:ti,ab,kw OR baby:ti,ab,kw OR birth:ti,ab,kw OR neonat*:ti,ab,kw OR 'new* born':ti,ab,kw OR newborn$:ti,ab,kw OR 'post-natal':ti,ab,kw OR postnatal:ti,ab,kw OR 'post neonatal':ti,ab,kw OR postneonatal:ti,ab,kw
#8	'baby'/de OR 'delivery room'/de OR 'neonatology'/exp OR 'newborn'/de OR 'newborn care'/exp OR 'perinatal period'/de OR 'postnatal care'/de
#9	#5 OR #6 OR #7 OR #8
#10	(shock OR shocks OR charge OR charges OR charged OR charging) NEAR/4 (one OR single OR multiple OR consecutive OR successive OR sequence OR sequential OR two OR three OR four OR many OR number OR stack OR stacks OR stacked)
#11	#4 AND #9 AND #12

Cochrane Library

#1	defibrill*:ti,ab,kw
#2	[mh ^"electric countershock"] OR [mh ^defibrillators]
#3	#1 OR #2
#4	((young NEAR/3 (person* OR people)):ti,ab,kw) OR adolescent*:ti,ab,kw OR boy*:ti,ab,kw OR child:ti,ab,kw OR children:ti,ab,kw OR infant*:ti,ab,kw OR girl*:ti,ab,kw OR juvenile*:ti,ab,kw OR kids:ti,ab,kw OR kinder*:ti,ab,kw OR paediatric*:ti,ab,kw OR pediatric*:ti,ab,kw OR 'preadolescen*':ti,ab,kw OR 'pre-adolescen*':ti,ab,kw OR 'preschool':ti,ab,kw OR 'pre-school':ti,ab,kw OR school*:ti,ab,kw OR schoolchild*:ti,ab,kw OR student*:ti,ab,kw OR teen*:ti,ab,kw OR teenager*:ti,ab,kw OR toddler*:ti,ab,kw OR 'young people':ti,ab,kw OR 'young person':ti,ab,kw OR youth:ti,ab,kw OR youths:ti,ab,kw
#5	babies:ti,ab,kw OR baby:ti,ab,kw OR birth:ti,ab,kw OR neonat*:ti,ab,kw OR 'new* born':ti,ab,kw OR newborn$:ti,ab,kw OR 'post-natal':ti,ab,kw OR postnatal:ti,ab,kw OR 'post neonatal':ti,ab,kw OR postneonatal:ti,ab,kw
#6	#4 OR #5
#7	(shock OR shocks OR charge OR charges OR charged OR charging) NEAR/4 (one OR single OR multiple OR consecutive OR successive OR sequence OR sequential OR two OR three OR four OR many OR number OR stack OR stacks OR stacked)
#8	#3 AND #6 AND #9

Both searches limited to 2019 onwards

Search Results (Number of articles identified and number identified as relevant):
16 articles after limit search 2019-2022
15 articles after 1 duplicate removed
0 articles after 15 excluded upon title and abstract screening

Summary of Evidence Update:
In the 2020 Evidence Update (Maconochie 2020 S140), there were no new pediatric studies since 2010 on the comparative clinical outcomes from the use of single defibrillation versus more than one shock for the initial or subsequent defibrillation attempt(s) in children with shockable rhythms in cardiac arrest, in any setting. They identified a single observational study on transthoracic impedence during defibrillation in children 8 years or more (n=5) which suggested that stacked-shocks may not improve defibrillation success. (Niles 2010 1540)

Our Evidence Update in 2022 did not find any new paediatric studies on this subject. As in the previous evidence update, we identified a number of adult studies, but these were excluded in view of the differences in physiology and pathophysiology of shockable rhythms in paediatric cardiac arrests and may not be extrapolatable to the paediatric population.

Relevant Guidelines or Systematic Reviews

Organization (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations
Maconochie, 2020	Guideline		0	No new paediatric studies	A single-shock strategy followed by immediate CPR (beginning with chest compressions) is recommended for children with out-of-hospital or in-hospital VF or pVT.

RCT:

Study Acronym; Author; Year Published	Aim of Study; Study Type; Study Size (N)	Patient Population	Study Intervention (# patients) / Study Comparator (# patients)	Endpoint Results (Absolute Event Rates, P value; OR or RR; & 95% CI)	Relevant 2° Endpoint (if any); Study Limitations; Adverse Events
No new pediatric RCTs published					

Nonrandomized Trials, Observational Studies

Study Acronym; Author; Year Published	Study Type/Design; Study Size (N)	Patient Population	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/Conclusion Comment(s)
No new pediatric studies published				

Reviewer Comments: *(including whether this PICOST should have a systematic or scoping review)*

Despite a number of recent adult studies comparing single versus stacked shocked in very selected settings, there remains very little pediatric specific evidence in this area. Our evidence update failed to identify any new publications since the last update in 2020. Therefore, a systematic review of pediatric cardiac arrest patients is not justified at this time.

Therefore, the ILCOR treatment recommendations from 2020 (Maconochie 2020 S140) should remain unchanged:

A single-shock strategy followed by immediate CPR (beginning with chest compressions) is recommended for children with out-of-hospital or in-hospital VF or pVT.

Reference list:

de Caen AR, 2010, e213 [https://pubmed.ncbi.nlm.nih.gov/20956041/]

Kleinman ME, 2010, S876 [https://pubmed.ncbi.nlm.nih.gov/20956230/]

Maconochie IK, 2020, S140 [https://pubmed.ncbi.nlm.nih.gov/33084393/]

Niles DE, 2010, 1540 [https://pubmed.ncbi.nlm.nih.gov/20708836/]

Evidence Update Worksheet

Resuscitation of the pediatric patient with a single ventricle, post Stage I repair (PLS 390)

Worksheet author(s): Tia Raymond

Collaborators: David Kloeck, Thomaz Couto, Ian Maconochie
Task Force: Pediatric Life Support
Date Submitted to SAC rep for peer review and approval: December 2022
SAC rep: Dianne Atkins, Ian Maconochie

PICOST / Research Question:
- Population: (P) Infants and children with single-ventricle, status-post Stage I repair who require resuscitation from cardiac arrest
- Intervention: (I) Any specific modification to standard practice
- Comparison: (C) Standard resuscitation practice
- Outcome: (O) ROSC, survival to discharge, survival with good neurological outcome
- Study Design: Included only observational studies and RCTs from the time of the previous search review
- Time Frame: All years and languages were included if there was an English abstract. The literature search was from January 2008 to July 2022.

Type (intervention, diagnosis, prognosis): Intervention

Additional Evidence Reviewer(s): None

Conflicts of Interest (financial/intellectual, specific to this question):
T Raymond is a paid consultant for New England Research Institutes, Inc., a wholly owned subsidiary of HealthCore, Inc., for the Pediatric Heart Network COMPASS study as an adjudicator for this NHLBI-sponsored prospective, multicenter, randomized trial of BT shunt vs. PDA stent for single ventricle patients.

Year of last full review: No scoping or systematic review ever done.

Year of last review: 2020 Evidence Update performed by AHA: Tia Raymond (worksheet author):

Current ILCOR Consensus on Science and Treatment Recommendation for this PICOST (PLS 390 EvUp): 2020

This EvUp was performed to identify any evidence published after the most recent PLS Task Force review in 2010.[1,2] The EvUp identified nonrandomized studies reporting the impact of modification to standard cardiac arrest care on outcomes in postsurgical
infants. The PLS Task Force agreed that this and additional evidence[3,4] may warrant consideration for a SysRev. Until a new SysRev is performed and analyzed by the PLS Task Force, the 2010 treatment recommendations remain in effect. These treatment recommendations are unchanged from 2010.[1,2]

Standard resuscitation (pre-arrest and arrest) procedures should be followed for infants and children with single-ventricle anatomy after stage I repair. Neonates with a single ventricle before stage I repair who demonstrate shock caused by elevated pulmonary to systemic flow ratio might benefit from inducing mild hypercarbia ($PaCO_2$ 50–60 mm Hg); this can be achieved during mechanical ventilation by reducing minute ventilation, adding CO_2 to inspired air, or administering opioids with or without chemical paralysis.

Current ILCOR Evidence Update 2022: This EvUp was performed to identify any evidence published after the most recent PLS Task Force review in 2020. The search strategy was updated to include single ventricle patients who may undergo surgical palliation with pulmonary artery banding (PAB) and/or non-surgical repair in the cardiac catheterization laboratory to include patent ductus arteriosus (PDA) stent (Hybrid palliation).

2019 Search Strategy: ((((((("cardiopulmonary resuscitation"[All Fields] OR "heart arrest"[All Fields] OR "prearrest"[All Fields] OR "near arrest"[All Fields] OR "ECPR"[All Fields] OR "Extracorporeal cardiopulmonary resuscitation"[All Fields]) AND ("heart defects, congenital"[All Fields] OR "hypoplastic left heart syndrome"[All Fields] OR "single ventricle"[All Fields] OR "univentricular"[All Fields] OR "Norwood"[All Fields] OR "BT shunt"[All Fields] OR "Sano"[All Fields] OR "Stage 1 repair"[All Fields])) AND ("neonate"[All Fields] OR "infant"[All Fields] OR "child"[All Fields] OR "pediatric"[All Fields])) OR ("venous saturation"[All Fields] OR "cerebral oxygenation"[All Fields] OR "near infrared spectroscopy"[All Fields] OR "low cardiac output"[All Fields] OR "alpha adrenergic blockade"[All Fields] OR "hypercarbia "[All Fields])) AND ("heart defects, congenital"[All Fields] OR "hypoplastic left heart syndrome"[All Fields] OR "single ventricle"[All Fields] OR "univentricular"[All Fields] OR "norwood"[All Fields] OR "bt shunt"[All Fields] OR "sano"[All Fields] OR "stage 1 repair"[All Fields])) AND ("neonate"[All Fields] OR "infant"[All Fields] OR "child"[All Fields] OR "pediatric"[All Fields])) AND ("2008/01/01"[PDAT] : "2019/10/26"[PDAT]) AND "observational study"[Publication Type] OR "randomized control"[Publication Type]

Database searched: Pubmed

Date Search Completed: 1/1/2008-10/26/2019

Search Results (Number of articles identified / number identified as relevant): 26/5+2
Inclusion/Exclusion Criteria: Included only observational and RCT from 1/1/2008-10/25/2019. Excluded studies involving subsequent surgical repairs (Stages 2 and 3), adults, non-single ventricle repairs, case reports, review articles, and editorials. Also searched "see related articles" in PubMed for relevant articles; hit =1.

Link to Article Titles and Abstracts (if available on PubMed):

https://pubmed.ncbi.nlm.nih.gov/27806964/
https://pubmed.ncbi.nlm.nih.gov/27755397/
https://pubmed.ncbi.nlm.nih.gov/27174513/
https://pubmed.ncbi.nlm.nih.gov/24403349/
https://pubmed.ncbi.nlm.nih.gov/24138790/
https://pubmed.ncbi.nlm.nih.gov/31404548/
https://pubmed.ncbi.nlm.nih.gov/28012642/

2022 Search Strategy: Reran search including dates since previous search in 2019 with new additional search terms *italicized.*

((("cardiopulmonary resuscitation"[All Fields] OR "heart arrest"[All Fields] OR "prearrest"[All Fields] OR "near arrest"[All Fields] OR "ECPR"[All Fields] OR "Extracorporeal cardiopulmonary resuscitation"[All Fields] *OR "extracorporeal membrane oxygenation"[All Fields] OR "ECLS"[All Fields] OR "ECMO"[All Fields])* AND ("heart defects, congenital"[All Fields] OR "hypoplastic left heart syndrome"[All Fields] OR "single ventricle"[All Fields] OR "univentricular"[All Fields] OR "Norwood"[All Fields] OR "BT shunt"[All Fields] OR "Sano"[All Fields] OR "Stage 1 repair"[All Fields]) *OR "PA band"[all fields] OR "pulmonary artery band"[all fields] OR "PDA stent" [all fields] OR "patent ductus arteriosus stent"[all fields] OR "hybrid procedure"[all fields]* AND ("neonate"[All Fields] OR "infant"[All Fields] OR "child"[All Fields] OR "pediatric"[All Fields])) OR ((("venous saturation"[All Fields] OR "cerebral oxygenation"[All Fields] OR "near infrared spectroscopy"[All Fields] OR "low cardiac output"[All Fields] OR "alpha adrenergic blockade"[All Fields] OR "hypercarbia "[All Fields]) AND ("heart defects, congenital"[All Fields] OR "hypoplastic left heart syndrome"[All Fields] OR "single ventricle"[All Fields] OR "univentricular"[All Fields] OR "norwood"[All Fields] OR "bt shunt"[All Fields] OR "sano"[All Fields] OR "stage 1 repair"[All

Fields]) *OR "PA band"[all fields] OR "pulmonary artery band"[all fields] OR "PDA stent" [all fields] OR "patent ductus arteriosus stent"[all fields]* AND ("neonate"[All Fields] OR "infant"[All Fields] OR "child"[All Fields] OR "pediatric"[All Fields]))) AND "observational study"[Publication Type] OR "randomized control"[Publication Type] - Saved search Filters: from 2008/1/1 - 2022/7/18 Sort by: Most Recent

Database searched: PubMed

Date Search Completed: July 18, 2022

Search Results (Number of articles identified / number identified as relevant): 77/7 (above 2019 search) + 4

Link to Article Titles and Abstracts (if available on PubMed):
https://pubmed.ncbi.nlm.nih.gov/23818569/

Found in similar articles section:
https://pubmed.ncbi.nlm.nih.gov/21507672/
https://pubmed.ncbi.nlm.nih.gov/22698774/
https://pubmed.ncbi.nlm.nih.gov/27885446/

Summary of Evidence Update:
Insufficient new evidence to justify a systematic or scoping review. New studies unlikely to change current TR.

Relevant Guidelines or Systematic Reviews

Organization (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations
ILCOR 2020 (AHA EvUp): Raymond, T	EvUp	**PICO / Research Question:** "For infants and children with single ventricle, s/p stage I repair, who require resuscitation from cardiac arrest or pre-arrest states (prehospital [OHCA] or in-hospital [IHCA]) (P), does any specific modification to standard	7 observational studies	Neonates s/p Stage I repair for functional single ventricle are at increased risk of cardiac arrest both pre-operatively and post-operatively compared to non-cardiac patients, cardiac patients with bi-ventricular physiology, and patients s/p other cardiac surgical procedures of less complexity. From this evidence review, the only known modification to standard practice for this population that	Standard resuscitation (pre-arrest and arrest) procedures should be followed for infants and children with single-ventricle anatomy after stage I repair. Neonates with a single ventricle before stage I repair who demonstrate shock caused by elevated pulmonary to systemic flow ratio might benefit from inducing mild hypercarbia (Pa_{CO_2} 50–60 mm Hg); this can be achieved during mechanical ventilation by reducing minute ventilation, adding CO_2 to inspired air, or administering opioids with

| | | practice (I) compared with standard resuscitation practice (C) improve outcome (e.g. ROSC, survival to discharge, survival with good neurologic outcome)(O)?" **Outcomes:** ROSC, survival to discharge, survival with good neurologic outcome | | improves outcomes in the arrest state is the rapid institution of extracorporeal cardiopulmonary support instituted in the setting of a cardiac arrest (ECPR) that is recalcitrant to standard CPR. Alfousi (2014) reports 37% of the SV group having ECPR, with decannulation and survival rates of 55% and 32%. The SV-ECMO outcomes were best in ECPR subgroup (54%), following shunt (57%) or Norwood (46%) with improved odds of survival in multivariable analysis for ECPR in patients with SV (OR: 11.84, CI: 1.11-126.07, P = .04). There are no data in the setting of HLHS receiving heparin administration during CPR for an arrest of unknown etiology (particularly if shunt blockage is suspected), however following general guidelines for significant vascular occlusion, it may be worth considering administering an intravenous bolus of unfractionated heparin (dose 100 U/kg if not concurrently receiving heparin, otherwise bolus | or without chemical paralysis. |

| | | | | dose 50 U/kg) (based on cardiac catheter guideline recommendations for antithrombotic therapy for suspected acute shunt thrombosis). | |

RCT

Study Acronym; Author; Year Published	Aim of Study; Study Type; Study Size (N)	Patient Population	Study Intervention (# patients) / Study Comparator (# patients)	Endpoint Results (Absolute Event Rates, P value; OR or RR; & 95% CI)	Relevant 2° Endpoint (if any); Study Limitations; Adverse Events
No new RCTs identified	Study Aim: Study Type:	Inclusion Criteria:	Intervention: Comparison:	1° endpoint:	Study Limitations:

Nonrandomized Trials, Observational Studies

Study Acronym; Author; Year Published	Study Type/Design; Study Size (N)	Patient Population	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/Conclusion Comment(s)
Results of rapid-response ECPR Alsoufi et al. 2014	Retrospective, observational	children requiring postoperative ECPR (2007-12) 39 children with 13 (33%) SV patients.	Survival rates for single- vs two-ventricle pathology patients were 54% and 35%, (P=0.25)	ECPR plays a valuable role in children having refractory postoperative cardiac arrest. Survival is unrelated to cardiac physiology or surgical complexity. Timely support prior to the emergence of end-organ injury and surgical correction of residual cardiac lesions might enhance survival.
Does Single Ventricle physiology affect Alsoufi et al. 2014	Retrospective, observational	100 consecutive children requiring postoperative ECMO (2007-2012)	The ECMO indication was failure to wean cardiopulmonary bypass (34%) and postoperative low cardiac output (66%) including 37%	ECMO is valuable in patients with SV however results depend on anatomy, procedure, and support indication. Persistent markers of poor perfusion, end-organ injury, and prolonged ECMO duration are associated with mortality. Those factors could be modified by early ECMO application before organ damage, meticulous homeostasis to ensure adequate perfusion, early diagnosis, and

			having extracorporeal cardiopulmonary resuscitation (ECPR). In SV group, decannulation and survival rates were 55% and 32%. The SV-ECMO outcomes were best in ECPR subgroup (54%), following shunt (57%) or Norwood (46%). On multivariable analysis, factors affecting odds of survival were: ECPR in patients with SV (OR: 11.84, CI: 1.11-126.07, P = .04).	reoperation on residual lesions to expedite weaning.
Post-cardiotomy extracorporeal cardiopulmonary Polimenakos et al. 2011	Retrospective, observational	48 patients who required post-cardiotomy ECMO (2007-2009); 27 were neonates with 20 FSV and 14 requiring ECPR.	Survival to ECMO discontinuation was 79% (11 of 14 patients) and at hospital discharge was 57% (8 of 14 patients).	ECMO support in neonates with FSV requiring ECPR can result in favorable outcome in more than half of patients at hospital discharge. Aggressive strategy toward timely application of ECPR is justified. Expeditious ECPR deployment after proper patients' selection, refinement of CPR quality and use of adjunctive neuroprotective interventions, such as induced hypothermia, might further improve outcomes.
Post-cardiotomy Rescue Extracorporeal Polimenakos et al. 2016	Retrospective, observational	58 patients who required post-cardiotomy ECMO (January 2007–December 2011). 41 were neonates, 32 had FSV and 21 had ECPR.	Survival to ECMO discontinuation was 72% (15 of 21 patients) and at hospital discharge 62% (13 of 21 patients). At last follow-up (median: 22 months; IQR25–75: 3–36), 47% of	Rescue post-cardiotomy ECMO support in neonates with FSV carries significant late attrition. ECMO duration and failure in lactate clearance after deployment are associated with unfavorable outcome. Emphasis on CPR quality, refinement of management directives early during ECMO and aggressive early identification of patients requiring heart transplantation might improve late survival.

			patients were alive.	

Reviewer Comments (including whether meet criteria for formal review):

On July 18, 2022, an Evidence Update was performed by the PLS task force following revision of the original search strategy to include single ventricle patients who may undergo surgical palliation with pulmonary artery banding (PAB) and/or non-surgical repair in the cardiac catheterization laboratory to include patent ductus arteriosus (PDA) stent (Hybrid palliation). No new RCTs were identified. Four additional publications fulfilled inclusion criteria; however, none would change the current treatment recommendations of standard resuscitation procedures for infants and children with single-ventricle anatomy after stage I repair.

There is some evidence for the use of ECMO in post cardiotomy SV patients, and ECPR use in SV patients, but that topic should be included in the SR on ECPR by the ALS with PLS input.

The task force did not identify sufficient new data to proceed to full systematic review.

The PLS task force recommendations from 2020 for the pediatric population therefore remain unchanged in 2022

Reference list

1. Kleinman ME, de Caen AR, Chameides L, Atkins DL, Berg RA, Berg MD, Bhanji F, Biarent D, Bingham R, Coovadia AH, et al.; on behalf of the Pediatric Basic and Advanced Life Support Chapter Collaborators. Part 10: pediatric basic and advanced life support: 2010 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations.Circulation. 2010; 122(suppl 2):S466–S515.
2. de Caen AR, Kleinman ME, Chameides L, Atkins DL, Berg RA, Berg MD, Bhanji F, Biarent D, Bingham R, Coovadia AH, et al.; on behalf of the Paediatric Basic and Advanced Life Support Chapter Collaborators. Part 10: paediatric basic and advanced life support: 2010 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations.Resuscitation. 2010; 81(suppl 1):e213–e259.
3. Marino BS, Tabbutt S, MacLaren G, Hazinski MF, Adatia I, Atkins DL, Checchia PA, DeCaen A, Fink EL, Hoffman GM, Jefferies JL, Kleinman M, Krawczeski CD, Licht DJ, Macrae D, Ravishankar C, Samson RA, Thiagarajan RR, Toms R, Tweddell J, Laussen PC; American Heart Association Congenital Cardiac Defects Committee of the Council on Cardiovascular Disease in the Young; Council on Clinical Cardiology; Council on Cardiovascular and Stroke Nursing; Council on Cardiovascular Surgery and Anesthesia; and Emergency Cardiovascular Care Committee. Cardiopulmonary resuscitation in infants and children with cardiac disease: a scientific statement from the American Heart Association.Circulation. 2018; 137:e691–e782.
4. Jolley M, Thiagarajan RR, Barrett CS, Salvin JW, Cooper DS, Rycus PT, Teele SA. Extracorporeal membrane oxygenation in patients undergoing superior cavopulmonary anastomosis.J Thorac Cardiovasc Surg. 2014; 148:1512–1518.
5. Alsoufi B, Awan A, Manlhiot C, Al-Halees Z, Al-Ahmadi M, McCrindle BW, Alwadai A. Does single ventricle physiology affect survival of children requiring extracorporeal membrane oxygenation support following cardiac surgery? World J Pediatr Congenit Heart Surg. 2014 Jan 1;5(1):7-15.
6. Alsoufi B, Awan A, Manlhiot C, Guechef A, Al-Halees Z, Al-Ahmadi M, McCrindle BW, Kalloghlian A. Results of rapid-response extracorporeal cardiopulmonary resuscitation in children with refractory cardiac arrest following cardiac surgery. Eur J Cardiothorac Surg. 2014 Feb;45(2):268-75.

7. Polimenakos AC, Wojtyla P, Smith PJ, Rizzo V, Nater M, El Zein CF, Ilbawi MN. Post-cardiotomy extracorporeal cardiopulmonary resuscitation in neonates with complex single ventricle: analysis of outcomes. Eur J Cardiothorac Surg. 2011 Dec;40(6):1396-405; discussion 1405.
8. Polimenakos AC, Rizzo V, El-Zein CF, Ilbawi MN. Post-cardiotomy Rescue Extracorporeal Cardiopulmonary Resuscitation in Neonates with Single Ventricle After Intractable Cardiac Arrest: Attrition After Hospital Discharge and Predictors of Outcome. Pediatr Cardiol. 2017 Feb;38(2):314-323.

Evidence Update Worksheet

Pulse Check Accuracy in pediatrics during resuscitation (PLS 393)

Worksheet author(s): Jason Acworth, Gabrielle Nuthall, Gene Ong
Task Force: Pediatric Life Support
Date Submitted to SAC rep for peer review and approval: Dec 2022
SAC rep: Dianne Atkins, Ian Maconochie

PICOST / Research Question: Pulse Check Accuracy (PLS 393)

Population	Infants and children in any setting (out of hospital or in-hospital)
Intervention	pulse check as per current guidelines by healthcare providers (brachial pulse for infants and carotid pulse for children and adolescents) in out-of-hospital and in-hospital settings
Comparison	any other site for pulse check (eg. femoral pulse, etc) OR method (not exclusively, cardiac auscultation, pulse oximetry, ultrasonography, rise in end-tidal values above specific thresholds, invasive monitoring, etc)
Outcomes	accuracy of detecting a perfusing rhythm
Study Design	STEP 1: Randomized controlled trials (RCTs) and non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies) that directly concern the population and intervention described above are eligible for inclusion. If it is anticipated that there will be insufficient studies from which to draw a conclusion, case series may be included in the initial search. The minimum number of cases for a case series to be included was set by the taskforce at 5. Unpublished studies (e.g., conference abstracts, trial protocols) are excluded. STEP 2: The same study designs and/or existing systematic or scoping reviews not directly concerning the population or intervention defined above but considered informative as additional evidence – taking into account severe indirectness- for the development of the final taskforce insights.
Timeframe	For STEP 1, all languages are included as long as there is an English abstract. We searched articles from 2019 onwards. For STEP 2, if a systematic or scoping review of high quality (as per AMSTAR 2 tool) is identified, search can be limited to beyond data and/or scope of that review.

Year of last full review: 2020

Current ILCOR Consensus on Science and Treatment Recommendation for this PICOST:
Palpation of a pulse (or its absence) is not reliable as the sole determinant of cardiac arrest and need for chest compressions. If the victim is unresponsive, not breathing normally, and there are no signs of life, lay rescuers should begin CPR.
In infants and children with no signs of life, healthcare providers should begin CPR unless they can definitely palpate a pulse within 10 seconds. (Kleinman 2010 S466; de Caen 2010 e215)

Database searched: Embase database and indexed journals in Medline

Time Frame: Last updated 1 December 2019. New search 1 January 2019 to 11 August 2022 to include the date of previous search
Date Search Completed: 11 August 2022

Search Strategies:

SEARCH STRATEGY #1: Previously utilized strategy from 2019 EvUp

PUBMED.ncbi.nlm.nih.gov
((((("pulse"[MeSH Terms] OR "heart rate"[MeSH Terms] OR "pulse"[Title/Abstract] OR "pulse check"[Title/Abstract] OR "gasp*"[Title/Abstract]) AND (("infan*"[Text Word] OR "child*"[Text Word] OR "adolescen*"[Text Word] OR "pediatric*"[Text Word] OR "paediatric*"[Text Word] OR "pube*"[Text Word] OR "juvenil*"[Text Word] OR "school*"[Text Word] OR "newborn*"[Title/Abstract] OR "new born*"[Title/Abstract] OR "neo nat*"[Title/Abstract] OR "neonat*"[Title/Abstract] OR "premature*"[Title/Abstract] OR "postmature*"[Title/Abstract] OR "pre mature*"[Title/Abstract] OR "post mature*"[Title/Abstract] OR "preterm*"[Title/Abstract] OR "pre term*"[Title/Abstract] OR "baby"[Title/Abstract] OR "babies"[Title/Abstract] OR "toddler*"[Title/Abstract] OR "youngster*"[Title/Abstract] OR "preschool*"[Title/Abstract] OR "kindergart*"[Title/Abstract] OR "kid"[Title/Abstract] OR "kids"[Title/Abstract] OR "playgroup*"[Title/Abstract] OR "play group*"[Title/Abstract] OR "playschool*"[Title/Abstract] OR "prepube*"[Title/Abstract] OR "preadolescen*"[Title/Abstract] OR "junior high*"[Title/Abstract] OR "highschool*"[Title/Abstract] OR "senior high"[Title/Abstract] OR "young people*"[Title/Abstract] OR "minors"[Title/Abstract]) NOT ("animals"[MeSH Terms] NOT ("humans"[MeSH Terms] AND "animals"[MeSH Terms]))) AND ("life support care"[MeSH Terms] OR "life support"[Title/Abstract] OR "cardiopulmonary resuscitation"[MeSH Terms] OR "cardiopulmonary resuscitation"[Title/Abstract] OR "ROSC"[Title/Abstract] OR "return of spontaneous circulation"[Title/Abstract] OR "heart arrest"[MeSH Terms] OR "cardiac arrest"[Title/Abstract])) NOT ("animals"[MeSH Terms] NOT "humans"[MeSH Terms])) NOT ("Letter"[Publication Type] OR "Editorial"[Publication Type] OR "Comment"[Publication Type])) AND 2019/12/01:2022/08/11[Date - Publication]) AND (2019/12/1:2022/8/11[pdat])

Search Results for Search Strategy #1 (Number of articles identified and number identified as relevant):
148 articles after limit search 2019-2022
137 articles after 11 duplicates removed
13 articles after 124 excluded upon title and abstract screening
0 articles included in analysis after full text review

SEARCH STRATEGY #2: Revised search strategy devised in collaboration with information specialist

EMBASE.com

#1	((pulse NEAR/3 (find OR feel OR feeling OR finger$ OR manual OR check$ OR checking OR take OR taking OR assess*)):ti) OR (palpation:ti AND pulse:ti) OR 'perfusing rythm':ti OR 'brachial pulse':ti OR 'carotid pulse':ti OR 'femoral pulse':ti
#2	(pulse NEAR/3 detect*):ti
#3	'cardiac activity':ti
#4	predict*:ti OR sensitiv*:ti OR accura*:ti OR specific*:ti OR positive:ti OR negative:ti OR diagnos*:ti OR validity:ti OR reliab*:ti OR test:ti
#5	detect*:ti
#6	(#1 OR #2 OR #3) AND #4
#7	(#1 OR #3) AND (#4 OR #5)

#8	#6 OR #7
#9	'cardiac arrest$':ti OR 'heart arrest$':ti OR 'circulatory arrest$':ti OR 'cardiovascular arrest$':ti OR 'cardiopulmonary arrest$':ti OR 'cardio-pulmonary arrest$':ti OR cpr:ti OR resuscitat*:ti OR rosc:ti OR 'return of spontaneous circulation':ti
#10	(#1 OR #2) AND #9
#11	#8 OR #10
#12	((young NEAR/3 (person* OR people)):ti,ab,kw) OR adolescent$:ti,ab,kw OR boy$:ti,ab,kw OR child:ti,ab,kw OR children:ti,ab,kw OR infant$:ti,ab,kw OR girl$:ti,ab,kw OR juvenile*:ti,ab,kw OR kids:ti,ab,kw OR kinder*:ti,ab,kw OR paediatric$:ti,ab,kw OR pediatric$:ti,ab,kw OR 'preadolescen*':ti,ab,kw OR 'pre-adolescen*':ti,ab,kw OR 'preschool':ti,ab,kw OR 'pre-school':ti,ab,kw OR school$:ti,ab,kw OR schoolchild*:ti,ab,kw OR student$:ti,ab,kw OR teen$:ti,ab,kw OR teenager$:ti,ab,kw OR toddler$:ti,ab,kw OR 'young people':ti,ab,kw OR 'young person':ti,ab,kw OR youth:ti,ab,kw OR youths:ti,ab,kw
#13	'adolescent'/de OR 'adolescence'/de OR 'child'/de OR 'child health care'/de OR 'child hospitalization'/de OR 'hospitalized adolescent'/de OR 'hospitalized child'/de OR 'infant'/exp OR 'pediatrics'/de OR 'pediatric advanced life support'/de OR 'pediatric emergency medicine'/de OR 'preschool child'/de OR 'school child'/de OR 'toddler'/de OR 'boy'/de OR 'girl'/de
#14	#12 OR #13
#15	babies:ti,ab,kw OR baby:ti,ab,kw OR birth:ti,ab,kw OR neonat*:ti,ab,kw OR 'new* born':ti,ab,kw OR newborn$:ti,ab,kw OR 'post-natal':ti,ab,kw OR postnatal:ti,ab,kw OR 'post neonatal':ti,ab,kw OR postneonatal:ti,ab,kw
#16	'baby'/de OR 'delivery room'/de OR 'neonatology'/exp OR 'newborn'/de OR 'newborn care'/exp OR 'perinatal period'/de OR 'postnatal care'/de
#17	#15 OR #16
#18	((pulse NEAR/3 (find OR feel OR feeling OR finger$ OR manual OR check$ OR checking OR take OR taking OR assess*)):ti,ab,kw) OR (palpation:ti,ab,kw AND pulse:ti,ab,kw) OR 'perfusing rythm':ti,ab,kw OR 'brachial pulse':ti,ab,kw OR 'carotid pulse':ti,ab,kw OR 'femoral pulse':ti,ab,kw
#19	'pulse rate'/de
#20	'cardiac arrest$':ti,ab,kw OR 'heart arrest$':ti,ab,kw OR 'circulatory arrest$':ti,ab,kw OR 'cardiovascular arrest$':ti,ab,kw OR 'cardiopulmonary arrest$':ti,ab,kw OR 'cardio-pulmonary arrest$':ti,ab,kw OR cpr:ti,ab,kw OR resuscitat*:ti,ab,kw OR rosc:ti,ab,kw OR 'return of spontaneous circulation':ti,ab,kw
#21	'heart arrest'/de OR 'cardiopulmonary arrest'/de OR 'out of hospital cardiac arrest'/de OR cpr OR 'resuscitation'/de OR 'newborn resuscitation'/de OR 'basic life support'/de OR 'rescue breathing'/exp OR 'manual ventilation'/exp OR 'noninvasive ventilation'/de
#22	(#14 OR #17) AND (#18 OR #19) AND (#20 OR #21)
#23	#11 OR #22
#24	#23 NOT ([conference abstract]/lim OR [conference review]/lim OR [editorial]/lim OR [erratum]/lim OR [letter]/lim OR [note]/lim OR [book]/lim OR 'case report'/de)

Cochrane Library

#1	((pulse NEAR/3 (find OR feel OR feeling OR finger* OR manual OR check* OR checking OR take OR taking OR assess*)):ti) OR (palpation:ti AND pulse:ti) OR 'perfusing rythm':ti OR 'brachial pulse':ti OR 'carotid pulse':ti OR 'femoral pulse':ti
#2	(pulse NEAR/3 detect*):ti
#3	'cardiac activity':ti
#4	predict*:ti OR sensitiv*:ti OR accura*:ti OR specific*:ti OR positive:ti OR negative:ti OR diagnos*:ti OR validity:ti OR reliab*:ti OR test:ti
#5	detect*:ti
#6	(#1 OR #2 OR #3) AND #4
#7	(#1 OR #3) AND (#4 OR #5)

#8	#6 OR #7
#9	cardiac arrest*':ti OR 'heart arrest*':ti OR 'circulatory arrest*':ti OR 'cardiovascular arrest*':ti OR 'cardiopulmonary arrest*':ti OR 'cardio pulmonary arrest*':ti OR cpr:ti OR resuscitat*:ti OR rosc:ti OR 'return of spontaneous circulation':ti
#10	(#1 OR #2) AND #9
#11	#8 OR #10
#12	((young NEAR/3 (person* OR people)):ti,ab,kw) OR adolescent*:ti,ab,kw OR boy*:ti,ab,kw OR child:ti,ab,kw OR children:ti,ab,kw OR infant*:ti,ab,kw OR girl*:ti,ab,kw OR juvenile*:ti,ab,kw OR kids:ti,ab,kw OR kinder*:ti,ab,kw OR paediatric*:ti,ab,kw OR pediatric*:ti,ab,kw OR 'preadolescen*':ti,ab,kw OR 'pre-adolescen*':ti,ab,kw OR 'preschool':ti,ab,kw OR 'pre-school':ti,ab,kw OR school*:ti,ab,kw OR schoolchild*:ti,ab,kw OR student*:ti,ab,kw OR teen*:ti,ab,kw OR teenager*:ti,ab,kw OR toddler*:ti,ab,kw OR 'young people':ti,ab,kw OR 'young person':ti,ab,kw OR youth:ti,ab,kw OR youths:ti,ab,kw
#13	babies:ti,ab,kw OR baby:ti,ab,kw OR birth:ti,ab,kw OR neonat*:ti,ab,kw OR 'new* born':ti,ab,kw OR newborn$:ti,ab,kw OR 'post-natal':ti,ab,kw OR postnatal:ti,ab,kw OR 'post neonatal':ti,ab,kw OR postneonatal:ti,ab,kw
#14	((pulse NEAR/3 (find OR feel OR feeling OR finger$ OR manual OR check$ OR checking OR take OR taking OR assess*)):ti,ab,kw) OR (palpation:ti,ab,kw AND pulse:ti,ab,kw) OR 'perfusing rythm':ti,ab,kw OR 'brachial pulse':ti,ab,kw OR 'carotid pulse':ti,ab,kw OR 'femoral pulse':ti,ab,kw
#15	cardiac arrest$':ti,ab,kw OR 'heart arrest$':ti,ab,kw OR 'circulatory arrest$':ti,ab,kw OR 'cardiovascular arrest$':ti,ab,kw OR 'cardiopulmonary arrest$':ti,ab,kw OR 'cardio-pulmonary arrest$':ti,ab,kw OR resuscitat*:ti,ab,kw OR rosc:ti,ab,kw OR 'return of spontaneous circulation':ti,ab,kw
#16	(#12 OR #13) AND #14 AND #15
#17	#11 OR #16

Both searches limited to 2019 onwards

Search Results for Search Strategy #2 (Number of articles identified and number identified as relevant):
97 articles after limit search 2019-2022
94 articles after 3 duplicates removed
7 articles after 87 excluded upon title and abstract screening
0 articles included in analysis after full text review

Summary of Evidence Update:

In the 2020 Evidence Update (Maconochie 2020 S140) on the accuracy of pulse check in detecting return of circulation after cardiac arrest in children, 2 studies (Tibballs 2010 671; O'Connell 2019 158) were identified describing the use of manual pulse check in pediatric cardiac arrest.

Our Evidence Update in 2022 identified a number of adult studies comparing the utility of manual pulse palpation at different sites; and manual pulse palpation versus other innovative techniques such as arterial doppler ultrasound, POCUS, photoplethysmography, and ECG-based pulse detection. However, no new pediatric studies were identified.

Relevant Guidelines or Systematic Reviews

Organization (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations
Maconochie, 2020	Guideline		3	Identified two observational	The identification of pulseless CA and ROSC in advanced life

				studies on the use of ultrasound during CPR. (Tibballs 2010 671; O'Connell 2019 158) No studies compared manual pulse check with 'signs of life' in a RCT design. 'Signs of life' were implemented as part of the guidelines because of concern about false negatives and thus not providing CPR where it was needed. Starting CPR in those not needing it is of less concern not least because CPR-induced injury is rare in infants and children. Some data indicate that providing CPR to children with 'non- pulseless' bradycardia and severely impaired perfusion improves outcome. (Donoghue 2009 1541)	support relies on evaluation of circulation, including the manual palpation of pulses. Although experienced health care providers perform better than inexperienced providers, the risk of both type 1 and type 2 error and prolonged CPR pauses is still significant. The detection of circulation therefore should also include other intra-arrest parameters such as ETCO2, blood pressure and SpO2 (or possibly ultrasound).

RCT:

Study Acronym; Author; Year Published	Aim of Study; Study Type; Study Size (N)	Patient Population	Study Intervention (# patients) / Study Comparator (# patients)	Endpoint Results (Absolute Event Rates, P value; OR or RR; & 95% CI)	Relevant 2° Endpoint (if any); Study Limitations; Adverse Events
No new pediatric RCTs published					

Nonrandomized Trials, Observational Studies

Study Acronym; Author; Year Published	Study Type/Design; Study Size (N)	Patient Population	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/Conclusion Comment(s)
No new pediatric studies published				

Reviewer Comments: *(including whether this PICOST should have a systematic or scoping review)*

Despite a number of recent adult studies comparing manual pulse palpation with other methods of detecting return of circulation after arrest, there remains very little paediatric specific evidence in this area. Our evidence update failed to identify any new publications since the last update in 2019. Therefore, a systematic review of pediatric cardiac arrest patients is not justified at this time.

Therefore, the ILCOR treatment recommendations from 2020 (Maconochie 2020 S140) should remain unchanged:

Palpation of a pulse (or its absence) is not reliable as the sole determinant of cardiac arrest and need for chest compressions. If the victim is unresponsive, not breathing normally, and there are no signs of life, lay rescuers should begin CPR.
In infants and children with no signs of life, healthcare providers should begin CPR unless they can definitely palpate a pulse within 10 seconds.

Reference list:

de Caen AR, 2010, e213 [https://pubmed.ncbi.nlm.nih.gov/20956041/]

Donoghue A, 2009, 1541 [https://pubmed.ncbi.nlm.nih.gov/19917587/]

Kleinman ME, 2010, S876 [https://pubmed.ncbi.nlm.nih.gov/20956230/]

Maconochie IK, 2020, S140 [https://pubmed.ncbi.nlm.nih.gov/33084393/]

O'Connell KJ, 2019, 158 [https://pubmed.ncbi.nlm.nih.gov/31421191/]

Tibballs J, 2010, 671 [https://pubmed.ncbi.nlm.nih.gov/20227813/]

Evidence Update Worksheet

Adenosine use in supraventricular tachycardia (SVT) during resuscitation

Worksheet author(s): Group 4
Task Force: PLS
Date Submitted to SAC rep for peer review and approval: Dec 2022
SAC rep:

PICOST / Research Question: *(Attach SAC representative approved completed PICOST template)*

Among infants and children who are in supraventricular tachycardia in any setting (P), does adenosine use (I), compared with no use of adenosine (C), change outcome (O)?

Year of last full review: (*insert year where this PICOST was most recently reviewed***)**

Current ILCOR Consensus on Science and Treatment Recommendation for this PICOST:

Current Search Strategy (for an existing PICOST) included in the attached approved PICOST
New Search strategy: (for a new PICOST should be outlined here as per Evidence Update Process)
Database searched: eg Medline Embase Cochrane
Time Frame: (existing PICOST) – updated from end of last search (please specify)
Time Frame: (new PICOST) – at the discretion of the Task Force (please specify)
Date Search Completed: 09.11.2022
Search Results (Number of articles identified and number identified as relevant):

Summary of Evidence Update:

Relevant Guidelines or Systematic Reviews

Organization (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations
Cochrane Database of Systematic Reviews Review – Intervention Adenosine versus intravenous calcium channel antagonists for supraventricular tachycardia Samer Alabed, Ammar Sabouni, Rui Providencia, Edmond Atallah, Mohammed Qintar, Timothy JA	**Cochrane review**			**We identified two new studies for inclusion in the review update; the review now includes seven trials with 622 participants who presented to an emergency department with SVT. All included studies were RCTs, but only three described the randomization process, and none had blinded**	**Moderate-quality evidence shows no differences in effects of adenosine and calcium channel antagonists for treatment of SVT on reverting to sinus rhythm, and low- quality evidence suggests no appreciable**

Chico https://doi.org/10.1002 /14651858.CD005154.p ub4				participants, personnel, or outcome assessors to the intervention given. Moderate-quality evidence shows no differences in the number of people reverting to sinus rhythm who were treated with adenosine or CCA (89.7% vs 92.9%; OR 1.51, 95% confidence interval (CI) 0.85 to 2.68; participants = 622; studies = 7; I 2 = 36%). Low-quality evidence suggests no appreciable differences in major adverse event rates between CCAs and adenosine. Researchers reported only one case of hypotension in the CCA group and none in the adenosine group (0.66% vs 0%; OR 3.09, 95% CI 0.12 to 76.71; participants = 306; studies = 3; I2 = 0%). Included trials did not report length of stay in hospital nor patient satisfaction.	differences in the incidence of hypotension. A study comparing patient experiences and prospectively studied adverse events would provide evidence on which treatment is preferable for management of SVT.
VOLUME 1, ISSUE 1, P11-22, FEBRUARY 01, 2022 Medical Management of Infants With Supraventricular Tachycardia: Results From a Registry and Review of the Literature Nathan Wei, Avani Lamba, BS, Sonia Franciosi, PhD, Ash Sandhu, BS, Carolina A. Escudero, MD, MS, Shubhayan Sanatani, BS, MD, FHRS, CCDS DOI: https://doi.org/10.1016 /j.cjcpc.2021.09.001	Systemati c review of studies on infant re-entrant SVT in MEDLINE and EMBASE			A total of 2534 infants were included: n = 108 from the registry (median age, 9 days [0-324 days], 70.8% male) and n = 2426 from the literature review (median age, 14 days; 62.3% male). Propranolol was the most prevalent acute (61.4%) and maintenance treatment (53.8%) in the Registry, whereas digoxin was used sparingly (4.0% and 3.8%, respectively). Propranolol and digoxin were used frequently in the literature acutely	This was the largest cohort of infants with SVT analysed to date. Digoxin monotherapy use was rare amongst contemporary paediatric cardiologists. There was limited evidence to support one medication over another. Overall, recurrence and mortality rates on antiarrhythmic

				(31% and 33.2%) and for maintenance (17.8% and 10.1%) (P < 0.001). No differences in acute or prophylactic effectiveness between medications were observed. Recurrence was higher in the Registry (25.0%) vs literature (13.4%) (P < 0.001), and 22 (0.9%) deaths were reported in the literature vs none in the Registry.	treatment were low.

RCT:

Study Acronym; Author; Year Published	Aim of Study; Study Type; Study Size (N)	Patient Population	Study Intervention (# patients) / Study Comparator (# patients)	Endpoint Results (Absolute Event Rates, P value; OR or RR; & 95% CI)	Relevant 2° Endpoint (if any); Study Limitations; Adverse Events
	<u>Study Aim:</u> <u>Study Type:</u>	<u>Inclusion Criteria:</u>	<u>Intervention:</u> <u>Comparison:</u>	1° endpoint:	<u>Study Limitations:</u>

Nonrandomized Trials, Observational Studies

Study Acronym; Author; Year Published	Study Type/Design; Study Size (N)	Patient Population	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/ Conclusion Comment(s)
Adenosine and Pediatric Supraventricular Tachycardia in the Emergency Department: Multicenter Study and [Pediatric Emergency Medicine Collaborative	<u>Study Type:</u> Multicenter descriptive study with both prospective (convenience sample) and retrospective (chart review) patient entry.	<u>Inclusion Criteria:</u> Six investigators from 7 pediatric EDs entered 82 patients with 98 presumed SVT episodes (52 prospective and 46 retrospective) into the study.	<u>1° endpoint:</u> Determine the frequency of successful cardioversion and the adverse effects of adenosine treatment in pediatric emergency department patients with supraventricular tachycardia (SVT).	Intravenous administration of adenosine led to successful cardioversion in 72% of pediatric ED patientevents that

Research Committee, Losek JD, Endom E, Dietrich A, Stewart G, Zempsky W, Smith K: Adenosine and pediatric supraventricular tachycardia in the emergency department: Multicenter study and review. Ann Emerg Med February 1999;33:185-191.]				were presumed to be SVT. A dose range of .1 to .3 mg/kg was found to be most effective. Adenosine was not associated with significant adverse effects.
An Pediatr (Barc) 2007 Aug;67(2):133-8. doi: 10.1016/s1695-4033(07)70573-8. [Supraventricular tachycardia in infants and children] [Article in Spanish] M Balaguer Gargallo 1 , I Jordán García, J Caritg Bosch, F J Cambra Lasaosa, F Prada Hermogenes, A Palomaque Rico PMID: 17692258 DOI: 10.1016/s1695-	A retrospective review of 61 cases of SVT requiring PICU admission (1999-2004) was performed. PICU admission was due to persistent SVT after vagal maneuvers.	There were 61 patients and 39 were boys (63.9%). The mean age was 2.1 years (SD +/- 3.1). Twelve patients had congenital heart disease (19.7%); three (4.9%) were admitted after heart surgery, and the remaining patients had no antecedents (60.7%). The mean cardiac frequency was 238 beats/min (SD +/- 42.86). Heart failure (HF) was observed in 14 patients (23%). Statistically significant differences were found between the presence of HF and time since onset (p < 0.01) and younger age (p < 0.01). The most frequent diagnosis was SVT due to re-entry in 28 patients (45.9%). Medical treatment was required in 46 patients (75.4%) and response was achieved in 35 (57.4%). At crisis the first drug used was adenosine triphosphate (ATP) in 35 patients (61.4%) with good response in 21 (36.8%). As maintenance therapy digoxin was used in 29 patients (50.9%) without	1. To determine the clinical characteristics and treatment of SVT in infants and children. 2. To determine treatment response and the drugs used.	1. HF was observed mainly in infants. 2. Most of the patients had good response to ATP therapy. 3. Radiofrequency ablation was mainly required in patients aged more than 1 year.

4033(07)7057 3-8		relapses in 22 (78.6%). Radiofrequency ablation was required in 17 patients (27.9%), and there were three relapses (17.6%). The ages of patients who underwent ablation ranged from 3.5 days to 13 years.		
Zhonghua Er Ke Za Zhi 2018 Jan 2;56(1):13-18. doi: 10.3760/cma.j .issn.0578-1310. 2018.01.005. [An analysis of clinical characteristics and acute treatment of supraventricul ar tachycardia in children from a multicenter study] [Article in Chinese] X M Li 1 , H Y Ge, X Q Liu, L Shi, B J Guo, M T Li, H Jiang, Y Zhang, H J Liu, X C Zheng, A J Li, Y Y Zhang PMID: 29342991 DOI: 10.3760/cma.j .issn.0578-1310.2018.01. 005	Multicenter prospective descriptive study including 257 children from First Hospital of Tsinghua University, Peking University First Hospital, Children's Hospital Affiliated to Capital Institute of Pediatrics and Beijing Anzhen Hospital who received intravenous antiarrhythmic drug therapy for SVT from July 2014 to February 2017.	257 children from First Hospital of Tsinghua University, Peking University First Hospital.	The study assessed the clinical characteristics and response to acute intravenous antiarrhythmic drug therapy of supraventricular tachycardia (SVT) in children.	Most (57.6%) children with SVT have their first clinical episode within 1 year of age, and AVRT is the most common type. TIC occurs in 13.3% of children with SVT. Intravenou s antiarrhyth mic drug therapy has a 63.8% complete terminatio n rate for children with SVT and incidence of adverse effects is 3.5%. Propafeno ne and amiodaron e are more effective for SVT terminatio n in children

				than adenosine. Serious adverse effects may occur when using propafenone.

Reviewer Comments: *(including whether this PICOST should have a systematic or scoping review)*

During the search process, references are found in a limited number to issue a recommendation or change in a severe way.

Reference list: *(List by ILCOR ref standard (last name first author, year of publication, first page number) and insert hyperlink to all articles identified as relevant (if available on PubMed)*

An Pediatr (Barc) 2007 Aug;67(2):133-8. doi: 10.1016/s1695-4033(07)70573-8. [Supraventricular tachycardia in infants and children] [Article in Spanish] M Balaguer Gargallo 1 , I Jordán García, J Caritg Bosch, F J Cambra Lasaosa, F Prada Hermogenes, A Palomaque Rico PMID: 17692258 DOI: 10.1016/s1695-4033(07)70573-8

Adenosine and Pediatric Supraventricular Tachycardia in the Emergency Department: Multicenter Study and [Pediatric Emergency Medicine Collaborative Research Committee, Losek JD, Endom E, Dietrich A, Stewart G, Zempsky W, Smith K: Adenosine and pediatric supraventricular tachycardia in the emergency department: Multicenter study and review. Ann Emerg Med February 1999;33:185-191.]

VOLUME 1, ISSUE 1, P11-22, FEBRUARY 01, 2022 Medical Management of Infants With Supraventricular Tachycardia: Results From a Registry and Review of the Literature Nathan Wei, Avani Lamba, BS, Sonia Franciosi, PhD, Ash Sandhu, BS, Carolina A. Escudero, MD, MS, Shubhayan Sanatani, BS, MD, FHRS, CCDS DOI: https://doi.org/10.1016/j.cjcpc.2021.09.001

Cochrane Database of Systematic Reviews Review – Intervention Adenosine versus intravenous calcium channel antagonists for supraventricular tachycardia Samer Alabed, Ammar Sabouni, Rui Providencia, Edmond Atallah, Mohammed Qintar, Timothy JA Chico https://doi.org/10.1002/14651858.CD005154.pub4

Zhonghua Er Ke Za Zhi 2018 Jan 2;56(1):13-18. doi: 10.3760/cma.j.issn.0578-1310. 2018.01.005. [An analysis of clinical characteristics and acute treatment of supraventricular tachycardia in children from a multicenter study] [Article in Chinese] X M Li 1 , H Y Ge, X Q Liu, L Shi, B J Guo, M T Li, H Jiang, Y Zhang, H J Liu, X C Zheng, A J Li, Y Y Zhang PMID: 29342991 DOI: 10.3760/cma.j.issn.0578-1310.2018.01.005

Evidence Update Worksheet

Anti-arrhythmic for in cardiac arrest with shockable rhythms at any time during CPR or immediately after ROSC

Worksheet author(s): Janice Tijssen, Thomaz Bittencourt, Monica Kleinman, Amelia Reis
Task Force: PLS
Date Submitted to SAC rep for peer review and approval: Dec 2022
SAC rep: Dianne Atkins, Ian Maconichie

PICOST / Research Question: *(Attach SAC representative approved completed PICOST template)*
Population: Patients of all ages (neonates, children and adolescents <18) in any setting with cardiac arrest and a shockable rhythm at any time during CPR or immediately after ROSC
Intervention: Administration (IV or IO) of an anti-arrhythmic drug
Comparator: Another anti-arrhythmic or placebo
Outcome: Survival to hospital discharge with good neurologic outcome, survival to hospital discharge, ROSC and re-arrest after ROSC
Study Design: Randomized controlled trials (RCTs) and non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies) are eligible for inclusion.
Time Frame: All years and all languages were included as long as there was an English abstract
Year of last full review: 2018

Current ILCOR Consensus on Science and Treatment Recommendation for this PICOST:
We suggest that amiodarone or lidocaine may be used for the treatment of pediatric shock–resistant VF/pVT (weak recommendation, very-low-quality evidence).

Current Search Strategy (for an existing PICOST) included in the attached approved PICOST
----
1   exp Heart Arrest/ (54033)
2   exp Cardiopulmonary Resuscitation/ (21163)
3   cardiac arrest.tw. (38388)
4   cpr.tw. (14011)
5   resuscitation.tw. (61021)
6   heart arrest.tw. (596)
7   or/1-6 (120914)
8   (Antiarrhythmi$ agent$ or antiarrhythmi$ drug$ or antiarrhythmi$ medication$).tw. (12753)
9   (Anti-arrhythmi$ agent$ or anti-arrhythmi$ drug$ or anti-arrhythmi$ medication$).tw. (1933)
10   (Dysrhythmi$ agent$ or dysrhythmi$ drug$ or disrhythmi$ medication$).tw. (12)
11   exp Anti-Arrhythmia Agents/ (220242)
12   lidocaine.tw. (22980)
13   amiodarone.tw. (9866)
14   Lidocaine/ (25535)
15   Amiodarone/ (7937)
16   lignocaine.tw. (3016)
17   procainamide.tw. (2525)
18   Procainamide/ (3531)
19   Bretylium Tosylate/ (301)
20   bretylium.tw. (1000)
21   nifekalant.mp. (159)
22   quinidine.mp. or Quinidine/ (9184)
23   ajmaline.mp. (1338)

24   disopyramide.mp. (2083)
25   phenytoin.mp. (18765)
26   mexiletine.mp. (1980)
27   tocainide.mp. (510)
28   flecainide.mp. (2650)
29   encainide.mp. (449)
30   propafenone.mp. (1887)
31   moricizine.mp. (365)
32   carvedilol.mp. (3910)
33   propranolol.mp. (45887)
34   esmolol.mp. (1532)
35   timolol.mp. (5262)
36   metoprolol.mp. (8657)
37   atenolol.mp. (8462)
38   sotalol.mp. (3335)
39   bisoprolol.mp. (1913)
40   nebivolol.mp. (1109)
41   ibutilide.mp. (392)
42   dofetilide.mp. (1033)
43   dronedarone.mp. (703)
44   verapamil.mp. (26324)
45   diltiazem.mp. (9722)
46   adenosine.mp. (272357)
47   digoxin.mp. (15546)
48   exp Adrenergic beta-Antagonists/ or beta blocker$.mp. (101609)
49   slow channel blocker$.mp. (74)
50   exp Calcium Channel Blockers/ or fast channel blocker$.mp. (89888)
51   magnesium sulfate.mp. (7228)
52   or/8-51 (613366)
53   7 and 52 (6927)
54   limit 53 to "therapy (maximizes sensitivity)" (4715)
55   limit 53 to "reviews (maximizes sensitivity)" (3146)
56   54 or 55 (5548)
57   56 not (exp Adult/ not (exp Infant/ or exp Child/ or Adolescent/ or (child* or p?ediatric* or kid or kids or girl or girls or boy or boys or infant or infants or baby or babies or toddler* or youth* or young or youngster* or juvenile* or minors* or teen* or adolescent* or adolescence or puber* or pubescen* or pre?school* or kindergarten* or school* or highschool* or PICU).tw,kf.)) (3557)
58   limit 57 to ed=20170816-20220705 (445)

New Search strategy: (for a new PICOST should be outlined here as per Evidence Update Process)
Database searched: Medline
Time Frame: (existing PICOST) – updated from end of last search (please specify) August 16, 2017 and July 5, 2022

Time Frame: (new PICOST) – at the discretion of the Task Force (please specify)
Date Search Completed: July 5, 2022
Search Results (Number of articles identified and number identified as relevant):
442: 425 irrelevant, 14 excluded at full text, 3 extracted

Summary of Evidence Update:

Insufficient new evidence to justify a new SR. New studies are unlikely to change current TR.

Relevant Guidelines or Systematic Reviews

Organization (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations
Ali, 2018	**SR**	Exactly the same PICOST (+ adults)	1 observational study for pediatrics from 2014 (Valdes)	No new papers found in this SR	N/A
Meyer-Szary, 2021	**SR ("Research letter")**	Amiodarone vs Lidocaine for children in cardiac arrest	2 observational studies: Valdes, 2014 and Holmberg, 2020	Pooled analysis of both studies: lidocaine had improved ROSC (OR1.96 (1.39-2.77, p<0.001), improved survival to 24h (OR 1.94 (1.39-2.69, p<0.001), and survival to hospital discharge (OR 1.68 (1.16-2.44, p=0.006). No difference in survival with favourable neurological outcome. For Propensity Matched pooled analysis (methods not provided): no significant differences.	The observed differences in unadjusted analysis might be due to substantial differences in patient baseline and clinical characteristics.

RCT: n/a

Study Acronym; Author; Year Published	Aim of Study; Study Type; Study Size (N)	Patient Population	Study Intervention (# patients) / Study Comparator (# patients)	Endpoint Results (Absolute Event Rates, P value; OR or RR; & 95% CI)	Relevant 2° Endpoint (if any); Study Limitations; Adverse Events
	Study Aim: **Study Type:**	**Inclusion Criteria:**	**Intervention:** **Comparison:**	**1° endpoint:**	**Study Limitations:**

Nonrandomized Trials, Observational Studies

Study Acronym; Author; Year Published	Study Type/Design; Study Size (N)	Patient Population	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/Conclusion Comment(s)
IHCA				
Holmberg, 2020	Observational, n=365	IHCA (GWTG) with shockable rhythm who receive either lidocaine or	Unadjusted analysis: lidocaine associated with ROSC, survival to 24h and survival to hospital discharge (RR 1.15 (1.01-1.35),	No significant difference in clinical outcomes between those receiving lidocaine compared to amiodarone.

		amiodarone from 2000-2018; Lidocaine n=217 Amiodarone n=148 Propensity score matching: 90 in each group (well-matched)	1.34 (1.09-1.65), and 1.42 (1.04-1.94), respectively. No difference in neurological outcome. Matched analysis: no difference in any outcomes. Sensitivity analyses consistent with matched analyses.	

Reviewer Comments: *(including whether this PICOST should have a systematic or scoping review*)

The only new evidence since the last SR in 2018 is Holmberg's observational study using GWTG database, which found no significant difference in outcomes when propensity matched scores were used to compare children who received lidocaine vs children who received amiodarone for shockable rhythm during cardiac arrest. This study was pooled with Valdes, 2014, in a SR by Meyer-Szary, 2021 and adjusted (matched) analyses did not change. This SR was reported in a brief research letter with limited description of methods.

There is insufficient new evidence to trigger a systematic or scoping review.

Reference list: *(List by ILCOR ref standard (last name first author, year of publication, first page number) and insert hyperlink to all articles identified as relevant (if available on PubMed)*

Ali, 2018, 63, 10.1016/j.resuscitation.2018.08.025
Meyer-Szary J, 2021, 783, 10.5603/CJ.a2021.0077
Holmber, M, 2020, 191, 10.1016/j.resuscitation.2019.12.033

Evidence Update Worksheet

Beside ultrasound to identify perfusing rhythm during cardiac arrest

Worksheet author(s): Dr Barney Scholefield/ Dr Alexis Topjian / Dr Antonio Rodriguez-Nunez
Task Force: Pediatric Life Support Task Force
Date Submitted to SAC rep for peer review and approval: December 2022
SAC rep:

PICOST / Research Question: *(Attach SAC representative approved completed PICOST template)*

Population: Infants & Children in any setting (in-hospital or out-of-hospital) with cardiac arrest

Intervention: the presence of variables -images, cut-off values or trends- during CPR (intra-arrest) that can provide physiologic feedback to guide resuscitation efforts, namely:

Echocardiography / Point of care cardiac ultrasound

Comparators: the absence of such factors -images, cut-off values or trends.

Outcomes: Any clinical outcome.

Study Designs: STEP 1: Randomized controlled trials (RCTs) and non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies) that concern directly the population and intervention described above are eligible for inclusion. If it is anticipated that there will be insufficient studies from which to draw a conclusion, case series may be included in the initial search. The minimum number of cases for a case series to be included was set by the taskforce at 5 cases. Unpublished studies (e.g., conference abstracts, trial protocols) are excluded.
STEP 2: the same study designs and/or existing systematic or scoping reviews not directly concerning the population or intervention defined above but considered informative as additional evidence for the development of the final taskforce insights.

Timeframe: For STEP 1, all languages are included, as long as there is an English abstract. We searched articles from 2020 onwards. For STEP 2, if a systematic or scoping review of high quality (as per AMSTAR 2 tool) is identified, search can be limited to beyond data and/or scope of that review.

Year of last full review:
Scoping review last searched September 2020

Kool M, Atkins DL, Van de Voorde P, Maconochie IK, Scholefield BR; PLS ILCOR Task Force. Focused echocardiography, end-tidal carbon dioxide, arterial blood pressure or near-infrared spectroscopy monitoring during paediatric cardiopulmonary resuscitation: A scoping review. Resusc Plus. 2021 Mar 30;6:100109. doi: 10.1016/j.resplu.2021.100109. PMID: 34228034; PMCID: PMC8244529.

Current ILCOR Consensus on Science and Treatment Recommendation for this PICOST:

Task Force insights
The PLS Task Force agreed that they would not accept direct extrapolation from adult studies as a result of substantial differences between adult and pediatric cardiac arrest in terms of causes, anatomy and technical
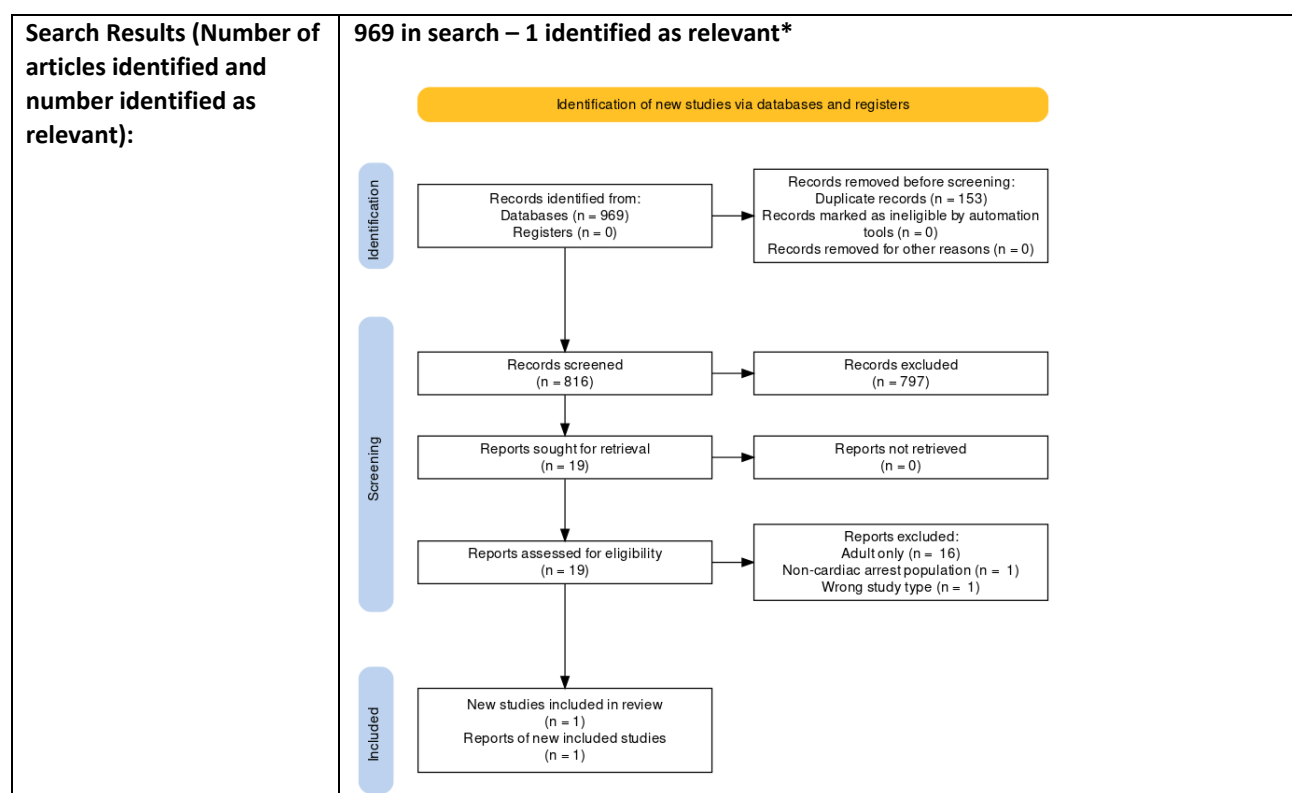
matters that could affect the usefulness and accuracy of the bedside echocardiography. While the technology is widely used within the pediatric critical care, emergency and resuscitation communities, more data detailing its advantages, pitfalls and characteristics of performance are needed so its usefulness and limitations in pediatric cardiac arrest can be fully defined.

In addition, there is inadequate pediatric literature regarding its intra-arrest prognostic utility and the Task Force urges great caution until more literature is available.

Treatment Recommendations

There is insufficient evidence to recommend for or against the routine use of echocardiography during a pediatric arrest. Echocardiography may be considered to identify potentially treatable causes of an arrest when appropriately skilled personnel are available, but the benefits must be carefully weighed against the known deleterious consequences of interrupting chest compressions. (Kleinman 2010 S466; de Caen 2010 e215) (1, 2)

Current Search Strategy (for an existing PICOST) included in the attached approved PICOST	1. Echocardiography, Transesophageal"[Mesh] OR "Echocardiography"[Mesh] 136,373 2. Point-of-Care Systems"[Mesh] OR "Diagnostic Imaging"[Mesh] 2,658,482 3. echocardiography, transthoracic OR point of care ultrasound OR POCUS 4. 1 or 2 or 3 5. "Life Support Care"[Mesh] 6. "Cardiopulmonary Resuscitation"[Mesh] 7. "Heart Arrest"[Mesh] 8. ((((life support) OR cardiopulmonary resuscitation) OR ROSC) OR return of spontaneous circulation) OR cardiac arrest (834771) 9. 5 or 6 or 7 or 8 10. (("Infant"[Mesh]) OR "Adolescent"[Mesh]) OR "Child"[Mesh] 11. (infan* OR baby OR baby* OR babies OR toddler* OR minors OR minors* OR kid OR kids OR child OR child* OR children* OR schoolchild* OR schoolchild OR school child[tiab] OR school child*[tiab] OR adolescen* OR juvenil* OR youth* OR teen* OR under*age* OR pubescen* OR pediatrics[mh] OR pediatric* OR paediatric* OR peadiatric* OR school[tiab] OR school*[tiab]) 12. 9 or 10 13. (animals [mh]) NOT humans [mh] 14. (newborn* OR new-born* OR perinat* OR neonat* OR prematur* OR preterm*) 15. 4 and 9 and 12 not 13 not 14 16. Limit to studies from 2020
New Search strategy: (for a new PICOST should be outlined here as per Evidence Update Process)	n/a
Database searched: eg Medline Embase Cochrane	Medline, Embase, Central
Time Frame: (existing PICOST) – updated from end of last search (please specify)	Last updated 11 September 2020. New Search Jan 2020 to 25th July 2022
Time Frame: (new PICOST) – at the discretion of the Task Force (please specify)	n/a
Date Search Completed:	25th July 2022

Search Results (Number of articles identified and number identified as relevant):	969 in search – 1 identified as relevant*

*figure created using on-line tool (3)

Summary of Evidence Update:

In the 2020 scoping review of intra-arrest monitoring (4), 2 studies were identified describing POCUS/Echo use during pediatric cardiac arrest (5, 6) adding to previous case series of 14 cases in 2008(7).

Our Evidence Update in 2022 identified only 1 further small case series(8, 9). The first included 2 patients (aged 4 months and 12 years). POCUS was used to
identify that cardiac activity was present in the infant with impalpable pulses which changed management (i.e. chest compressions were stopped and post-ROSC
care provided); however, the infant died. Unfortunately, the case report is incomplete minimizing interpretation of role of POCUS in decision making.
The second case utilized POCUS to visualize the femoral vessel. This demonstrated no pulse during the pulse check and flow during chest compressions.
Intraosseous infusion flow was also visualized using POCUS.

Relevant Guidelines or Systematic Reviews

Organization (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations
European Resuscitation Council Guidelines 2021: Paediatric Life Support

Van de Voorde P, 2021 (10) | Guideline | | 2 | In their 2020 scoping review PLS 814 the ILCOR paediatric Taskforce warned against rapid implementation of POCUS in paediatric practice without sufficient evidence, despite its great potential and widespread acceptance. Acquisition and interpretation | We suggest the use of POCUS by competent healthcare providers, when feasible, to identify reversible causes of cardiac arrest (4H/4T). POCUS may also have role in identifying the |

				of images in children is more complex, especially in children with pre-existing heart disease. Furthermore, there are significant material and training costs which might be important in low-resource setting	presence of perfusion, but currently this should be only in the context of research. POCUS should currently not be used for prognostication.
American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Topjian AA et al 2020 (11)	Guideline		**3**	Several case series evaluated the use of bedside echocardiography to identify reversible causes of cardiac arrest, including pulmonary embolism. One prospective observational study of children (without cardiac arrest) admitted to an ICU reported good agreement of estimates of shortening fraction and inferior vena cava volume between emergency physicians using bedside limited echocardiography and cardiologists performing formal echocardiography.	When appropriately trained personnel are available, echocardiography may be considered to identify potential treatable causes of arrest, such as pericardial tamponade and inadequate ventricular filling, but the potential benefits should be weighed against the known deleterious consequences for interrupting chest compressions.

RCT:

Study Acronym; Author; Year Published	Aim of Study; Study Type; Study Size (N)	Patient Population	Study Intervention (# patients) / Study Comparator (# patients)	Endpoint Results (Absolute Event Rates, P value; OR or RR; & 95% CI)	Relevant 2° Endpoint (if any); Study Limitations; Adverse Events
No new pediatric RCT published					

Nonrandomized Trials, Observational Studies

Study Acronym; Author; Year Published	Study Type/Design; Study Size (N)	Patient Population	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/Conclusion Comment(s)
Leviter et al (9)	Study Type: Case series	2 paediatric cases in cardiac arrest. A 4-month-old and 12-year-old	1) POCUS used to identify cardiac activity in an infant in cardiac arrest with absent pulses. Changed clinical management.	Examples of POCUS use in paediatric cardiac arrest. Only cases reports. High risk of confounding bias.

			2) POCUS use as a continuous pulse check over femoral artery and to confirm correct placement of intra-osseous needle and infusion.	

Reviewer Comments: *(including whether this PICOST should have a systematic or scoping review*)

There remains very little paediatric specific evidence examining the use of the POCUS/echo during cardiac arrest. Our evidence up-date only identified one very
small case series including 2 patients (one infant and one adolescent). Therefore a systematic review of paediatric cardiac arrest patients is not justified at this
time.

This limited evidence in paediatrics is different to the expanded body of evidence for POCUS use during cardiac arrest in adult cardiac arrest (12-17), with
international recommendations on practice (18). The use of POCUS/Echo is expanding with protocolized POCUS pathways for non-expert sonographers which, in simulated studies, has enabling rapid monitoring/investigation with minimal (<10 second) interruption to CPR delivery or peri-shock pauses (16) . Use of POCUS in pediatric resuscitation may be considered If you have skilled personnel available, and can assure ongoing CPR quality.

We excluded one study of note by Leviter et al (8) who performed a prospective observational study to demonstrate feasibility of 1) apical 4 chamber,
2) subxiphoid and 3) femoral artery view via POCUS in < 10 seconds in children who were not in cardiac arrest. Twenty two sonographers performed 50 scans on
22 stable children aged 6 weeks to 12 years old. Interpretable scans were obtained in 1) apical 4 chamber in 86%, 2) subxiphoid in 94% and 3) femoral artery view
in 74%. This study demonstrated of use of POCUS technique for rapid acquisition of cardiac and femoral vein views in less than 10 second. However, the patients
were not in cardiac arrest. Further evaluation is therefore warranted.

Therefore, the ILCOR treatment recommendations from 2010 remain unchanged:

There is insufficient evidence to recommend for or against the routine use of echocardiography during a pediatric arrest. Echocardiography may be considered to identify potentially treatable causes of an arrest when appropriately skilled personnel are available, but the benefits must be carefully weighed against the known deleterious consequences of interrupting chest compressions. (Kleinman 2010 S466; de Caen 2010 e215) (1, 2)

Reference list: *(List by ILCOR ref standard (last name first author, year of publication, first page number) and insert hyperlink to all articles identified as relevant (if available on PubMed)*

References

1.   de Caen AR, Kleinman ME, Chameides L, Atkins DL, Berg RA, Berg MD, et al. Part 10: Paediatric basic and advanced life support: 2010 International Consensus on Cardiopulmonary

Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations. Resuscitation. 2010;81 Suppl 1:e213-59.

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4.   Kool M, Atkins DL, Van de Voorde P, Maconochie IK, Scholefield BR, Force PIT. Focused echocardiography, end-tidal carbon dioxide, arterial blood pressure or near-infrared spectroscopy monitoring during paediatric cardiopulmonary resuscitation: A scoping review. Resusc Plus. 2021;6:100109.

5.   Morgan RW, Stinson HR, Wolfe H, Lindell RB, Topjian AA, Nadkarni VM, et al. Pediatric In-Hospital Cardiac Arrest Secondary to Acute Pulmonary Embolism. Crit Care Med. 2018;46(3):e229-e34.

6.   Steffen K, Thompson WR, Pustavoitau A, Su E. Return of Viable Cardiac Function After Sonographic Cardiac Standstill in Pediatric Cardiac Arrest. Pediatr Emerg Care. 2017;33(1):58-9.

7.   Tsung JW, Blaivas M. Feasibility of correlating the pulse check with focused point-of-care echocardiography during pediatric cardiac arrest: a case series. Resuscitation. 2008;77(2):264-9.

8.   Leviter JI, Chen L, O'Marr J, Riera A. The Feasibility of Using Point-of-Care Ultrasound During Cardiac Arrest in Children: Rapid Apical Contractility Evaluation. Pediatr Emerg Care. 2022.

9.   Leviter JI, Walsh S, Riera A. Point-of-Care Ultrasound for Pulse Checks in Pediatric Cardiac Arrest: Two Illustrative Cases. Pediatr Emerg Care. 2022.

10.   Van de Voorde P, Turner NM, Djakow J, de Lucas N, Martinez-Mejias A, Biarent D, et al. European Resuscitation Council Guidelines 2021: Paediatric Life Support. Resuscitation. 2021;161:327-87.

11.   Topjian AA, Raymond TT, Atkins D, Chan M, Duff JP, Joyner BL, Jr., et al. Part 4: Pediatric Basic and Advanced Life Support: 2020 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation. 2020;142(16_suppl_2):S469-s523.

12.   Ávila-Reyes D, Acevedo-Cardona AO, Gómez-González JF, Echeverry-Piedrahita DR, Aguirre-Flórez M, Giraldo-Diaconeasa A. Point-of-care ultrasound in cardiorespiratory arrest (POCUS-CA): narrative review article. Ultrasound J. 2021;13(1):46.

13.   Dudek M, Szarpak L, Peacock FW, Gasecka A, Michalski T, Wroblewski P, et al. Diagnostic performance of point-of-use ultrasound of resuscitation outcomes: A systematic review and meta-analysis of 3265 patients. Cardiol J. 2021.

14.   Kreiser MA, Hill B, Karki D, Wood E, Shelton R, Peterson J, et al. Point-of-Care Ultrasound Use by EMS Providers in Out-of-Hospital Cardiac Arrest. Prehosp Disaster Med. 2022;37(1):39-44.

15.   Lau V, Blaszak M, Lam J, German M, Myslik F. Point-of-Care Resuscitative Echocardiography Diagnosis of Intracardiac Thrombus during cardiac arrest (PREDICT Study): A retrospective, observational cohort study. Resusc Plus. 2022;10:100218.

16.   Taylor B, Joshi B, Hutchison L, Manivel V. Echocardiography does not prolong peri-shock pause in cardiopulmonary resuscitation using the COACH-RED protocol with non-expert sonographers in simulated cardiac arrest. Resusc Plus. 2020;4:100047.

17.   Reynolds JC, Del Rios M. Point-of-care cardiac ultrasound during cardiac arrest: a reliable tool for termination of resuscitation? Curr Opin Crit Care. 2020;26(6):603-11.

18.   Bronshteyn YS, Anderson TA, Badakhsh O, Boublik J, Brady MBW, Charnin JE, et al. Diagnostic Point-of-Care Ultrasound: Recommendations From an Expert Panel. J Cardiothorac Vasc Anesth. 2022;36(1):22-9.

Evidence Update Worksheet

Infants and children in cardiac arrest with sepsis

Worksheet author(s): Thomaz Bittencourt Couto
Task Force: PLS
Date Submitted to SAC rep for peer review and approval: December 2022
SAC rep: Dianne Atkins, Ian Maconichie

PICOST / Research Question: PLS 1534 (ERC RR33.2) *(Attach SAC representative approved completed PICOST template)*
Population: Infants and children in cardiac arrest with sepsis
Intervention: Specific alteration in treatment algorithm
Comparator: Standard care (according to current treatment algorithm)
Outcome: All
Study Design: Randomized controlled trials (RCTs) and non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies) are eligible for inclusion.

Time Frame: All years and all languages were included as long as there was an English abstract

Year of last full review: (*insert year where this PICOST was most recently reviewed)*
2020

Current ILCOR Consensus on Science and Treatment Recommendation for this PICOST:
The management of children with septic shock–associated cardiac arrest has not been previously reviewed by the PLS Task Force. This EvUp was requested to determine the available evidence about this topic. The EvUp identified several studies involving prevention of cardiac arrest, but there was insufficient evidence of unique management approaches to the children with septic shock–associated cardiac arrest. As a result, the task force agreed that there was no indication of a need to consider a SysRev, and no treatment recommendation could be made at this time.
Treatment Recommendation: There is no treatment recommendation at this time.

Current Search Strategy (for an existing PICOST) included in the attached approved PICOST
2019 Search Strategy:
Database searched: Pubmed - Embase
Date Search Completed: 1 DEC 2019

Used terms
• sepsis, septic shock, severe sepsis, septic*;either as individual term (ti,ab,kw) or related MESH Term; combined using Bolean
operators
• specific blocks defined for certain indicators:
o paediatric: to define the 'paediatric population' we used the predefined BMI block (https://blocks.bmi-online.nl)
o cardiac arrest: CPR/cardiac arrest: "life support care" [MESH] OR "lifesupport" [TIAB] Or cardiopulmonary resuscitation [MESH] OR "cardiopulmonary resuscitation" [TIAB] OR ROSC [TIAB] OR "return of spontaneous circulation" [TIAB] OR heart arrest[MESH] OR "cardiac arrest" [TIAB]
o To exclude animal studies: NOT (animals[mh] NOT humans[mh])
o To exclude NOT "Letter"[PublicationType] OR"Editorial"[PublicationType] OR"Comment" [PublicationType])
• For Embase we pre filtered to avoid Medline duplicates by using [embase]/ lim NOT([embase]/lim AND [medline]/lim)

o Cardiac arrest:(resuscitation:ti,ab,kw OR 'resuscitation' OR 'resuscitation'/exp OR resuscitation OR 'heart' OR 'heart'/exp
OR heart) AND (arrest:ti,ab,kw OR 'heart' OR 'heart'/exp OR heart) AND ('arrest' OR 'arrest'/exp OR arrest)

New Search strategy: (for a new PICOST should be outlined here as per Evidence Update Process

Pubmed:
((((("sepsis"[MeSH Major Topic] OR "shock, septic"[MeSH Major Topic] OR ("sepsis"[Text Word] OR "septic shock"[Text Word] OR "severe sepsis"[Text Word])) AND ("child"[MeSH Major Topic] OR "infant"[MeSH Major Topic] OR ("child*"[Text Word] OR "paediatric population"[Text Word])) AND "life support care"[MeSH Major Topic]) OR "lifesupport"[Text Word]) AND ("cardiopulmonary resuscitation"[MeSH Major Topic] OR "heart arrest"[MeSH Major Topic] OR "cardiopulmonary resuscitation"[Text Word] OR "ROSC"[Text Word] OR "return of spontaneous circulation"[Text Word] OR "cardiac arrest"[Text Word])) NOT ("animals"[MeSH Terms] NOT "humans"[MeSH Terms])) NOT ("Letter"[Publication Type] OR "Editorial"[Publication Type] OR "Comment"[Publication Type])) AND 2019/01/01:2022/12/31[Date - Publication]

Embase:

('sepsis'/mj OR 'septic shock'/mj OR 'severe sepsis':ti,ab,kw) AND ('resuscitation'/mj OR 'heart arrest'/mj OR 'return of spontaneous circulation'/mj) AND [embase]/lim NOT ([embase]/lim AND [medline]/lim) AND [child]/lim AND 'human'/de AND (2019:py OR 2020:py OR 2021:py OR 2022:py)

Database searched: Pubmed, Embase

Time Frame: (existing PICOST) – updated from 1 dec 2019 to 1 sept 2022

Date Search Completed: 1 sept 2022
Search Results (Number of articles identified and number identified as relevant): 24, 10

Summary of Evidence Update: No new evidence found

Relevant Guidelines or Systematic Reviews

None

Organizatio n (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations

RCT:

Study Acronym; Author; Year Published	Aim of Study; Study Type; Study Size (N)	Patient Population	Study Intervention (# patients) / Study Comparator (# patients)	Endpoint Results (Absolute Event Rates, P value; OR or RR; & 95% CI)	Relevant 2° Endpoint (if any); Study Limitations; Adverse Events
	Study Aim:	**Inclusion Criteria:**	**Intervention:**	**1° endpoint:**	**Study Limitations:**

	Study Type:		Comparison:		

Nonrandomized Trials, Observational Studies

Study Acronym; Author; Year Published	Study Type/Design; Study Size (N)	Patient Population	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/Conclusion Comment(s)
	Study Type:	Inclusion Criteria:	1° endpoint:	

Reviewer Comments: *(including whether this PICOST should have a systematic or scoping review*)

No new studies found since 2019. There is still insufficient evidence of specific management approaches to the children with septic shock–associated cardiac arrest. As a result, no treatment recommendation can be made at this time.

Reference list: *(List by ILCOR ref standard (last name first author, year of publication, first page number) and insert hyperlink to all articles identified as relevant (if available on PubMed)*

1. Maconochie IK, Aickin R, Hazinski MF, Atkins DL, Bingham R, Couto TB, Guerguerian AM, Nadkarni VM, Ng KC, Nuthall GA, Ong GYK, Reis AG, Schexnayder SM, Scholefield BR, Tijssen JA, Nolan JP, Morley PT, Van de Voorde P, Zaritsky AL, de Caen AR; Pediatric Life Support Collaborators. Pediatric Life Support: 2020 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. Circulation. 2020 Oct 20;142(16_suppl_1):S140-S184. doi: 10.1161/CIR.0000000000000894. Epub 2020 Oct 21. PMID: 33084393.

Evidence Update Worksheet

End-tidal CO2 monitoring during CPR

Worksheet author(s): Antonio Rodriguez-Nunez / Barney Scholefield / Alexis Topjian
Task Force: Pediatric Life Support Task Force
Date Submitted to SAC rep for peer review and approval: December 2022
SAC rep:

PICOST / Research Question: *(Attach SAC representative approved completed PICOST template)*

Population: Infants & Children in any setting (in-hospital or out-of-hospital) with cardiac arrest

Intervention: the presence of variables -images, cut-off values or trends- during CPR (intra-arrest) that can provide physiologic feedback to guide resuscitation efforts, namely:

End-tidal carbon dioxide (CO2)

Comparators: the absence of such factors -images, cut-off values or trends.

Outcomes: Any clinical outcome.

Study Designs: STEP 1: Randomized controlled trials (RCTs) and non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies) that concern directly the population and intervention described above are eligible for inclusion. If it is anticipated that there will be insufficient studies from which to draw a conclusion, case series may be included in the initial search. The minimum number of cases for a case series to be included was set by the taskforce at 5 cases. Unpublished studies (e.g., conference abstracts, trial protocols) are excluded.
STEP 2: the same study designs and/or existing systematic or scoping reviews not directly concerning the population or intervention defined above but considered informative as additional evidence for the development of the final taskforce insights.

Timeframe: For STEP 1, all languages are included, as long as there is an English abstract. We searched articles from 2020 onwards. For STEP 2, if a systematic or scoping review of high quality (as per AMSTAR 2 tool) is identified, search can be limited to beyond data and/or scope of that review.

Year of last full review:
Scoping review last searched September 2020
Kool M, Atkins DL, Van de Voorde P, Maconochie IK, Scholefield BR; PLS ILCOR Task Force. Focused echocardiography, end-tidal carbon dioxide, arterial blood pressure or near-infrared spectroscopy monitoring during paediatric cardiopulmonary resuscitation: A scoping review. Resusc Plus. 2021 Mar 30;6:100109. doi: 10.1016/j.resplu.2021.100109. PMID: 34228034; PMCID: PMC8244529. (1)

Current ILCOR Consensus on Science and Treatment Recommendation for this PICOST:

[h3**] Task Force insights**

Although some data from adults and animal studies indicate that end-tidal CO2 monitoring during CPR (intra-arrest) can provide some physiologic feedback to guide resuscitation efforts, there is inadequate pediatric literature regarding end-tidal CO2 intra-arrest prognostic utility and the Task Force urges great caution until more literature is available (1). The treatment recommendation remains unaltered from 2015 (De Caen 2015 S17; Maconochie 2015 e1477) (2,3).

Treatment Recommendations
The confidence in effect estimates is so low that the panel decided a recommendation was too speculative. (De Caen 2015 S17; Maconochie 2015 e1477)(1-3)

Current Search Strategy (for an existing PICOST) included in the attached approved PICOST	1. End-tidal carbon dioxide [MESH] 2. End-tidal CO2 OR carbon dioxide or Capnography 3. 1 or 2 4. "Life Support Care"[Mesh] 5. "Cardiopulmonary Resuscitation"[Mesh] 6. "Heart Arrest"[Mesh] 7. ((((life support) OR cardiopulmonary resuscitation) OR ROSC) OR return of spontaneous circulation) OR cardiac arrest 8. 4 or 5 or 6 or 7 9. (("Infant"[Mesh]) OR "Adolescent"[Mesh]) OR "Child"[Mesh] 10. (infan* OR baby OR baby* OR babies OR toddler* OR minors OR minors* OR kid OR kids OR child OR child* OR children* OR schoolchild* OR schoolchild OR school child[tiab] OR school child*[tiab] OR adolescen* OR juvenil* OR youth* OR teen* OR under*age* OR pubescen* OR pediatrics[mh] OR pediatric* OR paediatric* OR peadiatric* OR school[tiab] OR school*[tiab]) (4,970,579) 11. 9 or 10 12. (animals [mh]) NOT humans [mh] 13. (newborn* OR new-born* OR perinat* OR neonat* OR prematur* OR preterm*) 14. 3 and 8 and 11 not 12 not 13 15. Limit to studies from 2020
New Search strategy: (for a new PICOST should be outlined here as per Evidence Update Process)	n/a
Database searched: eg Medline Embase Cochrane	Medline, Embase, Central
Time Frame: (existing PICOST) – updated from end of last search (please specify)	Last updated 11 September 2020. New Search Jan 2020 to 28th July 2022
Time Frame: (new PICOST) – at the discretion of the Task Force (please specify)	n/a
Date Search Completed:	25th July 2022
Search Results (Number of articles identified and number identified as relevant):	**98 in search – 5 identified as relevant + 1 additional** Identificacion: Records identified from databases: n=98 Additional (from the BP search): n=1

	Removed before screen due to duplication: n=4
	Screening: n=95 Excluded: n=89
	Included: n=6

Summary of Evidence Update:

Our Evidence Update in 2022 identified one randomized clinical trial (4) four observational studies (5-8) and one systematic review of pediatric extracorporeal resuscitation (9) that reported end-tidal CO2 monitoring during CPR and/or outcomes.

Sutton et al and the ICU-RESUS and Eunice Kennedy Shriver National Institute of Child Health; Human Development Collaborative Pediatric Critical Care Research Network Investigator Groups 2022 (4) conducted a hybrid, stepped wedge RCT of physiological training in 18 intensive care units caring for children. The training and debriefing in this emphasized intra-arrest and post-arrest physiologic targets, specifically diastolic blood pressure (DBP) and end-tidal CO_2 ($ETCO_2$) during CPR, and systolic blood pressure (SBP) in the post-arrest period. There was no significant difference in the primary outcome of survival to hospital discharge with favorable neurologic outcomes in the intervention group (53.8%) vs control (52.4%); risk difference (RD), 3.2% (95%CI, −4.6%to 11.4%); adjusted OR, 1.08 (95%CI, 0.76 to 1.53). There was also no significant difference in survival to hospital discharge in the intervention group (58.0%) vs control group (56.8%); RD, 1.6% (95%CI, −6.2%to 9.7%); adjusted OR, 1.03 (95%CI, 0.73 to 1.47).

Sorcher et al (5) in a single-center cohort study examined the associations between ETCO2, ROSC, and chest compression quality markers in children during active resuscitation from 2013 to 2018. They included 2746 minutes corresponding to 143 events and observed that median even ETCO2 . was 16.8 [9.3-26.3] mmHg. There was a significant difference in median event ETCO2 between events that achieved ROSC and those that did not (ROSC: 19.3 [14.4-26.6] vs. NO ROSC: 13.9 [6.6-25.5] mmHg; p < 0.05). When the events were based on patient age, this relationship held in adolescents (ROSC: 18.8 [15.5-22.3] vs. NO ROSC: 9.6 [4.4-15.9] mmHg; p < 0.05), but not in children or infants. Median event ETCO2 was significantly associated with chest compression rate less than 140 (p < 0.0001) and chest compression fraction 90-100 (p < 0.0001). They conclude that the unadjusted analyses of ETCO2 and chest compression date indicates and association between ETCO2 and ROSC in some patients (adolescents).

For the other observational studies, only the abstracts are available and/or are not published in detail.

Yu et al (6) reported some preliminary results of the international pediatric in-hospital cardiac arrest pediRES-Q project. They hypothesized that ETCO2>20mmHg averaged during the first 10 min of recorded CPR is associated with 1) compliance with AHA CC depth quality targets, and 2) survival to hospital discharge. In this report data from 4 pediRES-Q sites were analyzed. Of 44 events (24 index):median 10-min averaged ETCO2 was 23 [IQR 13, 37] mmHg, CPR duration was 23 [IQR 10, 53] min, return of spontaneous circulation (ROSC) was 70% (31/44), and survival to hospital discharge was 33% (8/24).ETCO2>20 mmHg cutoff was associated with CC depth [RR 1.55 (95%CI: 1.20,2.00) p=0.0007], and age-specific AHA depth quality target compliance [RR 1.01 (95%CI: 1.00,1.02) p=0.02. However, ETCO2 >20mmHg cutoff was not significantly associated with survival: ROSC [RR 1.08 (95%CI: 0.71, 1.65), p=0.72)] nor survival to hospital discharge [RR 1.10 (95%CI: 0.33, 3.65), p=0.87]. Mean 10-min averaged ETCO2 (no cutoff) was not significantly associated with CC depth (p=0.09), age-specific AHA depth quality target compliance (p=0.07), ROSC (p=0.57) , nor survival to hospital discharge (26 [IQR 14, 43] mmHg vs. 16 [IQR13,34] mmHg non-survival to hospital discharge, p=0.28). The authors conclude that ETCO2>20mmHg cutoff averaged during the first 10-min of recorded CPR was significantly associated with CC depth and age-specific AHA depth quality target compliance, but not with ROSC or survival to hospital discharge.

Dachepally et al (7) performed a retrospective chart review with the aim to evaluate potential predictors of survival in pediatric in-hospital cardiac arrest in a tertiary center during 2015-2020). A total of 78 IHCA events requiring CPR in 74 children (0-18 years) were assessed. Median duration of CPR was 10 min (IQR: 2-200). Overall, 42 (56 %) children survived to hospital discharge, and 27(36%) children survived to discharge with good neurological outcome. Their preliminary analysis revealed that patients' demographics including age, weight, ethnicity, sex and location of the CPR did not influence outcome. There were 26 (34%) children with congenital heart disease and 9 (12%) patients who had cardiac surgery. Cyanotic, acyanotic, STAT category or inciting event (hypoxia, hypotension or bradycardia) did not influence the outcome. Factors that improved survival were shorter duration of CPR (4.5 min vs 33 min; p< 0.001), O2 saturation >60% during CPR (p< 0.045) and serum lactate levels < 4 mmol/L (p< 0.004). Factors that negatively impacted survival were a higher number of epinephrine doses per 5 minutes of CPR (8 doses vs. 1 dose, p < 0.001), higher dosage of calcium gluconate >28 mg/kg (IQR: 0-200, p < 0.001), and amount of fluid resuscitation >10 ml/kg (IQR: 0-65, p < 0.001). Patients with hematological/oncological conditions (P< 0.04) had lowest survival rates. Higher blood pressure measurements (systolic, diastolic or mean) during CPR were not associated with impact on survival. Only, 11 of the 78 patients had end tidal CO2 monitoring during CPR and we didn't not find correlation between end-tidal CO2 measurements and survival. The authors conclude that based on their preliminary results, shorter duration of CPR, higher oxygen saturation levels during CPR and lower serum lactate levels post CPR are associated with survival to discharge in pediatric IHCA patients.

Adhaware et al (8) performed a single center before (2013-2017)-after(2018-2020) analysis of effect of the implementation of a quality improvement bundle (hands-on training and debriefing) on the quality of resuscitation. They collected data from the critical events logbook on CPR duration, chest compressions (CC) rate, ventilation rate (VR), timing of first epinephrine, blood pressure (BP), end-tidal CO2(EtCO2) and vital signs monitoring during CPR and performed univariate analysis, concluding their QI bundle was associated with improved compliance with high-quality CPR in children. However, the quality metrics for ETCO2 monitoring (58 vs. 68%) didn't reach statistical significance.

Sangari et al (9) conducted a systematic review and meta-analysis to investigate if predictors of survival with pediatric ECPR have changed before and after 2009. Patient age was a significant predictor of survival pre-2009 but is not correlated with survival post-2009. PaO2 was significantly higher in survivors than non survivors pre-2009 RR 0.15 [0.12-0.18, p < 0.05] but was not significantly different post-2009 (p> 0.05). End-tidal CO2, CPR duration, pre-CPR serum lactate, and pre-CPR creatinine were not significantly different between survivors and non-survivors in either pre-2009 or post-2009.

Relevant Guidelines or Systematic Reviews

Organization (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations
European Resuscitation Council Guidelines 2021: Paediatric Life Support Van de Voorde P, 2021 (10)	Guideline		2	ETCO2 is thought to relate to cardiac output and perfusion. However, in on study it was not associated with diastolic blood pressure nor with any pre-defined outcomes. This might be because ETCO2 is also affected by minute volume and ventilation:perfusion matching. This study was only descriptive	The level of certainty of the available paediatric evidence is too low to make nay recommendation for or against the use of ETCO2 to guide resuscitation efforts in children with cardiac arrest. More specifically, there is no single ETCO2 value that can be used as a target during CPR

				in nature, in a very selected population and at no point evaluated the outcomes associated with ETCO2-directed CPR.	or as an indicator to continue or discontinue CPR.
American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Topjian AA et al 2020 (11)	Guideline		2	End-tidal CO2 reflects both the cardiac output produced and ventilation efficacy and may provide feedback on the quality of CPR. A sudden rise in ETCO2 may be an early sign of ROSC.	ETCO2 monitoring may be considered to assess the quality of chest compressions, but specified values to guide therapy have not* been established in children. * note: there is an error in the Pediatrics version.

RCT:

Study Acronym; Author; Year Published	Aim of Study; Study Type; Study Size (N)	Patient Population	Study Intervention (# patients) / Study Comparator (# patients)	Endpoint Results (Absolute Event Rates, P value; OR or RR; & 95% CI)	Relevant 2° Endpoint (if any); Study Limitations; Adverse Events
Sutton et al and the ICU-RESUS and Eunice Kennedy Shriver National Institute of Child Health; Human Development Collaborative Pediatric Critical Care Research Network Investigator Groups 2022 (4)	**Aim:** To evaluate the effectiveness of a bundled intervention comprising physiologically focused CPR training at the point of care and structured clinical event debriefings. **Study type**: A parallel, hybrid stepped-wedge, cluster randomized trial **n=18 pediatric intensive care units (ICUs) from 10 clinical sites in the US.**	**Inclusion**: (1) age 37 weeks' corrected gestation or older and 18 years or younger and (2) CPR of any duration in the ICU. **Exclusion**: (1) limitation of ICU therapies (prior to cardiac arrest); (2) were brain dead; or (3) had an out-of-hospital cardiac arrest associated with the current hospitalization.	Randomization was performed at the level of the hospital sites enrolled in the study. Stepped-wedge crossing over from control to intervention for some sites. **Intervention:** 2-part ICU QI bundle consisting of CPR training at the point of care on a manikin and structured physiologically focused postcardiac arrest debriefings **n=526** **Control:** Usual care consisted of existing	**Primary endpoint:** There was no significant difference in the primary outcome of survival to hospital discharge with favorable neurologic outcomes in the intervention group (53.8%) vs control (52.4%); risk difference (RD), 3.2%(95%CI, –4.6%to 11.4%); adjusted OR, 1.08 (95%CI, 0.76 to 1.53).	**Relevant Secondary outcome Intervention versus control group:** End-tidal CO2 monitoring was performed in 64.8% in the intervention and 60.8% in the control group. Achievement of target ETCO2 was similar in both groups (58.1% in the intervention and 54.3% in the control group (95% CI, -32.2% to 6.7%). **Comments:** Baseline rate of overall survival to hospital discharge with favourable neurological outcome were higher in control group.

	n=1129 patients		resuscitation practices at the enrolled pediatric ICUs **n=548**	There was also no significant difference in survival to hospital discharge in the intervention group (58.0%) vs control group (56.8%); RD, 1.6% (95%CI, −6.2%to 9.7%); adjusted OR, 1.03 (95%CI, 0.73 to 1.47).	Low implementation of training in 4 ICUs

Nonrandomized Trials, Observational Studies

Study Acronym; Author; Year Published	Study Type/Design; Study Size (N)	Patient Population	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/Conclusion Comment(s)
Sorcher et al (5)	Single center cohort study N events =143	Children and adolescents	The median event ETCO2 for all 143 events was 16.8 [9.3-26.3] mmHg. There was a significant difference in median event ETCO2 between events that achieved ROSC and those that did not (ROSC: 19.3 [14.4-26.6] vs. NO ROSC: 13.9 [6.6-25.5] mmHg; p < 0.05). When the events were based on patient age, this relationship held in adolescents (ROSC: 18.8 [15.5-22.3] vs. NO ROSC: 9.6 [4.4-15.9] mmHg; p < 0.05), but not in children or infants. Median event ETCO2 was significantly associated with chest compression rate less than 140 (p < 0.0001) and chest compression fraction 90-100 (p < 0.0001).	This collection of ETCO2 and chest compression data in paediatric patients with unadjusted analyses suggests an association between ETCO2 and ROSC in adolescents.
Yu et al (6)	****Abstract only**** Multicenter in-hospital CPR cohort (pediRES-Q study).	Children	Of 44 events (24 index): median 10-min averaged ETCO2 was 23 [IQR 13, 37] mmHg, CPR duration was 23 [IQR 10, 53] min, return of spontaneous circulation (ROSC) was	ETCO2>20mmHg cutoff averaged during the first 10-min of recorded CPR was significantly associated with CC depth and age-specific AHA depth quality target compliance,

			70% (31/44), and survival to hospital discharge was 33% (8/24). ETCO2>20 mmHg cutoff was associated with CC depth [RR 1.55 (95%CI: 1.20,2.00) p=0.0007], and age-specific AHA depth quality target compliance [RR 1.01 (95%CI: 1.00,1.02) p=0.02. However, ETCO2 >20mmHg cutoff was not significantly associated with survival: ROSC [RR 1.08 (95%CI: 0.71, 1.65), p=0.72)] nor survival to hospital discharge [RR 1.10 (95%CI: 0.33, 3.65), p=0.87]. Mean 10-min averaged ETCO2 (no cutoff) was not significantly associated with CC depth (p=0.09), age-specific AHA depth quality target compliance (p=0.07), ROSC (p=0.57), nor survival to hospital discharge (26 [IQR 14, 43] mmHg vs. 16 [IQR13,34] mmHg non-survival to hospital discharge, p=0.28).	but not with ROSC or survival to hospital discharge.
	N= 44 events in 4 centers			
Dachepally (7)	**Abstract only** Single center retrospective chart review. N=74 (78 in-hospital cardiac arrest events	Children (0-18 years)	Median duration of CPR was 10 min (IQR: 2-200). 42(56 %) children survived to hospital discharge, 27(36%) with good neurological outcome. Factors that improved survival were shorter duration of CPR (4.5 min vs 33 min; p< 0.001), O2 saturation >60% during CPR (p< 0.045) and serum lactate levels < 4 mmol/L (p< 0.004). Factors that negatively impacted survival were a higher number of epinephrine doses per 5 minutes of CPR, higher dosage of calcium gluconate, and amount of fluid resuscitation. Only, 11 of the 78 patients had end-tidal CO2 monitoring during CPR and they didn't find correlation between end-tidal CO2 measurements and survival.	Shorter duration of CPR, higher oxygen saturation levels during CPR and lower serum lactate levels post CPR were associated with survival to discharge in pediatric IHCA patients. The collected end-tidal CO2 were so limited that no conclusions can be made.
Adhaware (8)	**Abstract only** Single center before-after	Children	Median CPR duration for pre-and post-QI bundle were 5 vs. 3 minutes and timing of first dose of epinephrine were 2 vs. 2 minutes. They observed a significant improvement in compliance with	The implementation of a quality bundle (hands-on training and debriefing) was associated with improved compliance with some high-quality CPR metrics.

	analysis of quality improvement bundle. N events before=58 N events after=41		CC rate from 72% events before vs. 100% events after (p=0.0009). There was a significant decrease in hyperventilation from 100% events before vs. 63% events after (p< 0.00001). The improvement in monitoring of ETCO2 was not significant (from 58% before vs. 68% after, p=0.3. The BP monitoring improved from 14% to 39%, p=0.004.	However the improvement in ETCO2 was not significant and no data about CPR outcomes were reported.
Sangari (9)	****Abstract only**** Systematic review and meta-analysis including 3,454 patients from 30 studies Pre and post 2009 results were compared	Children	Patient age was a significant predictor of survival pre-2009 but not post-2009. PaO2 was significantly higher in survivors than non-survivors pre-2009 but not post-2009. End-tidal CO2, CPR duration, pre-CPR serum lactate, and pre-CPR creatinine were not significantly different between survivors and non-survivors in either pre-2009 or post-2009.	In the subset of children treated with ECPR, End-tidal CO2 was not a predictor of survival.

Reviewer Comments: *(including whether this PICOST should have a systematic or scoping review)*

The available data indicate that monitoring of ETCO2 contributes to improve the quality of CPR and to the adherence to current guidelines.
However, it has not been demonstrated the impact of ETCO2 monitoring and feedback on patients' outcomes that is the main focus of our PICOST.

We recommend awaiting the publication of the abstract only publications to allow full critical appraisal.
A task force led systematic review may be justified following their publication.

Reference list: *(List by ILCOR ref standard (last name first author, year of publication, first page number) and insert hyperlink to all articles identified as relevant (if available on PubMed)*

References
1.   Kool M, Atkins DL, Van de Voorde P, Maconochie IK, Scholefield BR, Force PIT. Focused echocardiography, end-tidal carbon dioxide, arterial blood pressure or near-infrared spectroscopy monitoring during paediatric cardiopulmonary resuscitation: A scoping review. Resusc Plus. 2021;6:100109.
2.   de Caen AR, Maconochie IK, Aickin R, Atkins DL, Biarent D, Guerguerian AM, et al. Part 6: Pediatric Basic Life Support and Pediatric Advanced Life Support: 2015 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. Circulation. 2015;132(16 Suppl 1):S177-203.
3.   Maconochie IK, de Caen AR, Aickin R, Atkins DL, Biarent D, Guerguerian AM, et al. Part 6: Pediatric basic life support and pediatric advanced life support: 2015 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations. Resuscitation. 2015;95:e147-68.

4.   Sutton RM, Wolfe HA, Reeder RW, Ahmed T, Bishop R, Bochkoris M, et al. Effect of Physiologic Point-of-Care Cardiopulmonary Resuscitation Training on Survival with Favorable Neurologic Outcome in Cardiac Arrest in Pediatric ICUs: A Randomized Clinical Trial. JAMA - Journal of the American Medical Association. 2022;327:934-45.

5.   Sorcher JL, Hunt EA, Shaffner DH, O'Brien CE, Jeffers JM, Jones SI, Newton H, Duval-Arnould J. Association of end-tidal carbon dioxide levels during cardiopulmonary resuscitation with survival in a large paediatric cohort. Resuscitation. 2022;170:316-323.

6.   Yu P, Sutton R, Hanna R, Zhang X, Griffis H, Niles D et al. Association of End Tidal Carbon Dioxide >20 mm Hg with Pediatric In-hospital Cardiac Arrest Quality of CPR and Survival. The Latest in Resuscitation Research: Highlights From the 2020 American Heart Association's Resuscitation Science Symposium. J Am Heart Assoc, 2021;10(16). https://doi.org/10.1161/JAHA.121.021575

7.   Dachepally R, Hamzah M, Worley S. Predictors of survival In pediatric inpatient Cardiac Arrest. Critical Care Medicine 50(1): 188, January 2022. DOI:10.1097/01.ccm.0000807924.94022.53

8.   Awadhare P, Frydson I, Balakumar N, Doerr D, Barot K, Bhalala US. Impact of quality improvement bundle on compliance with resuscitation guidelines in children. Critical Care Medicine 50(1):p 697, January 2022. | DOI: 10.1097/01.ccm.0000811884.96283.f4

9.   Sangari A, Sood N, Hauger J Quantifying the Effect of Technological Advancements and Guidelines on Pediatric Extracorporeal Cardiopulmonary Resuscitation Survival Outcomes. Circulation 2020; https://doi.org/10.1161/circ.142.suppl_4.

10.   Van de Voorde P, Turner NM, Djakow J, de Lucas N, Martinez-Mejias A, Biarent D, et al. European Resuscitation Council Guidelines 2021: Paediatric Life Support. Resuscitation. 2021;161:327-87.

11.   Topjian AA, Raymond TT, Atkins D, Chan M, Duff JP, Joyner BL, Jr., et al. Part 4: Pediatric Basic and Advanced Life Support: 2020 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation. 2020;142(16_suppl_2):S469-s523.

Evidence Update Worksheet

Energy doses for Pediatric Defibrillation (PLS) during resuscitation

Worksheet author(s): Jason Acworth, Gabrielle Nuthall, Gene Ong
Task Force: Pediatric Life Support
Date Submitted to SAC rep for peer review and approval: December 2022
SAC rep: Dianne Atkins, Ian Maconochie

PICOST / Research Question: Energy Dosing for Pediatric Defibrillation (PLS)

Population	Infants and children who are in ventricular fibrillation or pulseless ventricular tachycardia after out-of-hospital or in-hospital cardiac arrest (excluding newborn children)
Intervention	initial defibrillation dose of 2J/kg
Comparison	initial defibrillation dose of 4J/kg or any other specified dose
Outcomes	Clinical outcomes, including - short-term survival and neurological outcomes (e.g. survival to hospital discharge, survival at 30-days), - long-term survival and neurological outcomes (e.g. PCPC at 6-months, and 1-year).
Study Design	Randomized controlled trials (RCTs) and non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies) that directly concern the population and intervention described above are eligible for inclusion. If it is anticipated that there will be insufficient studies from which to draw a conclusion, case series may be included in the initial search. The minimum number of cases for a case series to be included was set by the taskforce at 5. Unpublished studies (e.g., conference abstracts, trial protocols) are excluded.
Timeframe	All studies published since last search (December 1, 2019) and all languages are included as long as there is an English abstract

Year of last full review: 2015

Current ILCOR Consensus on Science and Treatment Recommendation for this PICOST:
We suggest the routine use of an initial dose of 2 to 4 J/kg of monophasic or biphasic defibrillation waveforms for infants or children in VF or pVT cardiac arrest [weak recommendation, very-low-quality evidence].
There is insufficient evidence from which to base a recommendation for second and subsequent defibrillation dosages.
(Maconochie 2015 e147; de Caen 2015 S177)

Database searched: Embase database and indexed journals in Medline
Time Frame: Last updated 30 October 2019. New search 1 January 2019 to 5 September 2022 to include date of previous search.
Date Search Completed: 5 September 2022

Search Strategies:

SEARCH STRATEGY #1: Previously utilized strategy from 2019 EvUp

PUBMED.ncbi.nlm.nih.gov
((((("pulse"[MeSH Terms] OR "heart rate"[MeSH Terms] OR "pulse"[Title/Abstract] OR "pulse check"[Title/Abstract] OR "gasp*"[Title/Abstract]) AND (("infan*"[Text Word] OR "child*"[Text Word] OR "adolescen*"[Text Word] OR "pediatric*"[Text Word] OR "paediatric*"[Text Word] OR "pube*"[Text Word] OR "juvenil*"[Text Word] OR "school*"[Text Word] OR "newborn*"[Title/Abstract] OR "newborn*"[Title/Abstract] OR "neonat*"[Title/Abstract] OR "neonat*"[Title/Abstract] OR "premature*"[Title/Abstract] OR "postmature*"[Title/Abstract] OR "premature*"[Title/Abstract] OR "post mature*"[Title/Abstract] OR "preterm*"[Title/Abstract] OR "preterm*"[Title/Abstract] OR "baby"[Title/Abstract] OR "babies"[Title/Abstract] OR "toddler*"[Title/Abstract] OR "youngster*"[Title/Abstract] OR "preschool*"[Title/Abstract] OR "kindergart*"[Title/Abstract] OR "kid"[Title/Abstract] OR "kids"[Title/Abstract] OR "playgroup*"[Title/Abstract] OR "play group*"[Title/Abstract] OR "playschool*"[Title/Abstract] OR "prepube*"[Title/Abstract] OR "preadolescen*"[Title/Abstract] OR "junior high*"[Title/Abstract] OR "highschool*"[Title/Abstract] OR "senior high"[Title/Abstract] OR "young people*"[Title/Abstract] OR "minors"[Title/Abstract]) NOT ("animals"[MeSH Terms] NOT ("humans"[MeSH Terms] AND "animals"[MeSH Terms]))) AND ("life support care"[MeSH Terms] OR "life support"[Title/Abstract] OR "cardiopulmonary resuscitation"[MeSH Terms] OR "cardiopulmonary resuscitation"[Title/Abstract] OR "ROSC"[Title/Abstract] OR "return of spontaneous circulation"[Title/Abstract] OR "heart arrest"[MeSH Terms] OR "cardiac arrest"[Title/Abstract])) NOT ("animals"[MeSH Terms] NOT "humans"[MeSH Terms])) NOT ("Letter"[Publication Type] OR "Editorial"[Publication Type] OR "Comment"[Publication Type])) AND 2019/12/01:2022/08/11[Date - Publication]) AND (2019/12/1:2022/8/11[pdat])

Search Results for Search Strategy #1 (Number of articles identified and number identified as relevant):
671 articles after limit search 2019-2022
668 articles after 3 duplicates removed
21 articles after 647 excluded upon title and abstract screening
1 article included in analysis after full text review

SEARCH STRATEGY #2: Revised search strategy devised in collaboration with information specialist

EMBASE.com

#1	defibrill*:ti,ab,kw
#2	'defibrillation'/de OR 'defibrillator'/de OR 'external defibrillator'/exp OR 'low energy defibrillator'/de OR 'high energy defibrillator'/de
#3	(#1 OR #2) NOT (implant*:ti OR icd:ti OR external:ti)
#4	#3 NOT ([conference abstract]/lim OR [conference review]/lim OR [editorial]/lim OR [erratum]/lim OR [letter]/lim OR [note]/lim OR [book]/lim OR 'case report'/de) AND [2019-2022]/py
#5	((young NEAR/3 (person* OR people)):ti,ab,kw) OR adolescent$:ti,ab,kw OR boy$:ti,ab,kw OR child:ti,ab,kw OR children:ti,ab,kw OR infant$:ti,ab,kw OR girl$:ti,ab,kw OR juvenile*:ti,ab,kw OR kids:ti,ab,kw OR kinder*:ti,ab,kw OR paediatric$:ti,ab,kw OR pediatric$:ti,ab,kw OR 'preadolescen*':ti,ab,kw OR 'pre-adolescen*':ti,ab,kw OR 'preschool':ti,ab,kw OR 'pre-school':ti,ab,kw OR school$:ti,ab,kw OR schoolchild*:ti,ab,kw OR student$:ti,ab,kw OR teen$:ti,ab,kw OR teenager$:ti,ab,kw OR toddler$:ti,ab,kw OR 'young people':ti,ab,kw OR 'young person':ti,ab,kw OR youth:ti,ab,kw OR youths:ti,ab,kw
#6	'adolescent'/de OR 'adolescence'/de OR 'child'/de OR 'child health care'/de OR 'child hospitalization'/de OR 'hospitalized adolescent'/de OR 'hospitalized child'/de OR 'infant'/exp OR 'pediatrics'/de OR 'pediatric advanced life support'/de OR 'pediatric emergency medicine'/de OR 'preschool child'/de OR 'school child'/de OR 'toddler'/de OR 'boy'/de OR 'girl'/de

#7	babies:ti,ab,kw OR baby:ti,ab,kw OR birth:ti,ab,kw OR neonat*:ti,ab,kw OR 'new* born':ti,ab,kw OR newborn$:ti,ab,kw OR 'post-natal':ti,ab,kw OR postnatal:ti,ab,kw OR 'post neonatal':ti,ab,kw OR postneonatal:ti,ab,kw
#8	'baby'/de OR 'delivery room'/de OR 'neonatology'/exp OR 'newborn'/de OR 'newborn care'/exp OR 'perinatal period'/de OR 'postnatal care'/de
#9	#5 OR #6 OR #7 OR #8
#10	energy:ti,ab,kw OR dose*:ti,ab,kw OR charge:ti,ab,kw OR charging:ti,ab,kw OR regimen:ti,ab,kw OR 'j/kg':ti,ab,kw OR joule$:ti,ab,kw
#11	#4 AND #9 AND #14

Cochrane Library

#1	defibrill*:ti,ab,kw
#2	[mh ^"electric countershock"] OR [mh ^defibrillators]
#3	#1 OR #2
#4	((young NEAR/3 (person* OR people)):ti,ab,kw) OR adolescent*:ti,ab,kw OR boy*:ti,ab,kw OR child:ti,ab,kw OR children:ti,ab,kw OR infant*:ti,ab,kw OR girl*:ti,ab,kw OR juvenile*:ti,ab,kw OR kids:ti,ab,kw OR kinder*:ti,ab,kw OR paediatric*:ti,ab,kw OR pediatric*:ti,ab,kw OR 'preadolescen*':ti,ab,kw OR 'pre-adolescen*':ti,ab,kw OR 'preschool':ti,ab,kw OR 'pre-school':ti,ab,kw OR school*:ti,ab,kw OR schoolchild*:ti,ab,kw OR student*:ti,ab,kw OR teen*:ti,ab,kw OR teenager*:ti,ab,kw OR toddler*:ti,ab,kw OR 'young people':ti,ab,kw OR 'young person':ti,ab,kw OR youth:ti,ab,kw OR youths:ti,ab,kw
#5	babies:ti,ab,kw OR baby:ti,ab,kw OR birth:ti,ab,kw OR neonat*:ti,ab,kw 'new* born':ti,ab,kw OR newborn$:ti,ab,kw OR 'post-natal':ti,ab,kw OR postnatal:ti,ab,kw OR 'post neonatal':ti,ab,kw OR postneonatal:ti,ab,kw
#6	#4 OR #5
#7	energy:ti,ab,kw OR dose*:ti,ab,kw OR charge:ti,ab,kw OR charging:ti,ab,kw OR regimen:ti,ab,kw OR joule$:ti,ab,kw
#8	#3 AND #6 AND #11

Both searches limited to 2019 onwards

Search Results (Number of articles identified and number identified as relevant):
48 articles after limit search 2019-2022
44 articles after 4 duplicates removed
4 articles after 40 excluded upon title and abstract screening
1 article included in analysis after full text review

Summary of Evidence Update:
The 2020 Scoping Review (Maconochie 2020 S140) identified a single 2019 systematic review (Mercier E 2019 241) that identified no pediatric studies linking the initial or cumulative energy delivered to survival to hospital discharge and no link between long-term survival or survival with good neurological outcome. Meta-analysis could not be performed because the component population groups were extremely heterogeneous.

Our Evidence Update in 2022 identified one new pediatric study on this subject. This in-hospital registry study (Hoyme 2020 88) had been noted in the 2020 Scoping Review (Maconochie 2020 S140) but had not been published until after the initial search so was not included in the analysis.

Relevant Guidelines or Systematic Reviews

Organization (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations
Maconochie, 2020	Guideline		1	Single 2019 systematic review (Mercier E 2019 241) that identified no pediatric studies linking the initial or cumulative energy delivered to survival to hospital discharge and no link between long-term survival or survival with good neurological outcome	Routine use of an initial dose of 2 to 4 J/kg of monophasic or biphasic defibrillation waveforms for infants or children in VF or pVT cardiac arrest is recommended. No recommendation for second and subsequent defibrillation dosages because of lack of evidence.

RCT:

Study Acronym; Author; Year Published	Aim of Study; Study Type; Study Size (N)	Patient Population	Study Intervention (# patients) / Study Comparator (# patients)	Endpoint Results (Absolute Event Rates, P value; OR or RR; & 95% CI)	Relevant 2° Endpoint (if any); Study Limitations; Adverse Events
No new pediatric RCTs published					

Nonrandomized Trials, Observational Studies

Study Acronym; Author; Year Published	Study Type/Design; Study Size (N)	Patient Population	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/Conclusion Comment(s)
Hoyme, 2020	In-hospital registry study (n=422).	Infants and children (18 years of age or younger) with cardiac arrest and initial VF/pVT	The primary outcome was survival to hospital discharge in the 301 patients ≤12 years old. After adjusting for patient-level variables, authors compared outcomes associated with first energy doses of 1.7-2.5 J/kg (n = 122) versus outcomes associated with all other first energy dose categories (n = 179). The aOR for survival to hospital discharge was significantly lower when first defibrillation doses differed from 1.7-2.5 J/kg (aOR 0.64 [95% CI 0.44-0.89], p < 0.01). Secondary outcome measure was ROSC and secondary analysis also done on	First shock energy doses other than 1.7 to 2.5 J/kg were associated with lower survival to hospital discharge among the 301 patients 12 years of age or younger with initial VF/pVT, and first shock doses more than 2.5 J/kg were associated with lower survival rates in all patients 18 years of age or younger with initial VF.

			all patients ≤ 18 years old and those with VF as initial rhythm.	

Reviewer Comments: *(including whether this PICOST should have a systematic or scoping review)*

Differences remain in the first shock dose recommended by ILCOR member councils, with the ERC and ANZCOR recommending 4J/kg for the first and all
subsequent shocks and the AHA recommending an initial dose of 2-4 J/kg (for ease of teaching, a dose of 2 J/kg is used in algorithms and training materials).
For refractory VF, the AHA guidelines recommend increasing the defibrillation dose to 4 J/kg, suggesting that subsequent energy doses should be at least 4 J/kg
and noting that higher levels may be considered, not to exceed 10 J/kg.
The recently performed systematic review (Mercier 2019 241) failed to show a significant benefit of one dosing regimen over another but was hampered by small
sample sizes and study heterogeneity.
The more recent large pediatric in-hospital registry study (Hoyme 2020 88) provided support for a 2 J/kg dose for initial defibrillation but did not provide guidance
for subsequent doses.

As our evidence update identified only one new publications since the last update in 2020, and the finding of this study supported current ILCOR
recommendations, a new systematic review of energy dosing for pediatric cardiac arrest patients is not warranted at this time.

The ILCOR treatment recommendations from 2020 (Maconochie 2020 S140) should remain unchanged:

We suggest the routine use of an initial dose of 2 to 4 J/kg of monophasic or biphasic defibrillation waveforms for infants or children in VF or pVT cardiac arrest. There is insufficient evidence from which to base a recommendation for second and subsequent defibrillation dosages

Reference list:

Maconochie IK, 2015, e147 [https://pubmed.ncbi.nlm.nih.gov/26477423/]

de Caen AR, 2015, S177 [https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6191296/]

Maconochie IK, 2020, S140 [https://pubmed.ncbi.nlm.nih.gov/33084393/]

Mercier E, 2019, 241 [https://pubmed.ncbi.nlm.nih.gov/31029714/]

Hoyme DB, 2020, 88 [https://pubmed.ncbi.nlm.nih.gov/32522702/]

Evidence Update Worksheet

Epinephrine frequency during CPR

Worksheet author(s): Janice Tijssen, Thomaz Bittencourt, Monica Kleinman, Amelia Reis
Task Force: PLS
Date Submitted to SAC rep for peer review and approval: December 2022
SAC rep: Dianne Atkins, Ian Maconichie

PICOST / Research Question: *(Attach SAC representative approved completed PICOST template)*
Population: Infants and children in cardiac arrest (in or out of hospital) (excluding resuscitation at birth)

Intervention: 1) Administration of the initial dose of epinephrine earlier or later than current guideline recommendations. 2) Administration of epinephrine more or less frequently than every 3-5 minutes following the initial dose.

Comparators: Timing of administration of epinephrine in line with current guideline recommendations.

Outcomes: Clinical outcomes, including short-term survival and neurological outcomes (e.g. hospital discharge, 28-days, 30-days, and 1-month), and long-term survival and neurological outcomes (e.g. 3-months, 6-months, and 1-year).

Study designs: Randomized controlled trials (RCTs) and non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies) were eligible for inclusion. Unpublished studies (e.g., conference abstracts, trial protocols) were excluded.

Timeframe: All years and all languages were included as long as there was an English abstract

Year of last full review: 2020

Current ILCOR Consensus on Science and Treatment Recommendation for this PICOST:
We suggest the initial dose of epinephrine in pediatric patients with both non-shockable IHCA and OHCA be administered as early in the resuscitation as possible (weak recommendation, very-low-certainty evidence).

We cannot make a recommendation for the timing of the initial epinephrine dose in shockable pediatric cardiac arrest.

The confidence of the effect estimates is so low that we cannot make a recommendation regarding the optimal epinephrine interval for subsequent epinephrine doses in pediatric patients with IHCA or OHCA.

Current Search Strategy (for an existing PICOST) included in the attached approved PICOST
1   exp Heart Arrest/ (53815)
2   Ventricular Fibrillation/ (17645)
3   Tachycardia, Ventricular/ (16100)
4   exp Cardiopulmonary Resuscitation/ (21053)
5   heart arrest*.tw,kf. (2488)
6   cardi* arrest*.tw,kw. (45290)
7   asystole*.tw,kf. (4104)
8   ventric* fibrillation*.tw,kf. (20056)

9   ventric* tachycardia*.tw,kf. (26513)

10   pulseless electrical activity.tw,kf. (1031)

11   advanced cardi* life support.tw,kf. (1337)

12   ACLS.tw,kf. (1252)

13   resuscitat*.tw,kf. (72828)

14   CPR.tw,kf. (14481)

15   or/1-14 (174802)

16   Epinephrine/ (55769)

17   epinephrine.tw,kf. (40413)

18   adrenaline.tw,kf. (20413)

19   or/16-18 (79593)

20   Adolescent/ or exp Child/ or exp Infant/ or (child* or p?ediatric* or kid or kids or girl or girls or boy or boys or infant or infants or baby or babies or toddler* or youth* or young or youngster* or juvenile* or minors* or teen* or adolescent* or adolescence or puber* or pubescen* or pre?school* or kindergarten* or school* or highschool* or PICU).tw,kf. (4903057)

21   15 and 19 and 20 (890)

22   limit 21 to ed=19460101-20200311 (712)

23   21 not 22 (178)

New Search strategy: (for a new PICOST should be outlined here as per Evidence Update Process)
Database searched: Medline
Time Frame: (existing PICOST) – updated from end of last search (please specify) March 11, 2020 to May 31, 2022

Time Frame: (new PICOST) – at the discretion of the Task Force (please specify)
Date Search Completed: May 31, 2022
Search Results (Number of articles identified and number identified as relevant):
177: 151 irrelevant, 19 excluded at full text, 7 extracted (Lin in previous SR)
Summary of Evidence Update:
Insufficient new evidence to justify a new SR. New studies unlikely to change current TR.

Relevant Guidelines or Systematic Reviews

Organization (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations
ILCOR, Ohshimo, 2021	**SR**	This is the product of the last ILCOR SR for this topic	7 observational studies	The earlier administration of epinephrine was favorable for both in-hospital and out-of-hospital cardiac arrest. Because of a limited number of eligible studies and the presence of severe confounding factors, they could not determine the	We suggest the initial dose of epinephrine in pediatric patients with both non-shockable IHCA and OHCA be administered as early in the resuscitation as possible (weak recommendation,

				optimal interval of epinephrine administration.	very-low-certainty evidence). We cannot make a recommendation for the timing of the initial epinephrine dose in shockable pediatric cardiac arrest.
<u>**Faria, 2020**</u>	<u>SR</u>	To assess the efficacy of different doses, times for infusion of the first dose, intervals of administration of subsequent doses, and the number of epinephrine doses in the survival of children and adolescents who had an in-hospital or out-of-hospital cardiorespiratory arrest	2 RCTs and 14 observational studies (broader question, therefore more articles)	Fukuda and Andersen showed shorter time to epinephrine administration was associate with higher survival and better neurological survival (Andersen), but Lin showed no associations but was in trauma OHCA. Only one study assessed the interval between doses of epinephrine and concluded that the interval currently recommended (3 to 5 minutes) leads to lower survival when compared to longer intervals (IHCA, Hoyme 2017).	Epinephrine should be administered in cardiorespiratory arrest (OHCA) in children as soon as possible.

RCT: n/a

Study Acronym; Author; Year Published	Aim of Study; Study Type; Study Size (N)	Patient Population	Study Intervention (# patients) / Study Comparator (# patients)	Endpoint Results (Absolute Event Rates, P value; OR or RR; & 95% CI)	Relevant 2° Endpoint (if any); Study Limitations; Adverse Events

	Study Aim: Study Type:	Inclusion Criteria:	Intervention: Comparison:	1° endpoint:	Study Limitations:

Nonrandomized Trials, Observational Studies

Study Acronym; Author; Year Published	Study Type/Design; Study Size (N)	Patient Population	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/Conclusion Comment(s)
TIMING FIRST DOSE EPI- OHCA				
All-Japan Utstein Registry of the Fire and Disaster Management Agency, Matsuyama, 2020	Study Type: Observational	Inclusion Criteria: OHCA 8-17 years	1° endpoint: Propensity score: risk of receiving epinephrine balanced by utstein criteria with an SD of <0.25- stratified by timing- (<=15minutes vs no epinephrine) earlier time was associated with 1 month survival (RR 1.92 (1.02-3.61) and pre-hospital ROSC (RR2.40 (1.19-4.83)	No difference for epi vs no epi, but if epi administered within 15 minutes, then survival benefit.
Lee, 2019	Observational, single centre (Taiwan)	OHCA and pulseless on ED arrival	Epi was not the focus of this study. Mean time to first epi dose (not in pre-hospital setting) in ED in those with ROSC vs no ROSC and those with	Long time to first dose epi if not given in the pre-hospital setting by EMS.

			survival to HD and no survival to HD: no difference (both ~17 minutes)	
TIMING FIRST DOSE EPI- IHCA				
GWTG, Raymond, 2019 (but not in ILCOR SR)	Observational	IHCA (exclude shockable rhythm, trauma, vasopressors at time of arrest, ECMO, epi before loss of pulse, delay in epi >20 minutes after loss of pulse, vasopressin before epi)	Analyzed delayed epinephrine (>5 minutes) by hospital rates of delayed epinephrine (quartiles) (so not patient-level analyses)- higher rates of ROSC and 24h survival for adjusted analyses for hospitals with lowest rates of delayed epinephrine (p=0.019 and 0.018, respectively), but no survival differences.	Extensive differences in epinephrine administration time across institutions-opportunity for quality improvement.
GWTG, Holmberg, 2020	Observational	In-hospital **bradycardia** + CPR, excluded pulseless)	Propensity score: risk of epi <10 minutes after start of CPR vs no epi at that time point (SD <0.1): Lower ROC (RR 0.94 (0.91-0.96)), 24h survival (RR0.85 (0.81-0.90)), and favourable neurological outcomes (0.76 (0.68-	Epinephrine was associated with worse outcomes in children receiving cardiopulmonary resuscitation for bradycardia with poor perfusion.

			0.84)). Epi was also associated with increased progression to pulselessness (RR 1.17 (1.06-1.28)). All P<0.001. Consistent findings in sensitivity analyses.	
EPI DOSING INTERVAL				
Kienzle, 2021	Observational Single centre (CHOP)	IHCA (exclude: bolus dose of other vasopressor used, ECPR)	Adjusted OR for survival with favourable neurological outcome 2.56 (1.07-6.14, p=0.036), survival to discharge (2.69 (1.12-6.43) and ROSC (8.88, 1.91-41.3) (and shorter CPR duration) for frequent epi (i.e., interval between doses <2minutes	These results suggest that a more frequent epinephrine dosing interval than recommended in current guidelines, at least during the initial minutes of resuscitation, may be a strategy to improve outcomes from pediatric cardiac arrest.

Reviewer Comments: *(including whether this PICOST should have a systematic or scoping review)*
Time to first dose epi- OHCA
The new evidence suggest that epinephrine may not be effective if given beyond 15 minutes after EMS arrival. The evidence is low quality from observational studies.

Time to first dose epi- IHCA
One study examined hospital-level average timing of first dose epinephrine, and found extensive differences between institutions. After adjustment for patient and hospital variables, those higher-performing hospitals (i.e., shorter time to first dose epi) had higher ROSC and 24h survival, but no difference in critical outcomes.

For poorly perfused bradycardia requiring CPR but with a pulse, epinephrine administration was associated with worse critical outcomes and increased progression to pulselessness. This is a different population than cardiac

arrest, but included in this EvUp because the patients received CPR >2minutes. The treatment for bradycardia is reviewed in a different PICOST and should not be considered in the context of this PICOST.

Epinephrine dosing Interval
One study examined the dosing interval of epinephrine during IHCA and found an interval of <=2 minutes compared to >2minutes had improved critical outcomes.

Reference list: *(List by ILCOR ref standard (last name first author, year of publication, first page number) and insert hyperlink to all articles identified as relevant (if available on PubMed)*

Matsuyama T, 2020; 194 [https://www.ncbi.nlm.nih.gov/pubmed/31948649
Lee J, 2019; 1 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6505536
Raymond T, 2019; 405 https://dx.doi.org/10.1097/PCC.0000000000001863
Holmberg M, 2020; 230 [https://www.ncbi.nlm.nih.gov/pubmed/32092403
Kienzle M, 2021; 885 https://www.ncbi.nlm.nih.gov/pubmed/34411505]

Evidence Update Worksheet

FiO2 titrated to oxygenation during cardiac arrest

Worksheet author(s): Steve Schexnayder, Allan De Caen, Florian Hoffmann, Jana Djakow
Task Force: PLS
Date Submitted to SAC rep for peer review and approval: December 2022
SAC rep: Dianne Atkins, Ian Maconochie

PICOST / Research Question: Oxygen Titration during Pediatric Cardiac Arrest (PLS #396)

Population	Among infants and children who are in cardiac arrest in any setting (excluding newborn infants)
Intervention	does an FiO2 titrated to oxygenation during cardiac arrest
Comparison	compared with the use of 100% oxygen
Outcomes	Any clinical outcome
Study Design	Randomized controlled trials (RCTs) and non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies) that directly concern the population and intervention described above are eligible for inclusion. If it is anticipated that there will be insufficient studies from which to draw a conclusion, case series may be included in the initial search. The minimum number of cases for a case series to be included was set by the taskforce at 5. Unpublished studies (e.g., conference abstracts, trial protocols) are excluded.
Timeframe	All studies published since last search (December 1, 2019) and all languages are included as long as there is an English abstract

PICOST / Research Question: *(Attach SAC representative approved completed PICOST template)*

Year of last full review: 2019
Current ILCOR Consensus on Science and Treatment Recommendation for this PICOST: There is insufficient information to recommend a specific inspired oxygen concentration for ventilation during attempted resuscitation after cardiac arrest in infants and children.
Current Search Strategy (for an existing PICOST) included in the attached approved PICOST
Database searched: Medline
((((((((((((((((Air[MesH] or air[Title/Abstract]) OR Oxygen[MeSH]) OR oxygen*[Title/Abstract] OR O2[Title/Abstract] OR hypoxia[Title/Abstract] OR hypoxaemia[Title/Abstract]) OR hypoxemia[Title/Abstract] OR hyperoxia[Title/Abstract] OR hyperoxia[Title/Abstract] OR hyperoxemia[Title/Abstract] OR hyperoxaemia[Title/Abstract] OR oxygen titration[Title/Abstract] OR saturation[Title/Abstract] OR oximetry[Title/Abstract] OR Ventilation[MeSH]) OR Ventilation[Title/Abstract]) AND ((((((((((((((((((Heart

Arrest[MeSH Terms]) OR heart massage*[Title/Abstract]) OR heart arrest[Title/Abstract]) OR cardiac arrest[Title/Abstract]) OR cardiopulmonary arrest[Title/Abstract]) OR cardiovascular arrest[Title/Abstract]) OR Ventricular Fibrillation[MeSH Terms]) OR ventricular fibrillation[Title/Abstract]) OR asystol*[Title/Abstract]) OR pulseless electrical activity[Title/Abstract]) OR PEA[Title/Abstract]) OR resuscitation[Title/Abstract] OR Cardiopulmonary Resuscitation[MeSH Terms]) OR cardiopulmonary resuscitation[Title/Abstract]) OR life support[Title/Abstract]) OR ACLS[Title/Abstract]) OR Heart Massage[MeSH Terms]) OR heart massage*[Title/Abstract]) OR cardiac massage*[Title/Abstract]) OR chest compression*[Title/Abstract]) OR cardiac compression*[Title/Abstract])) AND (((((((Child [MeSH Terms]) OR child*[Title/Abstract]) OR Infant[MeSH Terms]) OR infant*[Title/Abstract]) OR Adolescent[MeSH Terms]) OR adolescen*[Title/Abstract]) OR teenage*[Title/Abstract] OR Pediatrics[MeSH] OR pediatric*[Title/Abstract]) OR paediatric* [Title/Abstract]))

No data found in Cochrane
Time Frame: 2019 to present
Date Search Completed: last search conducted: November 11, 2022

Search Results

1345 articles after limit search 2019-2022
No articles after 1345 excluded upon title searching and selected abstract review

Summary of Evidence Update:

Relevant Guidelines or Systematic Reviews

Organization (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations
NONE					

RCT:

Study Acronym; Author; Year Published	Aim of Study; Study Type; Study Size (N)	Patient Population	Study Intervention (# patients) / Study Comparator (# patients)	Endpoint Results (Absolute Event Rates, P value; OR or RR; & 95% CI)	Relevant 2° Endpoint (if any); Study Limitations; Adverse Events
NONE	Study Aim: Study Type:	Inclusion Criteria:	Intervention: Comparison:	1° endpoint:	Study Limitations:

Nonrandomized Trials, Observational Studies

Study Acronym; Author; Year Published	Study Type/Design; Study Size (N)	Patient Population	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/Conclusion Comment(s)
	Study Type:	Inclusion Criteria:	1° endpoint:	

NONE				

Reviewer Comments: *(including whether this PICOST should have a systematic or scoping review)*

This PICOST remains a challenge as finding any data during non-neonatal cardiac arrest is problematic. While there is great interest in titration of oxygen post cardiac arrest and more specifically to the prevention of post-ROSC hyperoxia, titration of oxygenation for intraarrest management remains unreported in the human literature. No scoping or systematic review is warranted at this point.

Reference list: none

Evidence Update Worksheet

Invasive blood pressure monitoring during CPR

Worksheet author(s): Dr Barney Scholefield/ Dr Alexis Topjian / Dr Antonio Rodriguez-Nunez

Task Force: Pediatric Life Support Task Force

Date Submitted to SAC rep for peer review and approval: December 2022

SAC rep:

PICOST / Research Question: *(Attach SAC representative approved completed PICOST template)*

Population: Infants & Children in any setting (in-hospital or out-of-hospital) with cardiac arrest

Intervention: the presence of variables -images, cut-off values or trends- during CPR (intra-arrest) that can provide physiologic feedback to guide resuscitation efforts, namely:

Arterial blood pressure

Comparators: the absence of such factors -images, cut-off values or trends.

Outcomes: Any clinical outcome.

Study Designs: STEP 1: Randomized controlled trials (RCTs) and non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies) that concern directly the population and intervention described above are eligible for inclusion. If it is anticipated that there will be insufficient studies from which to draw a conclusion, case series may be included in the initial search. The minimum number of cases for a case series to be included was set by the taskforce at 5 cases. Unpublished studies (e.g., conference abstracts, trial protocols) are excluded.
STEP 2: the same study designs and/or existing systematic or scoping reviews not directly concerning the population or intervention defined above but considered informative as additional evidence for the development of the final taskforce insights.

Timeframe: For STEP 1, all languages are included, as long as there is an English abstract. We searched articles from 2020 onwards. For STEP 2, if a systematic or scoping review of high quality (as per AMSTAR 2 tool) is identified, search can be limited to beyond data and/or scope of that review.

Year of last full review:

Scoping review last searched September 2020

Kool M, Atkins DL, Van de Voorde P, Maconochie IK, Scholefield BR; PLS ILCOR Task Force. Focused echocardiography, end-tidal carbon dioxide, arterial blood pressure or near-infrared spectroscopy monitoring during paediatric cardiopulmonary resuscitation: A scoping review. Resusc Plus. 2021 Mar 30;6:100109. doi: 10.1016/j.resplu.2021.100109. PMID: 34228034; PMCID: PMC8244529.

Current ILCOR Consensus on Science and Treatment Recommendation for this PICOST:

[h3**] Task Force insights**

The information identified in this review does apply to only that subset of pediatric patients in cardiac arrest with intraarterial access and continuous monitoring of blood pressure. The work by Berg *et al* did identify optimal blood pressure curves associated with ROSC, and blood pressure thresholds below which no child survived. However, the evidence was too limited to consider the diastolic blood pressure threshold is itself sufficient to identify CPR futility.
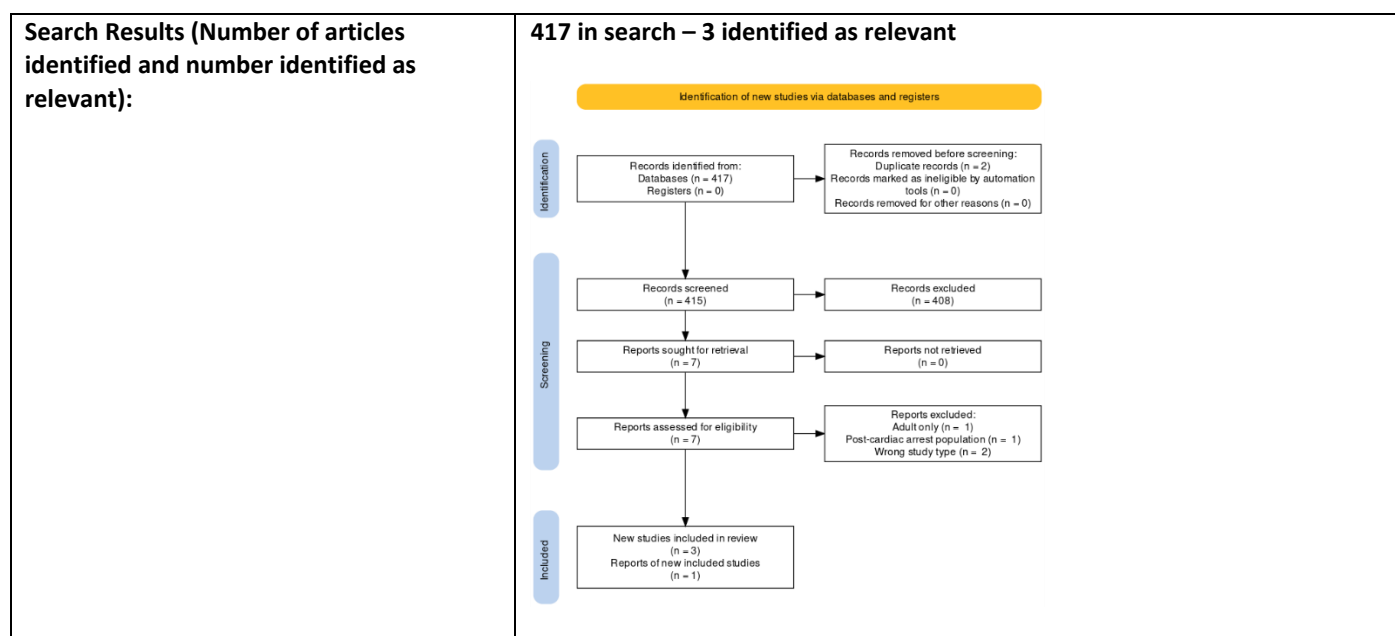
The PLS Task Force considered that, for children with IHCA and an arterial line already in place, hemodynamic-directed CPR might be considered. However, more evidence is required.

The treatment recommendation remains unaltered from 2015 (De Caen 2015 S17; Maconochie 2015 e1477)(1, 2) as there is insufficient evidence to consider a request for a SysRev.

Treatment Recommendations

The confidence in effect estimates is so low that the panel decided a recommendation was too speculative. (De Caen 2015 S17; Maconochie 2015 e1477)(1, 2)

Current Search Strategy (for an existing PICOST) included in the attached approved PICOST	1. Blood pressure [MESH] 2. Blood pressure, diastolic OR blood pressure, systolic OR mean arterial pressure OR arterial pressure OR coronary perfusion pressure OR hemodynamic directed OR haemodynamic directed 288,420 3. 1 or 2 4. "Life Support Care"[Mesh] 5. "Cardiopulmonary Resuscitation"[Mesh] 6. "Heart Arrest"[Mesh] 7. ((((life support) OR cardiopulmonary resuscitation) OR ROSC) OR return of spontaneous circulation) OR cardiac arrest 8. 4 or 5 or 6 or 7 9. (("Infant"[Mesh]) OR "Adolescent"[Mesh]) OR "Child"[Mesh] 10. (infan* OR baby OR baby* OR babies OR toddler* OR minors OR minors* OR kid OR kids OR child OR child* OR children* OR schoolchild* OR schoolchild OR school child[tiab] OR school child*[tiab] OR adolescen* OR juvenil* OR youth* OR teen* OR under*age* OR pubescen* OR pediatrics[mh] OR pediatric* OR paediatric* OR peadiatric* OR school[tiab] OR school*[tiab]) (4,970,579) 11. 9 or 10 12. (animals [mh]) NOT humans [mh] 13. (newborn* OR new-born* OR perinat* OR neonat* OR prematur* OR preterm*) 14. 3 and 8 and 11 not 12 not 13 15. Limit to studies from 2020
New Search strategy: (for a new PICOST should be outlined here as per Evidence Update Process)	n/a
Database searched: eg Medline Embase Cochrane	Medline, Embase, Central
Time Frame: (existing PICOST) – updated from end of last search (please specify)	Last updated 11 September 2020. New Search Jan 2020 to 25th July 2022
Time Frame: (new PICOST) – at the discretion of the Task Force (please specify)	n/a
Date Search Completed:	25th July 2022

Search Results (Number of articles identified and number identified as relevant):	417 in search – 3 identified as relevant

Summary of Evidence Update:

Our Evidence Update in 2022 identified one randomised control trial (3) and two observational studies (4, 5) utilising patients from the randomised control trial population.

Sutton et al and the ICU-RESUS and Eunice Kennedy Shriver National Institute of Child Health; Human Development Collaborative Pediatric Critical Care Research Network Investigator Groups 2022 (3) conducted a hybrid, stepped wedge RCT of physiological training in 18 intensive care units caring for children. The training and debriefing in this emphasized intra-arrest and postarrest physiologic targets, specifically diastolic blood pressure (DBP) and end-tidal CO_2 ($ETCO_2$) during CPR, and systolic blood pressure (SBP) in the postarrest period. There was no significant difference in the primary outcome of survival to hospital discharge with favorable neurologic outcomes in the intervention group (53.8%) vs control (52.4%); risk difference (RD), 3.2%(95%CI, −4.6%to 11.4%); adjusted OR, 1.08 (95%CI, 0.76 to 1.53). There was also no significant difference in survival to hospital discharge in the intervention group (58.0%) vs control group (56.8%); RD, 1.6% (95%CI, −6.2%to 9.7%); adjusted OR, 1.03 (95%CI, 0.73 to 1.47).

This trial did not formally compare the use or absence of DBP or SBP targeted management during cardiac arrest, rather, the use of a training implementation programme for physiological monitoring (of which DBP and SBP targeting was one component). High rate of adequate DBP targets in control (80%) and intervention group (90%) were reported in addition to adequate SBP targets. The authors therefore speculated that some of the control group ICUs may have also utilised intra-arrest physiological targets during resuscitation without the trial training intervention.

Two additional studies were identified during our search. Both used a sub-set of patients from the trial by Sutton et al (3); however, both were in abstract form only.

Berg et al (4) describe a validation cohort ≤18 years old and ≥37 weeks gestation who received chest compressions ≥1-min duration with invasive BP monitoring before and during CPR in 18 ICUs. *Exposure DBP* was defined as a mean DBP ≥25 mmHg for infants and ≥30 mmHg for older children during the first 10 minutes of CPR. Overall 85% attained exposure DBP. They found, adjusting for age, initial rhythm, location (PICU or CICU), and institution, attaining exposure DBP was significantly associated with ROSC (aRR 1.49; 1.13-1.98, P=0.002) and survival to discharge with favorable neurologic outcome (aRR 1.31; 1.00-1.72, P=0.035), but did not reach significance for survival to hospital discharge (aRR 1.29; 0.97-1.70, P=0.056).

Rappold et al (5) developed a novel score called the area duty cycle (ADC) calculated as the ratio between the area under the invasive Arterial BP waveform and the total area of the compression cycle (base of area calculation = line at compression cycle

diastolic BP [DBP]). In 160 children in cardiac arrest, the ADC during pediatric ICU CPR was rarely compliant with AHA recommendations. The SBP differed across ADC quartiles; however, DBP and outcomes were similar for quartiles of ADC.

These studies add to the two studies describing BP and intra-arrest monitoring (6, 7), identified in the 2020 scoping review of intra-arrest monitoring (8).

Relevant Guidelines or Systematic Reviews

Organization (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations
European Resuscitation Council Guidelines 2021: Paediatric Life Support Van de Voorde P, 2021 (9)	Guideline		3	The current evidence is of very low certainty due to study design, sample size and selection bias, but suggests a possible relation between diastolic BP and the child's outcome. Only IHCA events were studied because of the need for invasive BP monitoring. Although one study identified optimal ROC curve thresholds for test performance, and thresholds below which no child survived, the evidence is too limited to consider diastolic BP on its own sufficient to identify CPR futility or to predict favourable outcome.	The level of certainty of the available evidence is too low to make any recommendation for or against the use of diastolic blood pressure to guide resuscitation efforts in children with cardiac arrest. However, for those children with IHCA where an arterial line is already in place and within settings that allow for proper implementation, haemodynamic-directed CPR might be considered.
American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency	Guideline		1	Invasive arterial blood pressure monitoring during CPR provides insight to blood pressures generated with compressions and medications.	For patients with continuous invasive arterial blood pressure monitoring in place at the time of cardiac arrest, it is reasonable for providers to use diastolic blood pressure to assess CPR quality.

Cardiovascular Care. Topjian AA et al 2020 (10)					

RCT:

Study Acronym; Author; Year Published	Aim of Study; Study Type; Study Size (N)	Patient Population	Study Intervention (# patients) / Study Comparator (# patients)	Endpoint Results (Absolute Event Rates, P value; OR or RR; & 95% CI)	Relevant 2° Endpoint (if any); Study Limitations; Adverse Events
Sutton et al and the ICU-RESUS and Eunice Kennedy Shriver National Institute of Child Health; Human Development Collaborative Pediatric Critical Care Research Network Investigator Groups 2022 (3)	**Aim:** To evaluate the effectiveness of a bundled intervention comprising physiologically focused CPR training at the point of care and structured clinical event debriefings. **Study type**: A parallel, hybrid stepped-wedge, cluster randomized trial **n=18 pediatric intensive care units (ICUs) from 10 clinical sites in the US.** **n=1129 patients**	**Inclusion**: (1) age 37 weeks' corrected gestation or older and 18 years or younger and (2) CPR of any duration in the ICU. **Exclusion**: (1) limitation of ICU therapies (prior to cardiac arrest); (2) were brain dead; or (3) had an out-of-hospital cardiac arrest associated with the current hospitalization.	Randomization was performed at the level of the hospital sites enrolled in the study. Stepped-wedge crossing over from control to intervention for some sites. **Intervention:** 2-part ICU QI bundle consisting of CPR training at the point of care on a manikin and structured physiologically focused postcardiac arrest debriefings **n=526** **Control:** Usual care consisted of existing resuscitation practices at the enrolled pediatric ICUs **n=548**	**Primary endpoint:** There was no significant difference in the primary outcome of survival to hospital discharge with favorable neurologic outcomes in the intervention group (53.8%) vs control (52.4%); risk difference (RD), 3.2%(95%CI, −4.6%to 11.4%); adjusted OR, 1.08 (95%CI, 0.76 to 1.53). There was also no significant difference in survival to hospital discharge in the intervention group (58.0%) vs control group (56.8%); RD, 1.6% (95%CI, −6.2%to 9.7%); adjusted OR, 1.03 (95%CI, 0.73 to 1.47).	**Relevant Secondary outcome Intervention versus control group:** Adequate SBP 72.6% versus 65.1% (aOR 1.21 (95%CI, 0.7 to 2.06) Adequate DBP 90.9% versus 80.4% (aOR 2.18 (95%CI 1.04 to 4.54) High quality CPR with adequate SBP 47.2% versus 37.9% (aOR 1.17 (95%CI 0.7 to 1.94) High quality CPR and DBP 56.6% versus 44.7% (aOR 1.29 (95%CI 0.69 to 2.4) **Comments:** Baseline rate of overall survival to hospital discharge with favourable neurological outcome were higher in control group. High rate of adequate DBP in the control group (80.4%) Low implementation of training in 4 ICUs

Nonrandomized Trials, Observational Studies

Study Acronym; Author; Year Published	Study Type/Design; Study Size (N)	Patient Population	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/ Conclusion Comment(s)
Berg et al (4)	**Abstract only**. Multicentre prospective study N=357	≤18 years old and ≥37 weeks corrected gestational age who received chest compressions while admitted to one of the 18 participating intensive care units of The ICU-RESUScitation Project (NCT028374497) 65% were infants, 8% had initial shockable rhythm, median duration of CPR was 7 [3, 23] minutes, 86% received ≥1 dose of epinephrine, . 63% had ROSC, 56% survived to hospital discharge, and 54% survived with favorable neurologic outcome.	Primary endpoint: 85% attained DBP targets ≥25 mmHg in infants or >30 mmHg when ≥1year Adjusting for age, initial rhythm, location (PICU or CICU), and institution, attaining exposure DBP was significantly associated with ROSC (aRR 1.49; 1.13-1.98, P=0.002) and survival to discharge with favorable neurologic outcome (aRR 1.31; 1.00-1.72, P=0.035), but did not reach significance for survival to hospital discharge (aRR 1.29; 0.97- 1.70, P=0.056).	Achieving mean DBP during CPR ≥25 mmHg for infants or ≥30 mmHg for children ≥1yo is associated with higher rates of successful ROSC and survival to hospital discharge with favorable neurologic outcome. Abstract only. No assessment of Risk of bias.
Rappold et al (5)	**Abstract only** Multicentre observation study N=160	≤18 years old and ≥37 weeks corrected gestational age who received chest compressions while admitted to one of the 18 participating intensive care units of The ICU-RESUScitation Project (NCT028374497)	ADC was calculated as the ratio between the area under the invasive Arterial BP waveform and the total area of the compression cycle (base of area calculation = line at compression cycle diastolic BP [DBP]) ADC quartiles were: Q1 (≤30.6%), Q2 (>30.6–35.1%), Q3 (>35.1–38.2%), Q4 (>38.2%). Only 5 (3.1%) events met AHA DC compliance, significantly less than the *a priori* hypothesis of 10% (p < 0.01). SBP was significantly different across DC quartiles (Q1: 82.9 [66.3, 113.6] mmHg; Q2: 94.2 [71.1, 125.4] mmHg; Q3: 74.8 [59.8, 89.5] mmHg; Q4: 79.3	Using a novel method of ADC calculated from the ABP waveform, DC during pediatric ICU CPR is rarely compliant with AHA recommendations. The SBP differed across ADC quartiles;

				[55.5, 97.3] mmHg; p=0.049), but DBP and patient outcomes were similar.	however, DBP and outcomes were similar.

Reviewer Comments: *(including whether this PICOST should have a systematic or scoping review)*

The potential value of personalised haemodynamic-directed CPR, where CPR efforts are adjusted in view of pre-defined (diastolic) BP goals and not limited by current 'standard' guidelines, has yet to be defined. An additional survey report (in abstract form only) by Chan et al. (11) was identified. This reported 6/33 (18.2%) of U.S. hospitals that submit data on pediatric IHCA to GWTG-Resuscitation, routinely monitored diastolic pressures during resuscitations. This suggests at present there is a low rate of utilisation of diastolic blood pressure during resuscitation.

We recommend awaiting the publication of the abstract only publications to allow full critical appraisal. A task force led systematic review may be justified following their publication.

Reference list: *(List by ILCOR ref standard (last name first author, year of publication, first page number) and insert hyperlink to all articles identified as relevant (if available on PubMed)*

References

1.   de Caen AR, Maconochie IK, Aickin R, Atkins DL, Biarent D, Guerguerian AM, et al. Part 6: Pediatric Basic Life Support and Pediatric Advanced Life Support: 2015 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. Circulation. 2015;132(16 Suppl 1):S177-203.
2.   Maconochie IK, de Caen AR, Aickin R, Atkins DL, Biarent D, Guerguerian AM, et al. Part 6: Pediatric basic life support and pediatric advanced life support: 2015 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations. Resuscitation. 2015;95:e147-68.
3.   Sutton RM, Wolfe HA, Reeder RW, Ahmed T, Bishop R, Bochkoris M, et al. Effect of Physiologic Point-of-Care Cardiopulmonary Resuscitation Training on Survival with Favorable Neurologic Outcome in Cardiac Arrest in Pediatric ICUs: A Randomized Clinical Trial. JAMA - Journal of the American Medical Association. 2022;327:934-45.
4.   Berg R, Morgan R, Reeder R, Cooper K, Graham K, McQuillen P, et al. Diastolic blood pressure threshold during pediatric CPR and outcomes: A multicenter validation study. Critical Care Medicine. 2022;50:15.
5.   Rappold T, Morgan R, Weeks M, Widmann N, Graham K, Cooper K, et al. Pediatric chest compression duty cycle using arterial pressure waveforms. Critical Care Medicine. 2022;50:18.
6.   Berg RA, Sutton RM, Reeder RW, Berger JT, Newth CJ, Carcillo JA, et al. Association Between Diastolic Blood Pressure During Pediatric In-Hospital Cardiopulmonary Resuscitation and Survival. Circulation. 2018;137(17):1784-95.
7.   Wolfe HA, Sutton RM, Reeder RW, Meert KL, Pollack MM, Yates AR, et al. Functional outcomes among survivors of pediatric in-hospital cardiac arrest are associated with baseline neurologic and functional status, but not with diastolic blood pressure during CPR. Resuscitation. 2019;143:57-65.
8.   Kool M, Atkins DL, Van de Voorde P, Maconochie IK, Scholefield BR, Force PIT. Focused echocardiography, end-tidal carbon dioxide, arterial blood pressure or near-infrared spectroscopy monitoring during paediatric cardiopulmonary resuscitation: A scoping review. Resusc Plus. 2021;6:100109.

9.   Van de Voorde P, Turner NM, Djakow J, de Lucas N, Martinez-Mejias A, Biarent D, et al. European Resuscitation Council Guidelines 2021: Paediatric Life Support. Resuscitation. 2021;161:327-87.

10.   Topjian AA, Raymond TT, Atkins D, Chan M, Duff JP, Joyner BL, Jr., et al. Part 4: Pediatric Basic and Advanced Life Support: 2020 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation. 2020;142(16_suppl_2):S469-s523.

Evidence Update Worksheet

Use of near infrared spectroscopy (NIRS) during cardiac arrest

Worksheet author(s): Dr Barney Scholefield/ Dr Alexis Topjian / Dr Antonio Rodriguez-Nunez
Task Force: Pediatric Life Support Task Force
Date Submitted to SAC rep for peer review and approval: December 2022
SAC rep:

PICOST / Research Question: *(Attach SAC representative approved completed PICOST template)*

Population: Infants & Children in any setting (in-hospital or out-of-hospital) with cardiac arrest

Intervention: the presence of variables -images, cut-off values or trends- during CPR (intra-arrest) that can provide physiologic feedback to guide resuscitation efforts, namely:

Near Infrared Spectroscopy

Comparators: the absence of such factors -images, cut-off values or trends.

Outcomes: Any clinical outcome.

Study Designs: STEP 1: Randomized controlled trials (RCTs) and non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies) that concern directly the population and intervention described above are eligible for inclusion. If it is anticipated that there will be insufficient studies from which to draw a conclusion, case series may be included in the initial search. The minimum number of cases for a case series to be included was set by the taskforce at 5 cases. Unpublished studies (e.g., conference abstracts, trial protocols) are excluded.
STEP 2: the same study designs and/or existing systematic or scoping reviews not directly concerning the population or intervention defined above but considered informative as additional evidence for the development of the final taskforce insights.

Timeframe: For STEP 1, all languages are included, as long as there is an English abstract. We searched articles from 2020 onwards. For STEP 2, if a systematic or scoping review of high quality (as per AMSTAR 2 tool) is identified, search can be limited to beyond data and/or scope of that review.

Year of last full review:

Scoping review last searched September 2020

Kool M, Atkins DL, Van de Voorde P, Maconochie IK, Scholefield BR; PLS ILCOR Task Force. Focused echocardiography, end-tidal carbon dioxide, arterial blood pressure or near-infrared spectroscopy monitoring during paediatric cardiopulmonary resuscitation: A scoping review. Resusc Plus. 2021 Mar 30;6:100109. doi: 10.1016/j.resplu.2021.100109. PMID: 34228034; PMCID: PMC8244529.

Current ILCOR Consensus on Science and Treatment Recommendation for this PICOST:

Task Force insights

Treatment Recommendations
There has not been, to date, a recommendation on the use of NIRS in cardiopulmonary arrest to guide resuscitation efforts or predict outcome.

Current Search Strategy (for an existing PICOST) included in the attached approved PICOST	1. Spectroscopy, Near-Infrared [Mesh] (13304) 2. ((cerebral oximetry) OR regional cerebral oxygenation) OR regional cerebral oxygen saturation (19218) 3. 1 or 2 (31111) 4. "Life Support Care"[Mesh] (8835) 5. "Cardiopulmonary Resuscitation"[Mesh] (18226) 6. "Heart Arrest"[Mesh] (48239) 7. ((((life support) OR cardiopulmonary resuscitation) OR ROSC) OR return of spontaneous circulation) OR cardiac arrest (834771) 8. 4 or 5 or 6 or 7 (834771) 9. (("Infant"[Mesh]) OR "Adolescent"[Mesh]) OR "Child"[Mesh] (3570670) 10. (infan* OR baby OR baby* OR babies OR toddler* OR minors OR minors* OR kid OR kids OR child OR child* OR children* OR schoolchild* OR schoolchild OR school child[tiab] OR school child*[tiab] OR adolescen* OR juvenil* OR youth* OR teen* OR under*age* OR pubescen* OR pediatrics[mh] OR pediatric* OR paediatric* OR peadiatric* OR school[tiab] OR school*[tiab]) (4,970,579) 11. 9 or 10 (4,970,579) 12. (animals [mh]) NOT humans [mh] (4,733,545) 13. (newborn* OR new-born* OR perinat* OR neonat* OR prematur* OR preterm*) (1,044,074) 14. 3 and 8 and 11 not 12 not 13 (204)
New Search strategy: (for a new PICOST should be outlined here as per Evidence Update Process)	n/a
Database searched: eg Medline Embase Cochrane	Medline, Embase, Central
Time Frame: (existing PICOST) – updated from	Last updated 11 September 2020.

end of last search (please specify)	New Search Jan 2020 to 25th July 2022
Time Frame: (new PICOST) – at the discretion of the Task Force (please specify)	n/a
Date Search Completed:	25th July 2022
Search Results (Number of articles identified and number identified as relevant):	

Summary of Evidence Update:
Our Evidence Update in 2022 identified one observational study that reported near infrared monitoring during CPR and/or outcomes. (1) and one abstract (2). The single center study evaluated 21 patients with 23 events and found an association between higher rSO2 measurements during the entire monitored event and last 5 minutes of the event with ROSC. An abstract of 32 patients including children with congenital heart disease from three centers did not show an association with outcomes, nor on multivariable analysis.

Nonrandomized Trials, Observational Studies

Study Acronym; Author; Year Published	Study Type/Design; Study Size (N)	Patient Population	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/Conclusion Comment(s)
Francoeur (1)	**Study Type:** Single center observational study N= 23	**Inclusion Criteria:** Children with cardiac arrest in PICU, CICU, or ED with at least 30 seconds of	**1° endpoint:** Sustained ROSC > 20 min The median rSO2 was higher for events with ROSC compared to no ROSC for the overall event (62% [56,70] vs. 45% [35,51], p = 0.025)	Higher cerebral rSO2 during CPR for pediatric cardiac arrest was associated with higher rates of ROSC but not with survival to discharge.

		NIRS monitoring	and for the final five minutes of the event (66% [55,72] vs. 43% [35,44], p = 0.01). Patients who achieved ROSC had more rSO2 epochs above 50% during the final 5 minutes of the event (100% [100,100] vs. 0% [0,29], p = 0.01).	
Esangbedo (2)* abstract	Multicenter observational	Children < 18, > 2 min CPR, no ECMO	ROSC Mean intra-arrest cerebral rSO was 44.2% (+/-19.5) for ROSC vs. 37.4% (+/-15) for non-ROSC group (p=0.267). Using mean rSO cutoffs >25, >30, >35, >40, and>50%, we found no significant association with ROSC.	There was no significant association between cerebral rSO during pediatric cardiac arrest and ROSC, even after controlling for important confounders of age and SV physiology.

Reviewer Comments: *(including whether this PICOST should have a systematic or scoping review*)

There remains very little pediatric specific evidence examining the use of NIRS during cardiac arrest. Our evidence up-date only identified one small observational study and one abstract. Therefore a systematic review of pediatric cardiac arrest patients is not justified at this time.

There continues to be insufficient data to support or advise against a treatment recommendation related to NIRS usage during CPR to provide physiologic feedback to guide resuscitation efforts or predict outcome.

Reference list: *(List by ILCOR ref standard (last name first author, year of publication, first page number) and insert hyperlink to all articles identified as relevant (if available on PubMed)*

Francoeur C, Landis WP, Winters M, Naim MY, Donoghue A, Dominick CL, Huh JW, MacDonald JM, Lang SS, Yuan I, Berg RA, Nadkarni VM, Kilbaugh TJ, Sutton RM, Kirschen MP, Morgan RW, Topjian AA. https://pubmed.ncbi.nlm.nih.gov/35314211/ Resuscitation. 2022 May;174:35-41.

Esangbedo I, Rajapreyar P, Kirschen M, Hanna R, Niles DE, Zhang X, Griffis HM, Francoeur C, Wakeham MK, Petersen T, Topjian AA, Nadkarni VM, Raymond TT. Cerebral oximetry during pediatric in-hospital cardiac arrest. Circulation Conference, American Heart Association Resuscitation Science Symposium, ReSS- Volume 142, Issue 0, published 2020

2022 Evidence Update Worksheet

Resuscitation of the pediatric patient with single-ventricle, status-post Stage III/Fontan/total cavopulmonary connection/anastomosis

Worksheet author(s): Tia Raymond

Task Force: Pediatric Life Support
Date Submitted to SAC rep for peer review and approval: December 2022
SAC rep: Dianne Atkins, Ian Maconochie

PICOST / Research Question: (PLS 392)
- Population: (P) Infants and children with hemi-Fontan/bidirectional Glenn (BDG) circulation who require resuscitation from cardiac arrest
- Intervention: (I) Any specific modification to standard practice
- Comparison: (C) Standard resuscitation practice
- Outcome: (O) ROSC, survival to discharge, survival with good neurological outcome
- Study Design: Included only observational studies and RCTs from the time of the previous search review
- Time Frame: All years and languages were included if there was an English abstract. The literature search was from January 2008 to October 13, 2022.

Type (intervention, diagnosis, prognosis): Intervention

Additional Evidence Reviewer(s): None

Conflicts of Interest (financial/intellectual, specific to this question):
T Raymond is a paid consultant for New England Research Institutes, Inc., a wholly owned subsidiary of HealthCore, Inc., for the Pediatric Heart Network COMPASS study as an adjudicator for this NHLBI-sponsored prospective, multicenter, randomized trial of BT shunt vs. PDA stent for single ventricle patients.

Year of last full review: No scoping or systematic review ever done.

Year of last review: 2020 Evidence Update performed by AHA: Tia Raymond (worksheet author):

Current ILCOR Consensus on Science and Treatment Recommendation for this PICOST (PLS 392 EvUp): 2020

This EvUp was performed to identify any evidence about this topic published after the PLS Task Force's most recent review in 2010. (1,2) The EvUp identified 1 registry-based study that reported outcomes of infants and children with Fontan/ or bidirectional Glenn who had circulatory support initiated during a peri-arrest phase.(3) The PLS Task Force agreed that there is insufficient evidence (3,4) to recommend a new SysRev, and the 2010 treatment recommendation remains in effect (1,2) with the addition of a brief explanatory phrase within brackets.

This treatment recommendation (below) is unchanged from 2010 with the exception of limiting the recommendation to children with hemi-Fontan (1,2) or bidirectional Glenn physiology who are in a prearrest state; hypercarbia achieved by hypoventilation may be beneficial to increase oxygenation and cardiac output.

Negative-pressure ventilation, if available, may be beneficial for children with either hemi-Fontan or bi- directional Glenn or Fontan physiology by increasing cardiac output.

During cardiopulmonary arrest, it is reasonable to consider ECPR for patients with Fontan physiology.

There is insufficient evidence to support or refute the use of ECPR in patients with hemi-Fontan or bidirectional Glenn physiology.

Current ILCOR Evidence Update 2022: This EvUp was performed to identify any evidence published after the most recent PLS Task Force review in 2020. The search strategy was updated to include single ventricle patients s/p hemi-Fontan or BDG only (s/p Fontan separate PICO) in a cardiac arrest state only (not pre-arrest state).

2019 Search Strategy: ((((((("cardiopulmonary resuscitation"[All Fields] OR "heart arrest"[All Fields] OR "prearrest"[All Fields] OR "near arrest"[All Fields] OR "ECPR"[All Fields] OR "Extracorporeal cardiopulmonary resuscitation"[All Fields]) AND ("heart defects, congenital"[All Fields] OR "hypoplastic left heart syndrome"[All Fields] OR "single ventricle"[All Fields] OR "univentricular"[All Fields] OR "Norwood"[All Fields] OR "BT shunt"[All Fields] OR "Sano"[All Fields] OR "Stage 1 repair"[All Fields])) AND ("neonate"[All Fields] OR "infant"[All Fields] OR "child"[All Fields] OR "pediatric"[All Fields])) OR ("venous saturation"[All Fields] OR "cerebral oxygenation"[All Fields] OR "near infrared spectroscopy"[All Fields] OR "low cardiac output"[All Fields] OR "alpha adrenergic blockade"[All Fields] OR "hypercarbia "[All Fields])) AND ("heart defects, congenital"[All Fields] OR "hypoplastic left heart syndrome"[All Fields] OR "single ventricle"[All Fields] OR "univentricular"[All Fields] OR "norwood"[All Fields] OR "bt shunt"[All Fields] OR "sano"[All Fields] OR "stage 1 repair"[All Fields])) AND ("neonate"[All Fields] OR "infant"[All Fields] OR "child"[All Fields] OR "pediatric"[All Fields])) AND ("2008/01/01"[PDAT] : "2019/10/26"[PDAT]) AND "observational study"[Publication Type] OR "randomized control"[Publication Type]

2022 Search Strategy: ((((((("cardiopulmonary resuscitation"[All Fields] OR "heart arrest"[All Fields] OR "ECPR"[All Fields] OR "Extracorporeal cardiopulmonary resuscitation"[All Fields]) AND ("heart defects, congenital"[All Fields] OR "hypoplastic left heart syndrome"[All Fields] OR "single ventricle"[All Fields] OR "univentricular"[All Fields] OR "Stage 2 repair"[All Fields] OR "hemi-fontan"[All Fields] OR "bi-directional Glenn"[All Fields] OR "superior cavopulmonary anastomosis"[All Fields])) AND ("neonate"[All Fields] OR "infant"[All Fields] OR "child"[All Fields] OR "pediatric"[All Fields])) AND ("heart defects, congenital"[All Fields] OR "hypoplastic left heart syndrome"[All Fields] OR "single ventricle"[All Fields] OR "univentricular"[All Fields] OR "stage 2 repair"[All Fields] OR "hemi-fontan"[All Fields] OR "bi-directional Glenn"[All Fields] OR "superior cavopulmonary anastomosis"[All Fields])) AND ("neonate"[All Fields] OR "infant"[All Fields] OR "child"[All Fields] OR "pediatric"[All Fields])) AND ("2019/10/26"[PDAT] : "2022/10/13"[PDAT]) AND "observational study"[Publication Type] OR "randomized control"[Publication Type]

Database searched: Pubmed
Search Timeframe: 10/26/2019-10/13/2022

Date Search Completed: October 13, 2022

Search Results (Number of articles identified / number identified as relevant): 6/1

Link to Article Titles and Abstracts (if available on PubMed):
https://pubmed.ncbi.nlm.nih.gov/32343108/

Found in similar articles section: 0

Summary of Evidence Update:
Insufficient new evidence to justify a systematic or scoping review. New studies unlikely to change current TR.

Relevant Guidelines or Systematic Reviews

Organization (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations

ILCOR 2020 (AHA EvUp):	EvUp	**PICO / Research Question:** "For infants and children with single ventricle, s/p stage I repair, who require resuscitation from cardiac arrest or pre-arrest states (prehospital [OHCA] or in-hospital [IHCA]) (P), does any specific modification to standard practice (I) compared with standard resuscitation practice (C) improve outcome (e.g. ROSC, survival to discharge, survival with good neurologic outcome)(O)?" **Outcomes:** ROSC, survival to discharge, survival with good neurologic outcome			

RCT

Study Acronym; Author; Year Published	Aim of Study; Study Type; Study Size (N)	Patient Population	Study Intervention (# patients) / Study Comparator (# patients)	Endpoint Results (Absolute Event Rates, P value; OR or RR; & 95% CI)	Relevant 2° Endpoint (if any); Study Limitations; Adverse Events
No new RCTs identified	Study Aim: Study Type:	Inclusion Criteria:	Intervention: Comparison:	1° endpoint:	Study Limitations:

Nonrandomized Trials, Observational Studies

Study Acronym; Author; Year Published	Study Type/Design; Study Size (N)	Patient Population	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/Conclusion Comment(s)

Reviewer Comments (including whether meet criteria for formal review):

On July 18, 2022, an Evidence Update was performed by the PLS task force following revision of the original search strategy to include single ventricle patients who may undergo surgical palliation with pulmonary artery banding (PAB) and/or non-surgical repair in the cardiac catheterization laboratory to include patent ductus arteriosus (PDA) stent (Hybrid palliation). No new RCTs were identified. Four additional publications fulfilled inclusion criteria; however, none would change the current treatment recommendations of standard resuscitation procedures for infants and children with single-ventricle anatomy after stage I repair.

There is some evidence for the use of ECMO in post cardiotomy SV patients, and ECPR use in SV patients, but that topic should be included in the SR on ECPR by the ALS with PLS input.
The task force did not identify sufficient new data to proceed to full systematic review.

The PLS task force recommendations from 2020 for the pediatric population therefore remain unchanged in 2022

Reference list

1. Kleinman ME, de Caen AR, Chameides L, Atkins DL, Berg RA, Berg MD, Bhanji F, Biarent D, Bingham R, Coovadia AH, et al; on behalf of the Pe- diatric Basic and Advanced Life Support Chapter Collaborators. Part 10: pediatric basic and advanced life support: 2010 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. Circulation. 2010;122(suppl 2):S466–S515. doi: 10.1161/CIRCULATIONAHA.110.971093.
2. 10. de Caen AR, Kleinman ME, Chameides L, Atkins DL, Berg RA, Berg MD, Bhanji F, Biarent D, Bingham R, Coovadia AH, et al; on behalf of the Pae- diatric Basic and Advanced Life Support Chapter Collaborators. Part 10: paediatric basic and advanced life support: 2010 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations. Resuscitation. 2010;81(suppl 1):e213–e259. doi: 10.1016/j.resuscitation.2010.08.028.
3. Jolley M, Thiagarajan RR, Barrett CS, Salvin JW, Cooper DS, Rycus PT, Teele SA. Extracorporeal membrane oxygenation in patients undergoing superior cavopulmonary anastomosis. J Thorac Cardiovasc Surg. 2014;148:1512–1518. doi: 10.1016/j.jtcvs.2014.04.028.
4. Marino BS, Tabbutt S, MacLaren G, Hazinski MF, Adatia I, Atkins DL, Checchia PA, DeCaen A, Fink EL, Hoffman GM, Jefferies JL, Kleinman M, Krawczeski CD, Licht DJ, Macrae D, Ravishankar C, Samson RA, Thiagarajan RR, Toms R, Tweddell J, Laussen PC; Ameri- can Heart Association Congenital Cardiac Defects Committee of the Council on Cardiovascular Disease in the Young; Council on Clinical Cardiology; Council on Cardiovascular and Stroke Nursing; Council on Cardiovascular Surgery and Anesthesia; and Emergency Cardio- vascular Care Committee. Cardiopulmonary resuscitation in infants and children with cardiac disease: a scientific statement from the American Heart Association. Circulation. 2018;137:e691–e782. doi: 10.1161/CIR.0000000000000524.
5. Kramer P, Mommsen A, Miera O, Photiadis J, Berger F, Schmitt KRL. Survival and Mid-Term Neurologic Outcome After Extracorporeal Cardiopulmonary Resuscitation in Children. Pediatr Crit Care Med. 2020 Jun;21(6):e316-e324. doi: 10.1097/PCC.0000000000002291.

Evidence Update Worksheet

Resuscitation of the pediatric patient with hemi-Fontan/bidirectional Glenn (BDG) circulation

Worksheet author(s): Seth Gray

Collaborators: Tia Raymond
Task Force: Pediatric Life Support
Date Submitted to SAC rep for peer review and approval: December 2022
SAC rep: Dianne Atkins, Ian Maconochie

PICOST / Research Question:
- Population: (P) Children with single-ventricle, status-post Stage III/Fontan/total cavopulmonary connection/anastomosis who require resuscitation from cardiac arrest
- Intervention: (I) Any specific modification to standard practice
- Comparison: (C) Standard resuscitation practice
- Outcome: (O) ROSC, survival to discharge, survival with good neurological outcome
- Study Design: Included only observational studies and RCTs from the time of the previous search review
- Time Frame: All years and languages were included if there was an English abstract. The literature search was from January 2008 to November 11, 2022.

Type (intervention, diagnosis, prognosis): Intervention

Additional Evidence Reviewer(s): None

Conflicts of Interest (financial/intellectual, specific to this question):
T Raymond is a paid consultant for New England Research Institutes, Inc., a wholly owned subsidiary of HealthCore, Inc., for the Pediatric Heart Network COMPASS study as an adjudicator for this NHLBI-sponsored prospective, multicenter, randomized trial of BT shunt vs. PDA stent for single ventricle patients.

Year of last full review: No scoping or systematic review ever done.

Year of last review: 2020 Evidence Update performed by AHA: Javier Lasa, Tia Raymond

Current ILCOR Consensus on Science and Treatment Recommendation for this PICOST (PLS 392 EvUp): 2020

This EvUp was performed to identify any evidence about this topic published after the PLS Task Force's most recent review in 2010 (1,2). The EvUp identified 1 registry-based study that reported outcomes of infants and children with Fontan or bidirectional Glenn who had circulatory support initiated during a peri-arrest phase (3). The PLS Task Force agreed that there is insufficient evidence (3,4) to recommend a new SysRev, and the 2010 treatment recommendation remains in effect (1,2), with the addition of a brief explanatory phrase within brackets.

This treatment recommendation (below) is unchanged from 2010 with the exception of limiting the recommendation to children with hemi-Fontan (1,2) or bidirectional Glenn physiology who are in a prearrest state; hypercarbia achieved by hypoventilation may be beneficial to increase oxygenation and cardiac output.

Negative-pressure ventilation, if available, may be beneficial for children with either hemi-Fontan or bi-directional Glenn or Fontan physiology by increasing cardiac output.

During cardiopulmonary arrest, it is reasonable to consider ECPR for patients with Fontan physiology.

There is insufficient evidence to support or refute the use of ECPR in patients with hemi-Fontan or bidirectional Glenn physiology.

Current ILCOR Evidence Update 2022: This EvUp was performed to identify any evidence published after the most recent PLS Task Force review in 2020. The search strategy was updated to include single ventricle patients s/p Fontan/total cavopulmonary anastomosis only (s/p hemi-Fontan or BDG in separate PICO) in a cardiac arrest state only (not pre-arrest state).

2019 Search Strategy:
("cardiopulmonary resuscitation"[MeSH] AND "univentricular heart"[Title/Abstract]) OR ("cardiopulmonary resuscitation"[MeSH] AND "fontan"[Title/Abstract]) OR ("cardiopulmonary resuscitation"[MeSH] AND "hemi-fontan"[Title/Abstract]) OR ("cardiopulmonary resuscitation"[MeSH] AND "cavopulmonary anastomosis"[Title/Abstract]) OR ("cardiopulmonary resuscitation"[MeSH] AND "glenn"[Title/Abstract]) OR ("cardiopulmonary resuscitation"[MeSH] AND "bidirectional glenn"[Title/Abstract]) OR ("cardiopulmonary resuscitation"[MeSH] AND "cavopulmonary connection"[Title/Abstract]) OR ("cardiopulmonary resuscitation"[MeSH] AND "superior cavopulmonary connection"[Title/Abstract]) OR ("cardiopulmonary resuscitation"[MeSH] AND "superior cavopulmonary anastomosis"[Title/Abstract]) OR ("cardiopulmonary resuscitation"[MeSH] AND "single ventricle"[Title/Abstract]) OR ("heart arrest"[MeSH] AND "univentricular heart"[Title/Abstract]) OR ("heart arrest"[MeSH] AND "fontan"[Title/Abstract]) OR ("heart arrest"[MeSH] AND "hemi-fontan"[Title/Abstract]) OR ("heart arrest"[MeSH] AND "cavopulmonary anastomosis"[Title/Abstract]) OR ("heart arrest"[MeSH] AND "glenn"[Title/Abstract]) OR ("heart arrest"[MeSH] AND "bidirectional glenn"[Title/Abstract]) OR ("heart arrest"[MeSH] AND "cavopulmonary connection"[Title/Abstract]) OR ("heart arrest"[MeSH] AND "superior cavopulmonary connection"[Title/Abstract]) OR ("heart arrest"[MeSH] AND "superior cavopulmonary anastomosis"[Title/Abstract]) OR ("heart arrest"[MeSH] AND "single ventricle"[Title/Abstract]) OR ("advanced cardiac life support"[MeSH] AND "univentricular heart"[Title/Abstract]) OR ("advanced cardiac life support"[MeSH] AND "fontan"[Title/Abstract]) OR ("advanced cardiac life support"[MeSH] AND "hemi-fontan"[Title/Abstract]) OR ("advanced cardiac life support"[MeSH] AND "cavopulmonary anastomosis"[Title/Abstract]) OR ("advanced cardiac life support"[MeSH] AND "glenn"[Title/Abstract]) OR ("advanced cardiac life support"[MeSH] AND "bidirectional glenn"[Title/Abstract]) OR ("advanced cardiac life support"[MeSH] AND "cavopulmonary connection"[Title/Abstract]) OR ("advanced cardiac life support"[MeSH] AND "superior cavopulmonary connection"[Title/Abstract]) OR ("advanced cardiac life support"[MeSH] AND "superior cavopulmonary anastomosis"[Title/Abstract]) OR ("advanced cardiac life support"[MeSH] AND "single ventricle"[Title/Abstract]) OR ("respiration, artificial"[MeSH] AND "univentricular heart"[Title/Abstract]) OR ("respiration, artificial"[MeSH] AND "fontan"[Title/Abstract]) OR ("respiration, artificial"[MeSH] AND "hemi-fontan"[Title/Abstract]) OR ("respiration, artificial"[MeSH] AND "cavopulmonary anastomosis"[Title/Abstract]) OR ("respiration, artificial"[MeSH] AND "glenn"[Title/Abstract]) OR ("respiration, artificial"[MeSH] AND "bidirectional glenn"[Title/Abstract]) OR ("respiration, artificial"[MeSH] AND "cavopulmonary connection"[Title/Abstract]) OR ("respiration, artificial"[MeSH] AND "superior cavopulmonary connection"[Title/Abstract]) OR ("respiration, artificial"[MeSH] AND "superior cavopulmonary anastomosis"[Title/Abstract]) OR ("respiration, artificial"[MeSH] AND "single ventricle"[Title/Abstract]) OR ("heart massage"[MeSH] AND "univentricular heart"[Title/Abstract]) OR ("heart massage"[MeSH] AND "fontan"[Title/Abstract]) OR ("heart massage"[MeSH] AND "hemi-fontan"[Title/Abstract]) OR ("heart massage"[MeSH] AND "cavopulmonary anastomosis"[All Fields] AND Title/Abstract[All Fields]) OR ("heart massage"[MeSH] AND "glenn"[Title/Abstract]) OR ("heart massage"[MeSH] AND "cavopulmonary connection"[Title/Abstract]) OR ("heart massage"[MeSH] AND "superior cavopulmonary connection"[Title/Abstract]) OR ("heart massage"[MeSH] AND "superior cavopulmonary anastomosis"[Title/Abstract]) OR ("heart bypass, right"[MeSH] AND "resuscitation"[Title/Abstract]) OR ("heart bypass, right"[MeSH] AND "pediatric advanced cardiac life support"[Title/Abstract]) OR ("heart bypass, right"[MeSH] AND "cardiopulmonary resuscitation"[Title/Abstract]) OR ("heart bypass, right"[MeSH] AND "heart arrest"[Title/Abstract]) OR ("heart bypass, right"[MeSH] AND "advanced cardiac life support"[Title/Abstract]) OR ("heart bypass, right"[MeSH] AND "heart massage"[Title/Abstract]) OR ("fontan procedure"[MeSH] AND "resuscitation"[Title/Abstract]) OR ("fontan procedure"[MeSH] AND "pediatric advanced cardiac life support"[Title/Abstract]) OR ("fontan procedure"[MeSH] AND "cardiopulmonary resuscitation"[Title/Abstract]) OR ("fontan procedure"[MeSH] AND "heart arrest"[Title/Abstract] AND

Title/Abstract[All Fields]) OR ("fontan procedure"[MeSH] AND "advanced cardiac life support"[Title/Abstract]) OR ("fontan procedure"[MeSH] AND "heart massage"[Title/Abstract]) OR ("cardiopulmonary resuscitation"[MeSH] AND "tricuspid atresia"[Title/Abstract]) OR ("cardiopulmonary resuscitation"[MeSH] AND "hypoplastic left heart syndrome"[Title/Abstract]) OR ("cardiopulmonary resuscitation"[MeSH] AND "double inlet left ventricle"[Title/Abstract]) OR ("heart arrest"[MeSH] AND "tricuspid atresia"[Title/Abstract]) OR ("heart arrest"[MeSH] AND "hypoplastic left heart syndrome"[Title/Abstract]) OR ("heart arrest"[MeSH] AND "double inlet left ventricle"[Title/Abstract]) OR ("advanced cardiac life support"[MeSH] AND "tricuspid atresia"[Title/Abstract]) OR ("advanced cardiac life support"[MeSH] AND "hypoplastic left heart syndrome"[Title/Abstract]) OR ("advanced cardiac life support"[MeSH] AND "double inlet left ventricle"[Title/Abstract]) OR ("respiration, artificial"[MeSH] AND "tricuspid atresia"[Title/Abstract]) OR ("respiration, artificial"[MeSH] AND "hypoplastic left heart syndrome"[Title/Abstract]) OR ("respiration, artificial"[MeSH] AND "double inlet left ventricle"[Title/Abstract]) OR ("heart massage"[MeSH] AND "tricuspid atresia"[Title/Abstract]) OR ("heart massage"[MeSH] AND "hypoplastic left heart syndrome"[Title/Abstract]) OR ("heart massage"[MeSH] AND "double inlet left ventricle"[Title/Abstract]) OR ("hypoplastic left heart syndrome"[MeSH] AND "resuscitation"[Title/Abstract]) OR ("hypoplastic left heart syndrome"[MeSH] AND "pediatric advanced cardiac life support"[Title/Abstract]) OR ("hypoplastic left heart syndrome"[MeSH] AND "cardiopulmonary resuscitation"[Title/Abstract]) OR ("hypoplastic left heart syndrome"[MeSH] AND "heart arrest"[Title/Abstract]) OR ("hypoplastic left heart syndrome"[MeSH] AND "advanced cardiac life support"[Title/Abstract]) OR ("hypoplastic left heart syndrome"[MeSH] AND "heart massage"[Title/Abstract]) OR ("tricuspid atresia"[MeSH] AND "resuscitation"[Title/Abstract]) OR ("tricuspid atresia"[MeSH] AND "pediatric advanced cardiac life support"[Title/Abstract]) OR ("tricuspid atresia"[MeSH] AND "cardiopulmonary resuscitation"[Title/Abstract]) OR ("tricuspid atresia"[MeSH] AND "heart arrest"[Title/Abstract]) OR ("tricuspid atresia"[MeSH] AND "advanced cardiac life support"[Title/Abstract]) OR ("tricuspid atresia"[MeSH] AND "heart massage"[Title/Abstract])) AND "observational study"[Publication Type] AND ("2013/01/01"[PDAT] : "2019/09/25"[PDAT])

2022 Search Strategy:
((((((("cardiopulmonary resuscitation"[All Fields] OR "heart arrest"[All Fields] OR "ECPR"[All Fields] OR "Extracorporeal cardiopulmonary resuscitation"[All Fields]) AND ("heart defects, congenital"[All Fields] OR "hypoplastic left heart syndrome"[All Fields] OR "single ventricle"[All Fields] OR "univentricular"[All Fields] OR "Stage 3 repair"[All Fields] OR "Stage III repair"[All Fields] OR "total cavopulmonary connection"[All Fields] OR "Fontan"[All Fields] OR "total cavopulmonary anastomosis"[All Fields])) AND ("child"[All Fields] OR "pediatric"[All Fields])) AND ("heart defects, congenital"[All Fields] OR "hypoplastic left heart syndrome"[All Fields] OR "single ventricle"[All Fields] OR "univentricular"[All Fields] OR "stage 3 repair"[All Fields] OR "Stage III repair"[All Fields] OR "total cavopulmonary connection"[All Fields] OR "Fontan"[All Fields] OR "total cavopulmonary anastomosis"[All Fields])) AND ("child"[All Fields] OR "pediatric"[All Fields])) AND ("2019/10/26"[PDAT] : "2022/11/17"[PDAT]) AND "observational study"[Publication Type] OR "randomized control"[Publication Type]

Database searched: Pubmed

Search TimeFrame: 10/26/2019 – 11/17/2022

Date Search Completed: November 17, 2022

Search Results (Number of articles identified / number identified as relevant): 4/0

Link to Article Titles and Abstracts (if available on PubMed):

Found in similar articles section: 0

Summary of Evidence Update:
Insufficient new evidence to justify a systematic or scoping review. New studies unlikely to change current TR.

Relevant Guidelines or Systematic Reviews

Organization (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations
ILCOR 2020 (AHA EvUp): Raymond, T	EvUp	**PICO / Research Question:** "For children with single ventricle, s/p stage III repair, who require resuscitation from cardiac arrest or pre-arrest states (prehospital [OHCA] or in-hospital [IHCA]) (P), does any specific modification to standard practice (I) compared with standard resuscitation practice (C) improve outcome (e.g. ROSC, survival to discharge, survival with good neurologic outcome)(O)?" **Outcomes:** ROSC, survival to discharge, survival with good neurologic outcome			

RCT

Study Acronym; Author; Year Published	Aim of Study; Study Type; Study Size (N)	Patient Population	Study Intervention (# patients) / Study Comparator (# patients)	Endpoint Results (Absolute Event Rates, P value; OR or RR; & 95% CI)	Relevant 2° Endpoint (if any); Study Limitations; Adverse Events
No new RCTs identified	Study Aim: Study Type:	Inclusion Criteria:	Intervention: Comparison:	1° endpoint:	Study Limitations:

Nonrandomized Trials, Observational Studies

Study Acronym; Author; Year Published	Study Type/Design; Study Size (N)	Patient Population	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/Conclusion Comment(s)

Reviewer Comments (including whether meet criteria for formal review):

Optimizing outcomes for patients with single-ventricle physiology status-post total cavopulmonary connection (Fontan palliation) requires a nuanced understanding of anatomic and physiologic considerations as well as cardiopulmonary and cardio-cerebral interactions. The previous Evidence Update was performed by the PLS task force in July 2018 following revision of the original search strategy to include single ventricle patients who may undergo surgical palliation with pulmonary artery banding (PAB) and/or non-surgical repair in the cardiac catheterization laboratory to include patent ductus arteriosus (PDA) stent (Hybrid palliation).

This Evidence Update has identified no new RCTs or sufficient new data to proceed to full systematic review.

The PLS task force recommendations from 2020 for the pediatric population therefore remains unchanged in 2022.

<u>Reference list</u>

1. Kleinman ME, de Caen AR, Chameides L, Atkins DL, Berg RA, Berg MD, Bhanji F, Biarent D, Bingham R, Coovadia AH, et al; on behalf of the Pe- diatric Basic and Advanced Life Support Chapter Collaborators. Part 10: pediatric basic and advanced life support: 2010 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. Circulation. 2010;122(suppl 2):S466–S515. doi: 10.1161/CIRCULATIONAHA.110.971093.
2. 10. de Caen AR, Kleinman ME, Chameides L, Atkins DL, Berg RA, Berg MD, Bhanji F, Biarent D, Bingham R, Coovadia AH, et al; on behalf of the Pae- diatric Basic and Advanced Life Support Chapter Collaborators. Part 10: paediatric basic and advanced life support: 2010 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations. Resuscitation. 2010;81(suppl 1):e213–e259. doi: 10.1016/j.resuscitation.2010.08.028.
3. Jolley M, Thiagarajan RR, Barrett CS, Salvin JW, Cooper DS, Rycus PT, Teele SA. Extracorporeal membrane oxygenation in patients undergoing superior cavopulmonary anastomosis. J Thorac Cardiovasc Surg. 2014;148:1512–1518. doi: 10.1016/j.jtcvs.2014.04.028.
4. Marino BS, Tabbutt S, MacLaren G, Hazinski MF, Adatia I, Atkins DL, Checchia PA, DeCaen A, Fink EL, Hoffman GM, Jefferies JL, Kleinman M, Krawczeski CD, Licht DJ, Macrae D, Ravishankar C, Samson RA, Thiagarajan RR, Toms R, Tweddell J, Laussen PC; Ameri- can Heart Association Congenital Cardiac Defects Committee of the Council on Cardiovascular Disease in the Young; Council on Clinical Cardiology; Council on Cardiovascular and Stroke Nursing; Council on Cardiovascular Surgery and Anesthesia; and Emergency Cardio- vascular Care Committee. Cardiopulmonary resuscitation in infants and children with cardiac disease: a scientific statement from the American Heart Association. Circulation. 2018;137:e691–e782. doi: 10.1161/CIR.0000000000000524.

Evidence Update Worksheet

EIT 6404 Feedback Device

Worksheet author(s): Yiqun Lin (Jeffrey),
Task Force: EIT
Date Submitted to SAC rep for peer review and approval: Nov 20, 2022
Collaborator(s): Adam Cheng, Jeffrey Pellegrino
SAC rep: Judith Finn, Joyce Yeung

PICOST / Research Question: *(EIT 6404 (former 648) – CPR feedback devices during resuscitation training)*
Population: People who are receiving resuscitation training
Intervention: Use of CPR feedback/guidance device during resuscitation training
Comparison: No use of CPR feedback/guidance device during resuscitation training
Outcomes:
1. Patient survival [CRITICAL]
2. Quality of performance in actual resuscitations [CRITICAL]
3. Skill retention (performance after course conclusion) [IMPORTANT]
4. Skill acquisition (performance at course conclusion) [IMPORTANT]
5. Knowledge at course conclusion [IMPORTANT]

Study design: Randomized controlled trials (RCTs) and non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies) were eligible for inclusion. Unpublished studies (e.g., conference abstracts, trial protocols), animal studies, and case series, were excluded.
Timeframe: All languages were included if there is an English abstract. The search was run to include studies published between 1 Jan 2019 and 3 Oct 2022.
 Year of last full review: 2020 SyR (Search run in Jul 2019)

Current ILCOR Consensus on Science and Treatment Recommendation for this PICOST:

We suggest the use of feedback devices that provide directive feedback on compression rate, depth, release, and hand position during CPR training (weak recommendation, low certainty evidence). If feedback devices are not available, we suggest the use of tonal guidance (examples include music or metronome) during training to improve compression rate only (weak recommendation, low-certainty evidence).

Current Search Strategy (for an existing PICOST) included in the attached approved PICOST

((((((((((((((((((((((((((((((((((((("feedback, sensory"[mesh] OR "feedback device"[tiab]) OR "feedback"[MeSH Terms]) OR feedback[tiab]) OR feed-back[tiab]) OR guidance[tiab]) OR e-learning[tiab]) OR elearning[tiab]) OR prompt[tiab]) OR prompts[tiab]) OR prompting[tiab]) OR prompted[tiab]) OR "real-time"[tiab]) OR video[tiab]) OR "Video Recording"[mesh]) OR "audio visual"[tiab]) OR "audiovisual"[tiab]) OR "audiovisual aids"[tiab]) OR "audio-visual aids"[tiab]) OR "virtual realities"[tiab]) OR "virtual reality"[tiab]) OR "virtual reality"[tiab]) OR "cpr-plus"[tiab]) OR "q-cpr"[tiab]) OR "cpr-sensing"[tiab]) OR "cprezy"[tiab]) OR "cpr-ezy"[tiab]) OR "phone"[tiab]) OR "telephone"[tiab]) OR "Telephone"[Mesh]) OR "smartphone"[Mesh]) OR "smartphone"[tiab]) OR "smart phone"[tiab]) OR "smart-phone"[tiab]) OR "computer assisted instruction"[tiab]) OR "computer-assisted instruction"[tiab]) OR "Reinforcement, Verbal"[mesh]) OR "cardiopulmonary Resuscitation/instrumentation"[mesh]) OR "metronomes"[tiab]) OR metronome[tiab]) OR "cell phone"[mesh]) OR "smartphone"[mesh]) OR "patient simulation"[mesh]))) AND ((((((("patient simulation"[mesh]) OR "computer simulation"[mesh]) OR "high fidelity simulation training"[mesh]) OR "simulation training"[mesh])) OR (((((((((((((("cardiopulmonary resuscitation"[tiab]) OR "cardiopulmonary resuscitation"[mesh]) OR "cardio-pulmonary resuscitation"[tiab]) OR "cpr"[tiab]) OR "advanced cardiac life support"[tiab]) OR "acls"[tiab]) OR "basic life support"[tiab]) OR "bls"[tiab]) OR "mock cardiac arrest"[tiab]) OR "simulated cardiac arrest"[tiab]) OR "advanced life support"[tiab]) OR "cardiac arrest"[tiab]) OR "pediatric advanced life support"[tiab]) OR "paediatric advanced life support"[tiab]) OR "pals"[tiab]))) AND ((((((((((((((((((training[tiab]) OR "learning acquisition"[tiab]) OR "skill acquisition"[tiab]) OR retention[tiab]) OR "Retention (Psychology)"[mesh]) OR curriculum[mesh]) OR learners[tiab]) OR learner[tiab]) OR learning[tiab]) OR learn[tiab]) OR education[tiab]) OR "Learning"[mesh]) OR "Education, Professional"[mesh]) OR "Professional Competence"[mesh]) OR "students, health occupations"[mesh]) OR ("internship and residency"[mesh])) OR "Health Occupations/education"[mesh]) OR "Allied Health Occupations/education"[Mesh]) OR "Schools, health occupations"[mesh]) OR "Clinical competence"[mesh]) OR "Cardiopulmonary Resuscitation/education"[mesh]))) NOT ((((((("humans"[Mesh Terms]) OR "animals"[mesh terms]) OR letter[pt]) OR comment[pt]) OR editorial[pt]) OR "Case Reports"[ptyp])
Current database searched: Pubmed

New Search strategy:

1. exp Feedback/
2. exp Feedback, Sensory/
3. feedback.tw,kf.
4. guidance.tw,kf.
5. prompt*.tw,kf.
6. real-time.tw,kf.
7. qcpr.tw,kf.
8. "Q-CPR".tw,kf.
9. "audiovisual aids".tw,kf.
10. metronome.tw,kf.
11. "audio-visual aids".tw,kf.
12. exp Smartphone/
13. smartphone.kf,tw.
14. apps.tw,kf.
15. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14
16. exp Cardiopulmonary Resuscitation/
17. CPR.kf,tw.
18. "cardiopulmonary resuscitation".tw,kf.
19. exp Resuscitation/
20. resuscitation.kf,tw.
21. "life support".kf,tw.
22. BLS.kf,tw.
23. ACLS.tw,kf.
24. PALS.kf,tw.
25. exp Heart Arrest/
26. "cardiac arrest".kf,tw.
27. "mock code".kf,tw.
28. 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27
29. exp Learning/
30. course.kf,tw.
31. exp Teaching/
32. exp Education, Medical/
33. exp Simulation Training/
34. exp High Fidelity Simulation Training/
35. simulat*.kf,tw.
36. train*.kf,tw.
37. learn*.kf,tw.
38. 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37
39. 15 and 28 and 38
40. limit 39 to yr="2019 -Current"

Database searched: Medline on OVID platform

Search strategy developed by Jeffrey Lin with support from local information specialist Caitlin McClurg (librarian at University of Calgary)

Time Frame: (new PICOST) – From 1 Jan 2019 to 3 Oct 2022

Date Search Completed: 3 Oct 2022

Search Results (Number of articles identified and number identified as relevant): 692 identified / 15 relevant

Summary of Evidence Update:

Of the 15 relevant papers, 5 were previously identified in the prior review (3 identified in 2020, 2 identified in 2021). Ten new studies were identified, including 7 RCTs and 3 non-RCTs. All studies examined the effect of corrective feedback on objectively measured CPR quality as a primary outcome measure. Two RCTs were downgraded due to the study design. One study combined feedback with distributed practice compared to conventional training. In this study, the effect of the feedback device during training and distributed practice were not separated (Lin, Hecker, et al. 2021). In the other study, the intervention group received a 4-minute brief CPR practice session with real-time feedback, while the control group received a 30 to 45-minute long classroom-based CPR course (with no real-time feedback). The huge practice time difference between the groups resulted in significant confounding biases (Heard et al. 2019).

Three RCT studies were conducted in novice healthcare providers (i.e., medical students) and examined the effect of real-time feedback use during BLS training on CPR quality at course conclusion (Arrogante et al. 2021; Labuschagne et al. 2022; Lin, Ni, et al. 2021). All 3 studies favored the use of feedback devices during training; two yielded statistical significance (Arrogante et al. 2021; Lin, Ni, et al. 2021) and one was not statistically significant due to being underpowered (Labuschagne et al. 2022).

Two RCTs were conducted in lay providers (e.g., high school students). The use of CPR feedback devices improved CPR quality at course conclusion (Chamdawala et al. 2021; Tanaka et al. 2019), with demonstrated retention in skills at 12 months as well. (Chamdawala et al. 2021).

The 5 RCTs demonstrate significant benefits of the CPR feedback device used during resuscitation courses, although the study populations were mostly novice healthcare providers and lay people. All studies focused on initial training rather than renewal course.

Three observational studies or quasi-experiment trials were identified with mixed results. Kuyt et al., (2021) compared the quality of CPR in practicing healthcare providers exposed to the Resuscitation Quality Improvement (RQI) program (distributed practice + real-time feedback) to those who weren't exposed to RQI and found that no significant difference was detected between the groups. Although it was a large study (N=1861), the study was limited by non-randomized design. The combination of multiple educational strategies made it difficult to separate the effect of real-time feedback during training. Kim et al., (2020) found that the introduction of real-time feedback during BLS training in medical students did not have additional benefit on compression depth but have significantly improved compliance with complete recoil during chest compressions. Eshel et al., (2019) concluded in a quasi-experimental trial that medical students trained with manikins with real-time feedback features were superior to those who were trained with conventional manikins (without feedback)

Relevant Guidelines or Systematic Reviews: 0

Organization (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations

RCT: 5

Study Acronym; Author; Year Published, 1st page number	Aim of Study; Study Type; Study Size (N)	Patient Population	Study Intervention (# patients) / Study Comparator (# patients)	Endpoint Results (Absolute Event Rates, P value; OR or RR; & 95% CI)	Relevant 2° Endpoint (if any); Study Limitations; Adverse Events
Labuschagne et al, 2022, 106	Aim: to compare the effectiveness of CPR training with feedback QCPR manikin vs conventional manikin design: RCT	Undergraduate medical student (N = 53)	Intervention: Student practice chest compression for 10 min on a manikin with CPR feedback feature (n=25) Comparator: Student practice chest compression for 10 min on a conventional manikin (without feedback features) (n=28)	Feedback group vs no feedback group: Total effectiveness score: median 83 vs 75; p = 0.0658 Percentage of learners > 80: 56% vs 28%; p = 0.08	Study Limitations: - Small Sample size (under power) - short training sessions - Randomization technique problematic (risk of bias)

Lin et al, 2021, 80	Aim: to compare the effect of synchronous online and face-to-face CPR training; effect of feedback during training design: 2 x 2 factorial RCT	Undergraduate medical student (N = 118)	TF: online training with feedback (n =30) TN: online training without feedback (n=29) FF: face-to-face training with feedback (n=30) FN: face-to-face training without feedback (n=29)	Face-to-Face Training Group % of guideline compliance (feedback vs no feedback): Depth: 83.7 vs 71.9, p=0.123 Rate: 84.7 vs 69.1, p=0.014 Recoil: 93.6 vs 84.6, p = 0.016 Online Training Group % of guideline compliance (feedback vs no feedback): Depth: 82.2 vs 61.2, p=0.008 Rate: 72.8 vs 64.1, p=0.178 Recoil: 94.9 vs 87.0, p = 0.038	Limitations: -No major concerns
Arrogante et al, 2021, 101037	Aim: analyze the effects of deliberate practice using a feedback device on the CPR performance prior to, after, and 3 months after training Design: RCT	Undergraduate nursing students (N=59)	Intervention: 2 hr course, deliberate practice model with CPR instructor, feedback using QCPR device, 20 x 2min CPR cycles completed on average (n=31) Comparator: No CPR training (n=28)	Intervention Group - improvement in CPR scores pre 67.7 (31) vs. post 95.2 (8.3) vs. 3 months 94.5 (5.7). In control group no improvement in CPR scores pre 67.4 (31.1) vs post 64.3 (36.3) vs. 3 months 64.5 (32.7). No direct comparison done between control vs intervention (no p value provided)	Limitations: -CPR scores only (lack of validity evidence for outcome measures); no depth/rate data provided. -Evaluation done in 2 min cycle only as an individual -No between group difference presented (seems significant, but no p-value or comparison provided)
Chamdawala et al, 2021, 100079	Aim: to evaluate the effect of adding a real-time visual feedback device to a standard instructor-led CPR course on skill acquisition and retention. Design: RCT	High school students (N=220)	Intervention: CPR in the schools training + 2 minutes of CPR training with real time feedback (n=110). Control: CPR in the schools training + practice on manikin with no feedback (n=110)	Improved CC depth in feedback vs control groups immediate after training 5 mm difference (2,8), at week 10 5 mm difference (2,7), at week 28 4 mm difference (2,7) and week 52. 4 mm difference (1,7), P<0.001 for week 0, 10, 28; p=0.007 for week 52. No difference in CC rate at all time points.	Limitation: -Only 2 minutes of additional training with / without feedback (limited exposure to the intervention. Strength: Long term follow up

| Tanaka et al, 2019, e026140 | Study aim: To compare QCPR training (training with real-time feedback) and standard CPR training

Clustered RCT | Lay providers (N = 642) | Intervention (QCPR classroom): BLS training with real-time feedback
Comparison: BLS training without objective feedback, subjective feedback by the instructor only | QCPR group significantly superior to control group in both adequate depth (%) and adequate recoil (%)
Adequate depth (%): 73.7% vs 87.3%, p < 0.001
Adequate recoil (%): 66.9% vs 87.4%, p < 0.001 | Limitation
-Short assessment duration (1 min) |

Nonrandomized Trials, Observational Studies: 3

Study Acronym; Author; Year Published 1st page number	Study Type/Design; Study Size (N)	Patient Population	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/Conclusion Comment(s)
Kuyt et al, 2021, 14	Aim: evaluate the effects of the RQI Program on CPR skills. Design: Multi-institutional cohort study N=1861 Exposure: AHA RQI program with CPR feedback, repetitive practice (n=1374). Control: no RQI training (n=487)	Healthcare providers at 4 UK hospitals	No difference in improvement in compression score (from baseline to 1 year) between control site 5.9% improvement (10.6) and intervention site. 9.5% improvement (2.8) p=0.622. Also, no different in mean improvement in CPR score (which includes ventilations), control 15.1% (6.2) improvement vs intervention 14.5% (1.9), p=0.918	No statistically significant difference in improvement of mean scores was found between the grouped adopter sites (RQI) and the control site. Limitations: -Non-randomized design, potential selection biases and confounding biases -Feedback is combined with distributed practice, therefore difficult the separate the effect.
Kim et al 2020, 104	Study Aim: To evaluate the effect of introducing a visual feedback device to the CPR training on chest compression quality Prospective cohort study (historical control) N=159 Exposure: Year 2018: introduction of feedback device during CPR training (n=48) Year 2017: Emphasizing chest compression depth, no feedback device (n=37)	Fourth year medical student	Compression depth: Compression depth improved significantly by emphasizing the CC depth (from 22% to 99%, p < 0.001). No significant additional benefit after introducing the feedback device (99% vs 100%) Chest Recoil: Percentage of full chest recoil increased significantly from 81% to 95% after introducing the feedback device (p =0.018)	The chest compression depth significantly improves by emphasizing the compression depth. No additional benefit after introduction of feedback devices The percentage of full chest recoil significantly increased by the introduction of feedback devices during training Limitation: -Non-randomized design, potential selection biases and confounding factors

	Comparison: Year 2016: Conventional instructor-led training, no feedback (n=74)			
Eshel 2019, 359	Study aim: to quantitatively measure the effect of teaching cardiopulmonary resuscitation using a real-time audio-visual feedback manikin system Quasi-experiment N=201 Intervention: BLS training with manikins with real-time feedback features Comparison: BLS training with conventional manikins	medical student	Real-time audiovisual feedback training superior to conventional training groups in all metrics including Total score, compression score, ventilation score, CCF%, mean compression depth, mean rate, compression with adequate release, rate and depth, ventilation with adequate volumes % (p-value all < 0.001) The effect of real-time feedback during training remained significant when adjusting for potential confounding such as sex, age, BMI.	Learners receiving BLS training with real-time audiovisual were superior to the group received conventional BLS training (without feedback) in all metrics of CPR quality. Limitations: -Non-randomized design, but the investigators attempted to adjust for potential confounding factors in the analyses.

Reviewer Comments: *(including whether this PICOST should have a systematic or scoping review*)
Overall, the studies are consistent with the previous literature review and continue to support the use of CPR feedback devices during resuscitation training. Given the fairly large number of new studies, **a formal systematic review with meta-analysis is recommended for several reasons.**
(1) With more high-quality studies identified with consistent conclusion, a modification of recommendation strength might be considered (from week recommendation to strong recommendation)
(2) More recent studies used CPR quality as outcome measure. There is opportunity for a meta-analysis with various aspects of CPR quality as outcome measures.
(3) With the implementation of AHA RQI program (distributed practice + feedback during training), more studies have examined the effect of RQI on training. It is worthwhile to examine the effect of the 2 strategies combined on resuscitation training

Reference list: *(List by ILCOR ref standard (last name first author, year of publication, first page number) and insert hyperlink to all articles identified as relevant (if available on PubMed)*

Labuschagne et al. 2022 Jun;12(2):106-111doi: 10.1016/j.afjem.2022.02.001. Epub 2022 Feb 27. PMID: 35251921; PMCID: PMC8885445. A comparison of the effectiveness of QCPR and conventional CPR training in final-year medical students at a South African university - PubMed (nih.gov)

Lin et al. 2021 Dec;50:80-84. doi: 10.1016/j.ajem.2021.07.009. Epub 2021 Jul 9. PMID: 34314941. Effect of synchronous online vs. face-to-face cardiopulmonary resuscitation training on chest compression quality: A pilot randomized manikin study - PubMed (nih.gov)

Arrogante et al. 2021 Sep;58:101037. doi: 10.1016/j.ienj.2021.101037. Epub 2021 Jul 29. PMID: 34332453. Deliberate practice in resuscitation training using a feedback device, and the effects of the physical characteristics of the rescuer on the acquisition and retention of cardiopulmonary resuscitation skills: Randomized clinical trial - PubMed (nih.gov)

Chamdawala et al. 2021 Feb 6;5:100079. doi: 10.1016/j.resplu.2021.100079. PMID: 34223345; PMCID: PMC8244398. Cardiopulmonary resuscitation skill training and retention in teens (CPR START): A randomized control trial in high school students - PubMed (nih.gov)

Tanaka et al. 2019 Jun 11;9(6):e026140. doi: 10.1136/bmjopen-2018-026140. PMID: 31189674; PMCID: PMC6576135. Effect of real-time visual feedback device 'Quality Cardiopulmonary Resuscitation (QCPR) Classroom' with a metronome sound on layperson CPR training in Japan: a cluster randomized control td (nih.gov)

Heard et al. 2019 Jun;73(6):599-609. doi: 10.1016/j.annemergmed.2018.09.026. Epub 2018 Nov 12. PMID: 30442510. Hands-Only Cardiopulmonary Resuscitation Education: A Comparison of On-Screen With Compression Feedback, Classroom, and Video Education - PubMed (nih.gov)

Lin et al. 2020 Sep 29;7(5):297-303. doi: 10.1136/bmjstel-2020-000709. PMID: 35515736; PMCID: PMC8936521. Cost-effectiveness analysis of workplace-based distributed cardiopulmonary resuscitation training versus conventional annual basic life support training - PubMed (nih.gov)

Kim etal. 2020 Feb;35(1):104-108. doi: 10.1017/S1049023X19005223. Epub 2020 Jan 8. PMID: 31910923. Advantage and Limitation of Using a Visual Feedback Device during Cardiopulmonary Resuscitation Training - PubMed (nih.gov)

Kuyt et al. 2021 Apr 21;6(1):14. doi: 10.1186/s41077-021-00168-y. PMID: 33883025; PMCID: PMC8058602. The assessment of a manikin-based low-dose, high-frequency cardiac resuscitation quality improvement program in early UK adopter hospitals - PubMed (nih.gov)

Eshel et al. 2019 Dec;14(6):359-365. doi: 10.1097/SIH.0000000000000390. PMID: 31743309. Real-Time Audiovisual Feedback Training Improves Cardiopulmonary Resuscitation Performance: A Controlled Study - PubMed (nih.gov)

**2022 Evidence Update Worksheet
EIT 6406 CPR Self Vs. Instructor Guided Final**

Worksheet author(s): Kathryn Eastwood
Council: ANZCOR
Date Submitted: October 2022

PICO / Research Question: EIT 6406
Should self-directed digital vs. instructor-led training be used to teach adults and children basic life support skills?

Population: Adults and children undertaking BLS training.
Intervention: Self-directed digitally-based BLS training.
Comparators: Instructor-led BLS training
Outcomes: <u>Patient outcomes:</u> Good neurological outcome at hospital discharge/30-days; Survival at hospital discharge/30-days; Return of spontaneous circulation (ROSC); Rates of bystander CPR; Bystander CPR quality during an OHCA (any available CPR metrics); Rates of automated external defibrillator (AED) use.
<u>Educational outcomes at the end of training and within 12 months:</u> CPR quality (chest compression depth and rate; chest compression fraction; full chest recoil, ventilation rate, overall CPR competency) and AED competency; CPR and AED knowledge; Confidence and willingness to perform CPR.
Study Designs: Randomized controlled trials (RCTs) and non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies and case series where n>5 are eligible for inclusion. Unpublished studies (e.g., conference abstracts, trial protocols) commentary and editorial papers, reviews and animal studies were excluded.
Timeframe: All years and all languages were included as long as there is an English abstract. The search strategy was performed on the same day (11/10/2022) for the three databases.

PROSPERO Registration: submitted to PROSPERO on 27/08/2020. PROSPERO ID CRD42020199176

Outcomes: As above
Type (intervention, diagnosis, prognosis): Intervention
Additional Evidence Reviewer(s): None
Conflicts of Interest (financial/intellectual, specific to this question): None
Year of last full review: 2010 / 2015 / New question: 2020

Last ILCOR Consensus on Science and Treatment Recommendation:
We recommend instructor-led training (with manikin practice with feedback device) or the use of self-directed training with video kits (instructional video and manikin practice with feedback device) for the acquisition of CPR theory and skills in lay-adults and high school aged (>10 years) children (strong recommendation, moderate quality of evidence).

We recommend instructor-led training (with AED scenario and practice) or the use of self-directed video kits (instructional video with AED scenario) for the acquisition of AED theory and skills in lay-adults and high school aged (>10 years) children (strong recommendation, low quality of evidence).

We suggest BLS video education (without manikin practice) be used when instructor-led training or self-directed training with video kits (instructional video plus manikin with feedback device) are not accessible, or when quantity over quality of BLS training is needed in adults and children (weak recommendation, weak quality of evidence).

There was insufficient evidence to make a recommendation on gaming as a CPR or AED training method.

There was insufficient evidence to suggest a treatment effect on bystander CPR rates or patient outcomes.

2010/2015 Search Strategy: N/A
2020 Search Strategy:

1	Cardiopulmonary Resuscitation/ or resuscitation/ or heart massage/ or First Aid/ or Defibrillators/
2	(cpr or cardiopulmonary resus* or chest compression* or (bls or basic life support) or first aid or aed).mp.
3	1 or 2
4	computer-assisted instruction/ or simulation training/ or Education, Distance/
5	3 and 4
6	computer simulation/ or virtual reality/ or exp Video Recording/ or exp Internet/
7	education/ or teaching/ or learning/ or problem-based learning/ or self-directed learning as topic/ or programmed instructions as topic/
8	3 and 6 and 7
9	((digital* or electronic* or online or on-line or web-based or internet or video* or social media or app or apps or film* or mobile application* or smartphone* or game or smart phone* or smart device* or virtual or simulat* or computeri#ed) adj5 (educat* or teach* or instruction* or learn* or train* or skill* or taught or tuition* or tutor*)).mp.
10	(self directed or self regulated or self managed).mp.
11	(Self adj (learn* or teach* or taught or train* or study or studied or educat* or tuition* or tutor* or instruct*)).mp.
12	9 or 10 or 11
13	3 and 12
14	Cardiopulmonary Resuscitation/ed or resuscitation/ed or heart massage/ed or First Aid/ed
15	4 or 7 or 12
16	14 and 15
17	5 or 8 or 13 or 16
18	limit 17 to english language

Database searched: Ovid MEDLINE(R) and Epub Ahead of Print, In-Process, In-Data-Review & Other Non-Indexed Citations, Daily and Versions

Date Search Completed: 11th October 2022
Search Results (Number of articles identified / number identified as relevant): 93[1-93] / 2[29,57]
Inclusion/Exclusion Criteria: Randomized controlled trials (RCTs) and non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies) were eligible for inclusion. Unpublished studies (e.g., conference abstracts, trial protocols), animal studies, case series, and simulation studies were excluded.

Link to Article Titles and Abstracts (if available on PubMed):

PMID	Title	1st Author	Journal
35427855	Cardiopulmonary resuscitation training: A narrative review comparing traditional educational programs with alternative, reduced-resource methods of CPR instruction for lay providers https://pubmed.ncbi.nlm.nih.gov/35427855/	Edinboro, D.	American Journal of Emergency Medicine
35587346	Long-term Effect of Face-to-Face vs Virtual Reality Cardiopulmonary Resuscitation (CPR) Training on Willingness to Perform CPR, Retention of Knowledge, and Dissemination of CPR Awareness A Secondary Analysis of a Randomized Clinical Trial https://pubmed.ncbi.nlm.nih.gov/35587346/	Nas, J.	JAMA Network Open

Summary of Evidence Update:

Evidence Update Process for topics not covered by ILCOR Task Forces

This evidence update process is only applicable to PICOs which are *not* being reviewed as ILCOR systematic and scoping reviews.

Relevant Guidelines or Systematic Reviews: 1

Organisation (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations
Edinboro, D; 2022	Narrative review	Aim: to explore the capabilities and shortcomings of alternative CPR instruction and to determine their efficacy among the lay population when compared to traditional CPR instruction, the three- or four-hour lay provider courses.	20	"Assessment of alternative instructional methods found that video self-instruction and simplified CPR formats resulted in equivalent performance of CPR metrics and practical scenario assessment performance, as compared to traditional CPR instruction courses. While additional research is needed to further substantiate the value of self-directed learning, interactive digital, and abbreviated formats, these studies also suggested equivalence in CPR performance compared to traditional courses."	"we recommend that public safety leaders and CPR educators strongly consider the introduction of these programs within their communities and classrooms".

RCT: 0

Study Acronym; Author; Year Published	Aim of Study; Study Type; Study Size (N)	Patient Population	Study Intervention (# patients) / Study Comparator (# patients)	Endpoint Results (Absolute Event Rates, P value; OR or RR; & 95% CI)	Relevant 2° Endpoint (if any); Study Limitations; Adverse Events
	Study Aim: Study Type:	Inclusion Criteria:	Intervention: Comparison:	1° endpoint:	Study Limitations:

Nonrandomized Trials, Observational Studies: 1

Study Acronym; Author; Year Published	Study Type/Design; Study Size (N)	Patient Population	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/Conclusion Comment(s)
	Study Type:	**Inclusion Criteria:**	**1° endpoint:**	
Long-term Effect of Face-to-Face vs Virtual Reality Cardiopulmonary Resuscitation (CPR) Training on Willingness to Perform CPR, Retention of Knowledge, and Dissemination of CPR Awareness: A Secondary Analysis of a Randomized Clinical Trial; Nas, J; 2022 Note: the original study was included in the systematic review and CoSTR).	Secondary analysis of RCT outcomes: 6 month follow up survey; N=188 (320 agreed to be contacted for follow up at the time of the RCT).	Participants of the original RCT (RCT N=381) who provided written informed consent for follow-up assessment at six months. (N=320).	**Outcome measures:** The primary outcome measure was willingness to perform CPR on a stranger, theoretical knowledge retention and dissemination of CPR awareness. **Results: "**The overall proportion of participants who would start CPR on a stranger was 77% (144 of 188) (81% [79 of 97] in the face-to-face group vs 71% [65 of 91] in the VR group; P = .02)." "The overall median number of the theoretical knowledge questions that were answered correctly was 7 (IQR, 6-8) of 9 questions (7 [IQR, 6-8] in the face-to-face group and 7 [IQR, 6-8] in the VR group; P = .81)." "In total, 65% (123 of 188) told family or friends about the importance of CPR in general (64% [62 of 97] in the face-to-face group vs 67% [61 of 91] in the VR group; P = .87)."	**Conclusion:** "In this 6-month posttraining survey, young adult participants of short CPR training modules reported high willingness (77%) to perform CPR on a stranger, with slightly higher rates for face-to-face than for VR participants. Theoretical knowledge retention was good, and the high dissemination of awareness suggests that these novel CPR training modules staged at a public event are promising sensitizers for involvement in CPR, although further challenges include mitigating the fear of performing CPR."

Reviewer Comments (including whether meet criteria for formal review):

There were 93 new articles identified in the Medline search of which two were relevant to the PICO. These were a narrative review and a 6-month follow-up of an RCT already included in the original systematic review (not originally published, currently being updated for publication) and CoSTR. The results of both of these studies support the current ILCOR CoSTR recommendation. Therefore, based on the limited additional results of this search, this EvUp does not meet the criteria for a formal review.

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Evidence Update Worksheet

EIT 6106 ALS Training and Outcomes

Worksheet author(s): Catherine Patocka, Andrew Lockey, Kasper Lauridsen, Robert Greif
Council: Heart and Stroke Foundation of Canada
Date Submitted: December1, 2022

PICO / Research Question: 2020 number EIT4000
Are cardiac arrest patient outcomes improved as a result of a member of the resuscitation team having attended an accredited advanced life support course

Population: Patients requiring in-hospital cardiac arrest resuscitation of any age
Intervention: Prior participation of one or more members of the resuscitation team in an accredited advanced life support course (e.g. ALS, ACLS, PALS, EPALS, EPLS NRT (including NRP, HBB, NLS, ARNI)
Comparators: Compared with no such participation
Outcomes: All courses: ROSC, survival to hospital discharge or to 30 days, survival to one year, survival with favourable neurological outcome
NRT (in addition): stillbirth rate, neonatal and perinatal mortality
Study Designs: Included studies: Randomized controlled trials (RCTs) and non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies, and case series where n ≥ *5*), studies relating to in-hospital cardiac arrest
Excluded studies: unpublished results (e.g. trial protocols), commentary, editorial, reviews. Studies looking at impact of individual components of courses (e.g. airway, drug therapy, defibrillation), studies relating to basic life support and first aid courses, dedicated trauma courses (ATLS, ETC) as they address traumatic as opposed to cardiac emergencies, studies relating to out-of-hospital cardiac arrest.
Timeframe: Publications from all years and all languages are included if there is an English abstract

PROSPERO Registration: registered PROSPERO ID CRD42021253673

Outcomes: As above
Type (intervention, diagnosis, prognosis): Intervention
Additional Evidence Reviewer(s): None
Conflicts of Interest (financial/intellectual, specific to this question): None
Year of last full review: CoSTR 2021

Last ILCOR Consensus on Science and Treatment Recommendation:
We recommend the provision of accredited adult ACLS/ALS training for healthcare providers who provide advanced life support care for adults (strong recommendation, very low-certainty evidence)
We recommend the provision of accredited NRT courses for health care professionals who provide advanced life support care for newborns and babies (strong recommendation, very low-certainty evidence).
We recommend the provision of Helping Babies Breath support training for healthcare providers who provide advanced life support care for newborns and babies (strong recommendation, very low-certainty evidence).

2022 Search Strategy (Developed by IS Jenny Ring):
Appendix 1 Literature search strategy for EMBASE.com, CINAHL and Cochrane

Set	No.	Query	Results
Adult resus terms	#1	'resuscitation'/exp OR 'advanced cardiac life support'/de OR 'advanced life support'/de	120809
	#2	((advanced OR adult) NEXT/3 ('life support' OR resuscitation)):ti,ab	6557
	#3	#1 OR #2	123391
Paediatric resus terms	#4	'pediatric advanced life support'/de OR 'newborn resuscitation'/de OR ('newborn'/de AND 'resuscitation'/de)	7660
	#5	((neonatal OR newborn OR pediatric OR paediatric) NEXT/3 ('life support' OR resuscitation)):ti,ab	4906
	#6	#4 OR #5	10459
Personnel terms	#7	'nursing assistant'/de OR 'physician assistant'/de OR 'nursing staff'/de OR 'medical personnel'/de OR 'hospital personnel'/de OR 'medical staff'/de OR 'midwife'/exp OR 'birth attendant'/de	191389
	#8	doctor*:ti,ab OR physician*:ti,ab OR nurse*:ti,ab OR nursing:ti,ab OR midwife*:ti,ab OR midwive*:ti,ab OR 'birth attendant$':ti,ab OR clinician*:ti,ab OR internist*:ti,ab OR obstetrician*:ti,ab OR surgeon*:ti,ab OR 'health care assistant*':ti,ab OR 'health care professional*':ti,ab OR 'healthcare professional':ti,ab OR interprofessional*:ti,ab OR 'inter professional*':ti,ab OR 'multi professional*':ti,ab OR ((resuscitation OR 'life support' OR emergenc*) NEXT/2 (team* OR unit$ OR staff OR personnel*)) OR (((medical OR clinical) NEXT/2 (staff OR personnel* OR assistant* OR professional$ OR consultant$)):ti,ab)	1952179
	#9	#7 OR #8	2034124
Training terms	#10	'computer simulation'/de OR 'continuing education'/de OR 'vocational education'/de OR 'in service training'/de OR 'patient simulation'/exp OR 'problem based learning'/de OR 'teaching'/de OR 'clinical competence'/de	337929
	#11	train*:ti,ab,kw OR teach*:ti,ab,kw OR education*:ti,ab,kw OR program*:ti,ab,kw OR course$:ti,ab,kw	3297707
	#12	#10 OR #11	3481499
Medical training terms	#13	'medical education'/de OR 'clinical education'/de OR 'physician assistant education'/de	256261
	#14	#3 AND #9 AND #12 OR (#3 AND #13)	9686
	#15	#14 NOT ([conference abstract]/lim OR [conference review]/lim OR [editorial]/lim OR [erratum]/lim OR [letter]/lim OR [note]/lim OR [book]/lim OR 'case report'/de)	5938
	#16	#15 NOT ([animals]/lim NOT [humans]/lim)	5920
	#17	#16 AND [2018-2021]/py	1133
	#18	#6 AND #9 AND #12 OR (#6 AND #13)	1,674
	#19	#18 NOT ([conference abstract]/lim OR [conference review]/lim OR [editorial]/lim OR [erratum]/lim OR [letter]/lim OR [note]/lim OR [book]/lim OR 'case report'/de)	1,091
	#20	#19 NOT ([animals]/lim NOT [humans]/lim)	1,091
	#21	#17 OR #20	**1,984**

Database searched: EMBASE, CINAHL, and Cochrane

Date Search Completed: 1 November 2022

Search Results (Number of articles identified / number identified as relevant): 163 / 1

Inclusion/Exclusion Criteria: Randomized controlled trials (RCTs) and non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies) were eligible for inclusion. Unpublished studies (e.g., conference abstracts, trial protocols), animal studies, case series, and simulation studies were excluded.

Link to Article Titles and Abstracts (if available on PubMed):

PMID	Title	1ˢᵗ Author	Journal
34965451	Effect of resuscitation training and implementation of continuous electronic heart rate monitoring on identification of stillbirth https://pubmed.ncbi.nlm.nih.gov/34965451/	Patterson, J.	Resuscitation

Summary of Evidence Update:

Evidence Update Process for topics not covered by ILCOR Task Forces

This evidence update process is only applicable to PICOs which are *not* being reviewed as ILCOR systematic and scoping reviews.

Relevant Guidelines or Systematic Reviews: 0

Organisation (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations

RCT: 0

Study Acronym; Author; Year Published	Aim of Study; Study Type; Study Size (N)	Patient Population	Study Intervention (# patients) / Study Comparator (# patients)	Endpoint Results (Absolute Event Rates, P value; OR or RR; & 95% CI)	Relevant 2° Endpoint (if any); Study Limitations; Adverse Events

Nonrandomized Trials, Observational Studies: 1

Study Acronym; Author; Year Published	Study Type/Design; Study Size (N)	Patient Population Inclusion Criteria:	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/Conclusion Comment(s)
Effect of resuscitation training and implementation of continuous electronic heart rate monitoring on identification of stillbirth; Patterson; 2021	Pre-post training study helping babies breathe study in three health facilities Democratic Republic of Congo (retrospective pre,	All in-born neonates with the exception of newborns <28 weeks gestation (or if gestational age was unavailable, birth weight <1,000g).	**Outcome measures:** Total stillbirth, fresh stillbirth, macerated stillbirth, neonatal death before discharge, perinatal death **Results:** No change in total stillbirths following resuscitation training and continuous electronic HR monitoring of non-breathing newborns (aRR 1.15 [0.95, 1.39]).	**Conclusion:** in this pre-post trial of resuscitation training and continuous electronic HR monitoring, there was no difference in the primary outcome of total stillbirths. Despite continuous electronic HR monitoring, 20% of newborns classified by skilled birth attendants as stillborn were liveborn.

	prospective post)		Increased rate of macerated stillbirth (aRR 1.58 [1.24, 2.02]), death before discharge (aRR 3.31 [2.41,4.54]), and perinatal death (aRR 1.61 [1.38, 1.89]) during the intervention period.	

Reviewer Comments (including whether meet criteria for formal review):
There was one new article identified relevant to this PICO. The results of these studies support and strengthen the current ILCOR CoSTR recommendation. Given that this is an observational sztudy and no new randomized controlled trial is available, the identified study would not increase the existing very low certainty of evidence and change the current recommendation. Therefore, this EvUp does not meet the criteria to trigger a new systematic review.

	Approval Date
Evidence Update coordinator	
ILCOR board	

*Once approval has been made by Evidence Update coordinator, worksheet will go to ILCOR Board for acknowledgement.

Reference List

1.   Patterson J, Berkelhamer S, Ishoso D, et al. Effect of resuscitation training and implementation of continuous electronic heart rate monitoring on identification of stillbirth. *Resuscitation*. 2022;171(December 2021):57-63. doi:10.1016/j.resuscitation.2021.12.020

2022 Evidence Update Worksheet

EIT 6302 Technology to Summon Providers

Worksheet author(s): Catherine Patocka, Nino Fijacko
Council: Heart and Stroke Foundation of Canada
Date Submitted: December 2022

PICO / Research Question: EIT 6302
First responders engaged by mobile technology

Population: Adults and children with out-of-hospital cardiac arrest.
Intervention: Does having a citizen CPR responder notified of the event via mobile technology or social medial.
Comparators: Compared with no such notification
Outcomes: <u>Patient outcomes:</u> (1) Survival to hospital discharge with good neurological function; (2) Survival to hospital discharge; (3) Hospital admission; (4) Return of spontaneous circulation (ROSC); (5) Bystander CPR rates; (6) Time to first compression.
Study Designs: Randomized controlled trials (RCTs) and non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies and case series where n>5 are eligible for inclusion. Unpublished studies (e.g., conference abstracts, trial protocols) commentary and editorial papers, reviews and animal studies were excluded.
Timeframe: All years and all languages were included if there is an English abstract. The search strategy was performed on the same day (20 Oct 2022) for the three databases.

PROSPERO Registration: registered PROSPERO on 28/04/2020. PROSPERO ID CRD42020160694

Outcomes: As above
Type (intervention, diagnosis, prognosis): Intervention
Additional Evidence Reviewer(s): None
Conflicts of Interest (financial/intellectual, specific to this question): None
Year of last full review: 2020 (EIT 878 First responders engaged by technology)

Last ILCOR Consensus on Science and Treatment Recommendation:
We recommend that citizen/individuals who are in close proximity to a suspected Out-of-hospital Cardiac Arrest (OHCA) event and willing to be engaged/notified by a smartphone app with mobile positioning system (MPS) or Text Message (TM)-alert system should be notified (strong recommendation, very low-certainty evidence)

2020 Search Strategy:
Pubmed
(((("Heart Arrest"[Mesh] OR "heart arrest*"[TIAB] OR "cardiac arrest*"[TIAB] OR "cardiovascular arrest*"[TIAB] OR "cardiopulmonary arrest*"[TIAB] OR "cardio-pulmonary arrest*"[TIAB] OR "Out-of-Hospital Cardiac Arrest*"[Mesh] OR OHCA OR "Out of Hospital Cardiac Arrest*"[TIAB] OR "Out-of-Hospital Cardiac Arrest*"[TIAB] OR "outside of hospital Cardiac Arrest "[TIAB]) OR (resuscitation [Mesh] OR resuscitation* [TIAB] OR "cardiopulmonary resuscitation"[Mesh] OR "cardiopulmonary resuscitation"[TIAB] OR "Cardio-Pulmonary Resuscitation" OR "Cardio Pulmonary Resuscitation" OR CPR [TIAB] OR "Life Support Care"[Mesh] OR "Basic Cardiac Life Support" OR "basic life support" OR "Cardiac Life Support" [TIAB] OR "cardiorespiratory resuscitation"[TIAB] OR "Heart Massage*"[Mesh] OR heart massage*[TIAB] OR cardiac massage*[TIAB] OR chest compression*[TIAB] OR cardiac compression*[TIAB])) AND (public[TIAB] OR bystander*[TIAB] OR "first responder*"[TIAB] OR "first-responder*"[TIAB] OR Layperson*[TIAB] OR "lay people"[TIAB] OR "lay rescuer*"[TIAB] OR witness*[TIAB] OR "Firefighters"[Mesh] OR Firefighter*[TIAB] OR "fire fighter" OR "fire fighters" OR "Police"[Mesh] OR Police[TIAB] OR "non-healthcare professional*"[TIAB]) AND (((internet [Mesh] OR web) AND (technology OR app OR application OR alert)) OR "global positioning system" OR "Social Media"[Mesh] OR"Social Media" OR "telecommunications"[tiab] OR "streaming video" OR "video streaming" OR twitter[tiab] OR Tweet[tiab] OR "social web" OR "social network" OR "social

networking" OR "social software" OR "social medium" OR "instant messaging" OR "instant message" OR "IM"[tiab] OR "text message*" OR screencast* OR "video-sharing" OR "smart phone" OR "Phone app" OR "cell phone" OR VIMEO [tiab] OR "PulsePoint" OR "push technology" OR iGoogle[tiab] OR Web[tiab] OR "computer-generated phone call*" OR facebook OR instagram OR geolocalization OR geolocation OR "you tube" OR whatsapp OR Geofencing OR "Global Navigation Satellite System" OR GNSS OR "taxi driver"OR "virtual reality" OR "Recruitment system" OR "GoodSam app" OR DAE OR RespondER OR "smart watch" OR "AEDMAP"))))

Embase
(('heart arrest'/exp OR ('cardiac arrest*' OR 'cardiovascular arrest*' OR 'cardiopulmonary arrest*' OR 'cardio-pulmonary arrest'):ta,ab,kw OR 'out of hospital cardiac arrest'/exp OR (ohca OR 'out-of-hospital cardiac arrest*' OR 'outside-of-hospital cardiac arrest'):ta,ab,kw OR 'heart massage'/exp OR ('cardiopulmonary resuscitation' OR 'cardio-pulmonary resuscitation' OR 'cardio pulmonary resuscitation' OR cpr OR 'basic life support' OR 'cardiorespiratory resuscitation' OR 'heart massage*' OR 'cardiac massage*' OR 'chest compression*' OR 'cardiac compression*') :ta,ab,kw) AND (('layperson'/exp OR bystander* OR 'first responder*' OR 'first-responder*' OR layperson* OR 'lay people' OR 'lay rescuer*' OR 'lay public' OR witness* OR 'non-healthcare professional' OR public):ta,ab,kw OR ('firefighters' OR firefighter* OR 'fire fighter' OR 'fire fighters' OR police):ta,ab,kw) AND ((('internet'/exp OR web) AND (technology OR app OR application OR alert)) OR ('global positioning system' OR 'social media' OR 'telecommunications' OR 'streaming video' OR 'video streaming' OR twitter OR tweet OR 'social web' OR 'social network' OR 'social networking' OR 'social software' OR 'social medium' OR 'instant messaging' OR 'instant message' OR 'im' OR 'text message*' OR screencast* OR 'video-sharing' OR 'smart phone' OR 'phone app' OR 'cell phone' OR vimeo OR 'pulsepoint' OR 'push technology' OR igoogle OR web OR 'computer-generated phone call*' OR facebook OR instagram OR geolocalization OR geolocation OR 'you tube' OR whatsapp OR geofencing OR 'global navigation satellite system' OR gnss OR 'taxi driver' OR 'virtual reality' OR 'recruitment system' OR 'goodsam app' OR dae OR responder OR 'smart watch' OR 'aedmap'))

Cochrane
((MeSH descriptor: [Heart Arrest] OR ("cardiac arrest" OR "cardiovascular arrest*" OR "cardiopulmonary arrest*" OR "cardio-pulmonary arrest*"):ti,ab,kw OR MeSH descriptor: [Out-of-Hospital Cardiac Arrest] OR ("cardiopulmonary resuscitation" OR "Cardio Pulmonary Resuscitation" OR CPR OR "Life Support Care" OR "Basic Cardiac Life Support" OR "basic life support" OR "Cardiac Life Support" OR "cardiorespiratory resuscitation"):ti,ab,kw OR MeSH descriptor: [Heart Massage] OR ("cardiac massage*" OR "chest compression*" OR "cardiac compression"):ti,ab,kw) AND ((public OR bystander* OR "first responder*" OR "first-responder*" OR Layperson* OR "lay people" OR "lay rescuer*" OR "lay public" OR witness* OR "non-healthcare professional"):ti,ab,kw OR ('firefighters' OR firefighter* OR 'fire fighter' OR 'fire fighters' OR police):ta,ab,kw) AND (((MeSH descriptor: [Internet] OR web) AND (technology OR app OR application OR alert)) OR ('global positioning system' OR 'social media' OR 'telecommunications' OR 'streaming video' OR 'video streaming' OR twitter OR tweet OR 'social web' OR 'social network' OR 'social networking' OR 'social software' OR 'social medium' OR 'instant messaging' OR 'instant message' OR 'im' OR 'text message*' OR screencast* OR 'video-sharing' OR 'smart phone' OR 'phone app' OR 'cell phone' OR vimeo OR 'pulsepoint' OR 'push technology' OR igoogle OR web OR 'computer-generated phone call*' OR facebook OR instagram OR geolocalization OR geolocation OR 'you tube' OR whatsapp OR geofencing OR 'global navigation satellite system' OR gnss OR 'taxi driver' OR 'virtual reality' OR 'recruitment system' OR 'goodsam app' OR dae OR responder OR 'smart watch' OR 'aedmap'))

Database searched: Pubmed, Embase and Cochrane
Date Search Completed: 20th October 2022
Search Results (Number of articles identified / number identified as relevant): 450 / 9[1–9]
Inclusion/Exclusion Criteria: Randomized controlled trials (RCTs) and non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies) were eligible for inclusion. Unpublished studies (e.g., conference abstracts, trial protocols), animal studies, case series, and simulation studies were excluded.

Link to Article Titles and Abstracts (if available on PubMed):

PMID	Title	1st Author	Journal
34791171	Alert system-supported lay defibrillation and basic life-support for cardiac arrest at home https://pubmed.ncbi.nlm.nih.gov/34791171/	Stieglis, R.	European Heart Journal
34581532	Community first responders for out-of-hospital cardiac arrest in adults and children https://pubmed.ncbi.nlm.nih.gov/34581532/	Barry, T.	Emergencias
31923531	Global positioning system alerted volunteer first responders arrive before emergency medical services in more than four our of five emergency calls https://pubmed.ncbi.nlm.nih.gov/31923531/	Sarkisian, L.	Resuscitation
32437783	Enhancing citizens response to out-of-hospital cardiac arrest: A systematic review of mobile-phone systems to alert citizens as first responders https://pubmed.ncbi.nlm.nih.gov/32437783/	Scquizzato, T.	Resuscitation
34993887	Improved ROSC rates in out-of-hospital cardiac arrest patients after introduction of a text message alert system for trained volunteers https://pubmed.ncbi.nlm.nih.gov/34993887/	Oosterveer, DM.	Netherlands Heart Journal
32445436	Mobile Smartphone Technology Is Associated With Out-of- hospital Cardiac Arrest Survival Improvement: The First Year "Greater Paris Fire Brigade" Experience https://pubmed.ncbi.nlm.nih.gov/32445436/	Derkenne, C.	Academic Emergency Medicine
35283448	Dispatching citizens as first responders to out-of-hospital cardiac arrests: a systematic review and meta-analysis https://pubmed.ncbi.nlm.nih.gov/35283448/	Scquizzato, T.	European Journal of Emergency Medicine
34774964	PulsePoint dispatch associated patient characteristics and prehospital outcomes in a mid-sized metropolitan area https://pubmed.ncbi.nlm.nih.gov/34774964/	Smida, T.	Resuscitation
35024801	The effect of the GoodSAM volunteer first-responder app on survival to hospital discharge following out-of-hospital cardiac arrest https://pubmed.ncbi.nlm.nih.gov/35024801/	Smith, CM.	European Heart Journal of Acute Cardiovascular Care

Summary of Evidence Update:

Evidence Update Process for topics not covered by ILCOR Task Forces

This evidence update process is only applicable to PICOs which are *not* being reviewed as ILCOR systematic and scoping reviews.

Relevant Guidelines or Systematic Reviews: 3

Organisation (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations
Scquizzato, T. 2022, 1st page number	Systematic review and meta-analysis	Investigates whether activating citizen first responders increases bystanders' interventions and improves outcomes	10	"OHCAs for which citizen FR were activated had higher rates of survival at hospital discharge or 30 days compared with standard emergency response [nine studies; 903/9978 (9.1%) vs. 1104/13 247 (8.3%); odds ratio (OR), 1.45; 95% confidence interval (CI), 1.21–1.74; P < 0.001], return of spontaneous circulation [nine studies;	"Alerting citizen FR to OHCA patients is associated with higher rates of bystander-initiated CPR, use of AED before ambulance arrival, and survival at hospital discharge or 30 days."

				2575/9169 (28%) vs. 3445/12 607 (27%); OR, 1.40; 95% CI, 1.07–1.81; P = 0.01], bystander-initiated CPR [eight studies; 5876/9074 (65%) vs. 6384/11 970 (53%); OR, 1.75; 95% CI, 1.43–2.15; P < 0.001], and AED use [eight studies; 654/9132 (7.2%) vs. 624/14 848 (4.2%); OR, 1.82; 95% CI, 1.31–2.53; P < 0.001], but similar rates of neurological intact discharge [three studies; 316/2685 (12%) vs. 276/2972 (9.3%); OR, 1.37; 95% CI, 0.81–2.33; P = 0.24]."	
Barry, T. 2021, 1st page number	Cochrane Systematic Review	Assesses the effect of mobilizing community FR to out-of-hospital cardiac arrest.	2	The first found no difference in survival at hospital discharge (odds ratio (OR) 1.3, 95% confidence interval (CI) 0.8 to 2.2; 1 RCT; 469 participants; low-certainty evidence), despite the observation that all 72 incidences of defibrillation performed before EMS arrival occurred in the intervention group (OR and 95% CI - not applicable; 1 RCT; 469 participants; moderate- certainty evidence). This study reported increased survival to hospital admission in the intervention group (OR 1.5, 95% CI 1.1 to 2.0; 1 RCT; 469 participants; moderate-certainty evidence). The second found no difference in 30-day survival (OR 1.34, 95% CI 0.79 to 2.29; 1 RCT; 612 participants; low-certainty evidence), despite a significant increase in CPR performed before EMS arrival (OR 1.49, 95% CI 1.09 to 2.03; 1 RCT; 665 participants; moderate-certainty evidence).	Moderate-certainty evidence shows that context-specific FR interventions result in increased rates of CPR or defibrillation performed before EMS arrival. It remains uncertain whether this can translate to significantly increased rates of overall patient survival.
Scquizzato, T. 2020, 1st page number	Systematic review	Identifies existing systems and technologies to locate and alert citizens acting as first responders to nearby OHCAs. Determine their technical characteristics and analyze their impact in	28	First responders (FR) accepted to intervene in 28.7% (27-29% - median (IQR)) of alerts and reached the scene after 4.6 (4.4-5.5) minutes FR arrived in 47% (34-58%) before ambulance, started CPR in 24% (23-27%) and attached a defibrillator in 9% (6 - 14%) of cases. Pooled analysis showed that FR activation	"Implementing mobile-phone systems to locate and alert citizens as first responders in case of OHCA may increase early CPR and defibrillation and improve patients' outcomes."

| | | | increased layperson-CPR rates (1463/2292 [63.8%] in the intervention group vs. 1094/1989 [55.0%] in the control group; OR = 1.70; 95% CI, 1.11-2.60; p = 0.01) and survival to hospital discharge or at 30 days (327/2273 [14.4%] vs. 184/1955 [9.4%]); OR = 1.51; 95% CI, 1.24?1.84; p < 0.001)" | |

RCT: 0

Study Acronym; Author; Year Published	Aim of Study; Study Type; Study Size (N)	Patient Population	Study Intervention (# patients) / Study Comparator (# patients)	Endpoint Results (Absolute Event Rates, P value; OR or RR; & 95% CI)	Relevant 2° Endpoint (if any); Study Limitations; Adverse Events

Nonrandomized Trials, Observational Studies: 6

Study Acronym; Author; Year Published	Study Type/Design; Study Size (N)	Patient Population Inclusion Criteria	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/Conclusion Comment(s)
Alert system-supported lay defibrillation and basic life-support for cardiac arrest at home; Stieglis; 2022, 1st page number	Secondary analysis of the ARREST prospective registry for all OHCA in the province of North Holland.	Included all patients in North-Holland of whom dispatchers suspected and EMS confirmed and treated a bystander witnessed or unwitnessed CA with VF.	Outcome measures: The primary outcome measure was survival to hospital discharge for patients with VF. Secondary outcomes were the proportion of patient receiving CPR before arrival or EMS, the interval between the call to the dispatch center and the first defibrillation shock from either ambulance defibrillator or AED, and neurologically favorable survival to hospital discharge. Results: "Survival from OHCAs in residences increased from 26% to 39% (adjusted relative risk (RR) 1.5 [95% confidence interval (CI): 1.03–2.0]). RR for neurologically favorable survival was 1.4 (95% CI: 0.99–2.0). No CPR before ambulance arrival decreased from 22% to 9% (RR: 0.5, 95% CI: 0.3–0.7). Text- message-responders with AED administered shocks to 16% of all patients in VF in residences, while defibrillation by EMS decreased from 73% to 39% in residences (P< 0.001). Defibrillation by first responders in residences increased from 22 to 40% (P< 0.001). Use of public AEDs in residences remained unchanged (6% and 5%) (P= 0.81). Time from	"Introducing volunteer responders directed to AEDs, dispatched by text-message was associated with significantly reduced time to first defibrillation, increased bystander CPR and increased overall survival for OHCA patients in residences found with VF."

			emergency call to defibrillation decreased from median 11.7 to 9.3 min; mean difference –2.6 (95% CI: –3.5 to –1.6).	
Improved ROSC rates in out-of-hospital cardiac arrest patients after introduction of a text message alert system for trained volunteers; Oosterveer; 2022, 1st page number	Before and after study of introduction of a text message (TM) alert system for trained volunteers.	Patients were included if they were older than 16 years and ambulance staff administered CPR and/or defibrillation. Exclusion: National CPR protocol of the ambulance services was note started or stopped prematurely. Reasons were a do-not-resuscitate order and conditions where resuscitation was found to be medically pointless (signs of biological death, lethal injury, a cardiac arrest period longer than 15 min without hypothermia, drowning or traumatic pulseless electrical activity.	Outcomes measures: Primary outcome measures: the number of AEDs connected, ROSC at the emergency department, and 3-month and 1-year survival. Results: "TM responders reached 42 OHCA patients (15.9%) earlier than the first responders or ambulance. They connected 31 of these 42 OHCA patients (73.8%) to an AED before the ambulance arrived, leading to a higher percentage of AEDs being attached in 2018 compared to the 2012 non-TM group (55% vs 46%, p= 0.03). ROSC was achieved more often in the TM group (61.0% vs 29.4%, p< 0.01). Three-month and 1-year survival did not differ significantly between the two groups (29.3% vs 24.3%, p= 0.19, and 25.9% vs 23.5%, p= 0.51). Multivariate regression analyses con-firmed the positive association of ROSC with the TM"	"A TM alert system seems to improve the chain of survival; because TM responders reached patients early, AEDs were attached more often and more OHCA patients achieved ROSC. However, the introduction of a TM alert system was not associated with improved 3-month or 1-year survival in a region with above-average survival rates."
PulsePoint dispatch associated patient characteristics and prehospital outcomes in a mid-sized metropolitan area; Smida; 2022, 1st page number	Retrospective, observational study examining the operational characteristics of the Allegheny County Emergency Services' (ACES) deployment of PulsePoint (a bystander CPR recruitment system that has been deployed in the United States and	Any PulsePoint dispatch during the study period. Any 9-1-1 call for a patient described by emergency medical dispatchers using determining codes that also corresponded to a public location would automatically trigger a 'CPR needed' alert if a PulsePoint	Outcomes measures: OHCA case characteristics were extracted according to the Utstein template Results: "Of 840 total PulsePoint dispatches, 64 (7.6%) were for OHCA associated with a resuscitation attempt. Forty-one (64.1%) were witnessed, 38 (59.4%) received bystander CPR, and 13 (20.0%) of these patients had an AED applied prior to EMS arrival. Twenty-seven (39.7%) had an initial shockable rhythm, and 31 (48.4%) patients achieved ROSC in the field. In the city of Pittsburgh, there were	"A minority of PulsePoint dispatches in Pittsburgh were triggered by true OHCA. The majority of OHCA during the study period occurred within private residences where PulsePoint responders are not currently dispatched. PulsePoint dispatches were associated with prognostically favorable OHCA characteristics and increased bystander CPR performance"

	Canada) from July 2016 to October 2020. ACES provides 911 dispatch service to the entirety of Allegheny County, Pennsylvania, a population of 1.2 million people.	responder's mobile phone was detected within 400m of the event location. Exclusion: OHCA were excluded if they occurred in a nursing home or assisted living facility, patients with documented DNR/DNI, traumatic aetiology, witnessed cardiac by a healthcare provider within a facility with trained staff and an AED available.	1229 total OHCA during the study period, with an estimated 29.6% occurring in public. When PulsePoint-associated and publicly occurring non-PulsePoint-associated OHCA were compared, baseline characteristics (age, sex, witnessed status) were similar, but PulsePoint-associated OHCA received more bystander CPR (p = 0.008)."	
The effect of the GoodSAM volunteer first-responder app on survival to hospital discharge following out-of-hospital cardiac arrest; Smith; 2022, 1st page number	Out-of-Hospital Cardiac Arrest Outcome Registry study from the London Ambulance Service and East Midlands Ambulance Service and matched Out-of-hospital cardiac arrests to GoodSAM alerts.	Data for LAS between 1 April 2016 and 31 March 2017 and for EMAS between 1 January 2018 and 17 June 2018. Exclusion: In London, GoodSAM was non-operational from 30 August 2016 to 19 September 2016 and from 26 December 2016 to 30 December 2016, so results that we present exclude OHCAs on those dates.	Outcomes measures: The primary outcome was survival to hospital discharge Results: "We constructed logistic regression models to determine if there was an association between a GoodSAM first-responder accepting an alert and survival to hospital discharge, adjusting for location type, presenting rhythm, age, gender, ambulance service response time, cardiac arrest witnessed status, and bystander actions. Survival to hospital discharge was 9.6% (393/4196) in London and 7.2% (72/1001) in East Midlands. A GoodSAM first-responder accepted an alert for out-of-hospital cardiac arrest in 1.3% (53/4196) cases in London and 5.4% (51/1001) cases in East Midlands. When a responder accepted an alert, the adjusted odds ratio for survival to hospital discharge was 3.15 (95% CI: 1.19–8.36, P= 0.021) in London and 3.19 (95% CI: 1.17–8.73, P= 0.024) in East Midlands."	"Alert acceptance was associated with improved survival in both ambulance services. Alert acceptance rates were low, and challenges remain to maximize the potential benefit of GoodSAM."
Mobile Smartphone Technology Is Associated With Out-of-hospital	Nonrandomized cohort study of all adults with OHCA managed by the Greater	All OHCA events in the Greater Paris Area between July 2017 and July 2018	Outcome measures: Rate of ROSC upon hospital admission, survival outcomes upon hospital discharge, and impact of CPR-	We report that mobile smartphone technology was associated with OHCA survival through accelerated initiation of

Cardiac Arrest Survival Improvement: The First Year "Greater Paris Fire Brigade" Experience Derkenne; 2020, 1st page number	Paris Fire Brigade during 2018		trained volunteers (Bons Samaritains)(BS) on survival outcomes Results: "Approximately 4,107 OHCA cases were recorded in 2018. Among those, 320 patients were in the control group, whereas 46 patients, in the intervention group, received first responder–initiated CPR. After adjustment for confounders, survival at hospital discharge was significantly improved for patients in the intervention group (35% vs. 16%, adjusted odds ratio = 5.9, 95% confidence interval = 2.1 to 16.5, p < 0.001). All CPR metrics were improved in the intervention group."	efficient CPR by first responders in a large urban area
Global positioning system alerted volunteer first responders arrive before emergency medical services in more than four out of five emergency calls; Sarkisian; 2019, 1st page number	Retrospective cohort study conducted on the island of Langeland, Denmark	EMS-treated OHCAs that occurred on Langeland from April 21, 2012 until Dec 31, 2017. Volunteer first responders were introduced to the island in 2012. Exclusion: patients with obvious late signs of death, non-OHCA and OHCA due to non-medical causes (suicide, trauma, accidents etc.)	Outcome measures: Response rates and response times for FRs vs EMS. The secondary outcome is 30-day survival after OHCA in residential areas and public locations. Results: "In 2266 of 2662 emergency calls (85%) at least one FR arrived to the site before EMS. Median response times for VFRs (n = 2662) was 4:46 min:sec (IQR 3:16-6:52) compared with 10:13 min:sec (6:14-13:41) for EMS (p < 0.0001). A total of 17 OHCAs took place in public locations and 65 in residential areas. Thirty-day survival in these were 24% and 15%, respectively."	"Use of a smartphone GPS-tracking system to dispatch FRs ensures that in more than four of five cases, a FR arrives to the site before EMS. Response times for FRs were also found to be lower than EMS response times."

Reviewer Comments (including whether meet criteria for formal review):
There were 454 new articles identified in the Pubmed, EMBASE and Cochrane search of which nine were relevant to the PICO. There were three systematic reviews and six non-randomized studies. The summary of these studies supports the current ILCOR CoSTR recommendation. Given that no randomized controlled trial data is available, the identified studies would not change the existing recommendation based on very low certainty of evidence. Therefore, this EvUp does not meet the criteria to trigger a new systematic review but a scoping review on First Responder systems and its effects is proposed.

Reference List

1. Stieglis R, Zijlstra JA, Riedijk F, et al. Alert system-supported lay defibrillation and basic life-support for cardiac arrest at home. *Eur Heart J*. 2022;43(15):1465-1474. doi:10.1093/eurheartj/ehab802

2. Barry T, Doheny MC, Masterson S, et al. Community first responders for out-of-hospital cardiac arrest in adults and children. *Emergencias*. 2021;33(5):382-384. doi:10.1002/14651858.CD012764.pub2.www.cochranelibrary.com

3. Sarkisian L, Mickley H, Schakow H, et al. Global positioning system alerted volunteer first responders arrive before emergency medical services in more than four out of five emergency calls. *Resuscitation*. 2020;152(December 2019):170-176. doi:10.1016/j.resuscitation.2019.12.010

4. Scquizzato T, Pallanch O, Belletti A, et al. Enhancing citizens response to out-of-hospital cardiac arrest: A systematic review of mobile-phone systems to alert citizens as first responders. *Resuscitation*. 2020;151(January):59-66. https://www.resuscitationjournal.com/article/S0300-9572(20)30159-3/fulltext.

5. Scquizzato T, Belloni O, Semeraro F, et al. Dispatching citizens as first responders to out-of-hospital cardiac arrests: a systematic review and meta-analysis. *Eur J Emerg Med*. 2022;29(3):163-172. doi:10.1097/MEJ.0000000000000915

6. Oosterveer DM, de Visser M, Heringhaus C. Improved ROSC rates in out-of-hospital cardiac arrest patients after introduction of a text message alert system for trained volunteers. *Netherlands Hear J*. 2022. doi:10.1007/s12471-021-01656-6

7. Smith CM, Lall R, Fothergill RT, Spaight R, Perkins GD. The effect of the GoodSAM volunteer first-responder app on survival to hospital discharge following out-of-hospital cardiac arrest. *Eur Hear Journal Acute Cardiovasc Care*. 2022;11(1):20-31. doi:10.1093/ehjacc/zuab103

8. Smida T, Salerno J, Weiss L, Martin-Gill C, Salcido DD. PulsePoint dispatch associated patient characteristics and prehospital outcomes in a mid-sized metropolitan area. *Resuscitation*. 2022;170(June):36-43. doi:10.1016/j.resuscitation.2021.11.007

9. Derkenne C, Jost D, Roquet F, et al. Mobile Smartphone Technology Is Associated With Out-of-hospital Cardiac Arrest Survival Improvement: The First Year "Greater Paris Fire Brigade" Experience. *Acad Emerg Med*. 2020;27(10):951-962. doi:10.1111/acem.13987

2020 Evidence Update Worksheet

Worksheet author(s): Kasper G. Lauridsen, Kevin Nation, Robert Greif
Council: European Resuscitation Council
Date Submitted: December 1, 2022

PICO / Research Question:
Prehospital termination of resuscitation (TOR) rules (EIT 6303, former 642)

Population: Adults and children in cardiac arrest who do not achieve return of spontaneous circulation (ROSC) in the out-of-hospital environment
Intervention: TOR rules
Comparators: In-hospital outcomes (died/survived), and favorable/unfavorable neurological outcome
Outcomes: Ability of TOR to predict death in hospital (critically important) and unfavorable neurological outcome (critically important).
Study Designs: Randomized controlled trials and non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies). We excluded editorials, commentaries, opinion papers, non-published studies, and studies not having an abstract in English.

Timeframe: 05/02/2021 to 21/11/2022.

Outcomes: As above
Type (intervention, diagnosis, prognosis): Diagnosis
Additional Evidence Reviewer(s): None
Conflicts of Interest (financial/intellectual, specific to this question): None
Year of last full review: 2019

Last ILCOR Consensus on Science and Treatment Recommendation:
We conditionally recommend the use of TOR rules to assist clinicians in deciding whether to discontinue resuscitation efforts out of hospital or to transport to hospital with ongoing CPR (conditional recommendation/very low-certainty evidence).

2019 Search Strategy (EMBASE):
(('out-of-hospital cardiac arrest'/exp OR 'ohca' OR (('Heart Arrest'/exp OR 'Heart Arrest.mp.'/ OR 'ventricular fibrillation.mp.' OR 'heart ventricle fibrillation'/exp OR 'ventricular tachycardia.mp.' OR 'heart ventricle tachycardia'/exp OR 'cardiopulmonary arrest'/exp OR 'cardiopulmonary arrest.mp.' OR 'circulatory arrest.mp.' OR 'cardiac standstill.mp.' OR 'pulseless electrical activity.mp.' OR 'pea.mp.' OR 'pulseless.mp.' OR 'shockable.mp.' OR 'non-shockable' OR 'non shockable' OR 'cardiac arrest.mp.') AND (prehospital OR 'pre hospital' OR 'pre-hospital/ OR 'out-of-hospital' OR 'out of hospital' OR 'emergency health service'/exp OR 'emergency medical service*.mp.' 'paramedic*.mp.' OR 'paramedical personnel'/exp 'emergency medical technician.mp.' OR 'rescue personnel' OR 'air medical transport'/exp OR 'air ambulance*.mp.' OR 'hems.mp.' OR ambulance/exp OR ambulance*.mp. OR ems OR emt OR field)) AND (resuscitation/exp OR resuscitat*.mp. OR 'Resuscitation Orders' OR 'cardiopulmonary resuscitation' or CPR OR 'Life Support Care' OR 'heart massage.mp.' OR 'heart massage'/exp OR 'chest compression' OR 'basic life support' OR BLS OR 'advanced life support' OR ALS OR 'advanced cardiac life support') AND (Prognosis/exp OR (terminat* OR cease OR cessation OR withdraw* OR withhold* OR withheld OR futile OR futility OR TOR OR rule* OR decision* OR algorithm* OR stop)) NOT (letter or editorial)) limit to human.

2022 Search Strategy:
Same as above

Database searched: Embase
Date Search Completed: November 21, 2022

Search Results (Number of articles identified / number identified as relevant): 645 studies were identified and 2 studies were considered relevant.

Inclusion Criteria: We included studies on TOR rules used to predict survival or death for patients in out-of-hospital cardiac arrest (OHCA).

Exclusion: Studies utilizing pre-arrest factors (e.g. age and comorbidities) to identify patients at low risk of surviving a cardiac arrest and studies on clinical decision rules used to predict survival after ROSC were excluded.

Link to Article Titles and Abstracts (if available on PubMed):
Harris, 2021, 175. Doi: 10.1016/j.resuscitation.2021.09.015.
Lin, 2022, 22. Doi: 10.1186/s12873-022-00606-8.

Summary of Evidence Update: EMBASE was searched to identify eligible studies providing new information until November 21, 2022. Overall, 645 abstracts were screened and 2 cohort studies were considered relevant. One study applied The Maryland pediatric Termination of Resuscitation (pTOR) criteria for medical and traumatic cardiac arrests. The study reports data from 1395 pediatric patients with medical OHCA and 200 with traumatic OHCA.[1] The study correctly classified 322/323 pediatric patients as not eligible for TOR using the medical TOR rule, whereas the traumatic TOR rule misclassified 4 out of 54 patients with ROSC.[1] Another historical cohort study investigated use of the basic life support (BLS) and the advanced life support (ALS) TOR rules on 1260 cardiac arrests in 2015 (survival: 4.4%) and 979 in 2020 (survival: 5.1%). The TOR rules were applied to a larger proportion of cardiac arrests in 2015 due to lower numbers of pre-hospital ROSC when compared to 2020. Thus, the positive predictive value was 99% and 99.1% for the BLS TOR and ALS TOR rule in 2015 when compared to 100% for both the BLS TOR and ALS TOR in 2020.

Nonrandomized Trials, Observational Studies (2)

Study Acronym; Author; Year Published	Aim of Study; Study Type/Design; Study Size (N)	Patient Population	Study Intervention	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/Conclusion Comment(s)
Harris 2021[1]	Historical cohort study aiming to investigate the The Maryland pTOR criteria on pediatric OHCA patients.	All pediatric OHCAs from 2019 from the ESO Data Collaborative in the US with data on ET-CO2 (n=1595)	The Maryland medical pTOR criteria including: <18 years, two 15 min cycles of CPR, ≥3 doses of epinephrine, asystole, ET-CO2 <15 mmHg and adequate emotional support.	For 1395 patients, the medical pTOR criteria correctly classified 322 out of 323 patients who had prehospital ROSC as not eligible for TOR. Applying the trauma pTOR eligibility criteria to the 200 patients with traumatic arrests correctly classified 50 of the 54 patients who had prehospital ROSC as not eligible for TOR.	The medical pTOR correctly classified nearly all patients whereas 4/54 were missed using the trauma criteria for traumatic OHCAs. Patients without data on ET-CO2 were automatically classified as ineligible for pTOR which may inflate the specificity of the pTOR criteria.
Lin 2022[2]	Historical cohort study aiming to validate the BLS and ALS TOR rules in terms of the 2010 and 2015 AHA resuscitation guidelines.	All non-traumatic OHCAs in the city of Tainan (Taiwan) in 2015 (n=1260) and 2020 (n=979). Those treated by the BLS or ALS teams	BLS rule: unwitnessed by EMS, only non-shockable rhythm, and no ROSC before transport. ALS rule: non-witnssed, no bystander	Among the 1260 OHCAs in 2015, 757 (60.1%) and 124 (9.8%) met the BLS and ALS TOR rules whereas this was 438 (44.7%) for BLS and 104 (10.6%) for ALS in 2020. Survival to hospital discharge was 4.4% in 2015 and 5.1% in 2020. The PPV for predicting unfavorable neurological outcome was 99.0% and 99.2% for the BLS and ALS	In 2020, where more patients had pre-hospital ROSC and were non-eligible for the TOR rules, PPV was perfect whereas it was 99% in 2015 where less patients had pre-hospital ROSC.

| | | were evaluated according to the BLS and ALS TOR rules respectively | CPR, no shocks and no ROSC before transport. | TOR rules in 2015, whereas it was 100% and 100% in 2020. | |

Abbreviations: CPR = cardiopulmonary resuscitation; OHCA: out-of-hospital cardiac arrest; ROSC: return of spontaneous circulation; ROSC After Cardiac Arrest Score; BLS: basic life support; ALS: advanced life support; PPV: positive predictive value;

Evidence Update Process for topics not covered by ILCOR Task Forces
This evidence update process is only applicable to PICOs which are *not* being reviewed as ILCOR systematic and scoping reviews.

Reviewer Comments (including whether meet criteria for formal review):
This Evidence Update identified 2 new studies in addition to 1 study identified for the 2021 evidence update. One of these studies applied a medical TOR rule and a surgical TOR rule for pediatric patients (pTOR) with OHCA due to medical and traumatic causes for cardiac arrest respectively. This study found that 322/323 patients were correctly classified as not eligible for pTOR using the medical pTOR rule whereas the traumatic pTOR rule misclassified 4 out of 54 patients with ROSC. Although the criteria for the pediatric TOR rules were more strict than previously published TOR rules, it was unable to correctly classify all patients as not eligible for TOR. As pediatric cardiac arrests may be considered a specific situation with many life years at risk, and because only 1 historical cohort study has looked at pTOR rules for pediatric cardiac arrests specifically without showing convincing results, a new systematic review may find that TOR rules cannot be recommended for pediatric OHCAs. Accordingly, we suggest conducting an updated systematic review. Hopfully including more studies in pediatric cardiac arrest.

	Approval Date
Evidence Update coordinator	
ILCOR board	

*Once approval has been made by Evidence Update coordinator, worksheet will go to ILCOR Board for acknowledgement.

Reference list
[1]   Harris MI, Crowe RP, Anders J, D'Acunto S, Adelgais KM, Fishe J. Applying a set of termination of resuscitation criteria to paediatric out-of-hospital cardiac arrest. Resuscitation 2021;169:175–81. doi:10.1016/j.resuscitation.2021.09.015.

[2]   Lin Y-Y, Lai Y-Y, Chang H-C, Lu C-H, Chiu P-W, Kuo Y-S, et al. Predictive performances of ALS and BLS termination of resuscitation rules in out-of-hospital cardiac arrest for different resuscitation protocols. BMC Emerg Med 2022;22:53. doi:10.1186/s12873-022-00606-8.

Evidence Update Worksheet
EIT 6407 In Situ Simulation

Worksheet author(s): Taylor Sawyer; Cristian Abelairas-Gómez
Council: AHA
Date Submitted: November 2022
PICO / Research Question: EIT 6407 (previously EIT 4007)
Question: *Does in situ (workplace-based) simulation-based resuscitation training for healthcare providers lead to improve learning, performance, and patient outcomes?*

Population: healthcare providers
Intervention: in situ (workplace-based) simulation-based cardiopulmonary resuscitation (CPR) training
Comparator: traditional training (i.e. classroom or laboratory-based training)
Outcomes: improved learning, performance, and patient outcomes
Study Designs: Randomized controlled trials (RCTs) and non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies) were eligible for inclusion.
Timeframe: The literature was searched from the date of last Evidence Update (9 Feb 2021) to 26 Oct 2022
PROSPERO Registration: N/A

Outcomes: As above
Type (intervention, diagnosis, prognosis): Intervention
Additional Evidence Reviewer(s): None
Conflicts of Interest (financial/intellectual, specific to this question): None
Year of last full review: New question 2020 (EvUp) / EvUP 2021 / EvUP 2022

Last ILCOR Consensus on Science and Treatment Recommendation: (2020 EIT International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations)
This EvUp does not enable a treatment recommendation to be made.

2010/2015 Search Strategy: N/A
2020 Search Strategy (SysRev): An EvUp was conducted for 2020. Database searched: Medline on Ovid Platform. Date Search Completed: 20 October 2019. Literature search was from 1 January 2013, to 20 October, 2019. The search identified 791 studies, of which 15 were identified as relevant.

PubMed
1. in situ.mp.
2. clinical setting.mp.
3. learning environment.mp.
4. 1 or 2 or 3
5. life support.mp.
6. exp Resuscitation/ or resuscitation.mp. or exp Cardiopulmonary Resuscitation/
7. CPR.mp. or exp Cardiopulmonary Resuscitation/
8. training.mp.
9. simulat*.mp.
10. 5 or 6 or 7 or 8 or 9
11. 4 and 10
12. limit 11 to yr="2013 -Current"
13. letter/

14. case report.tw.
15. cancer.mp. or exp Neoplasms/
16. 13 or 14 or 15
17. 11 not 16

2021 Search Strategy (EvUp): An EvUp was conducted for 2021. Database searched: PubMed, Embase, Cochrane. Date Search Completed: 9 Feb 2021. Literature search was from 20 October 2019 to 9 Feb 2021. The search identified 45 articles, of which 4 articles were identified as relevant.

PubMed
("in situ"[tw] OR "clinical setting"[tw] OR "learning environment"[tw]) AND ("Resuscitation"[mh] OR "resuscitation"[tw] OR "Cardiopulmonary Resuscitation"[mh] OR "CPR"[tw]) AND (training[tw] OR simulat*[tw]) AND (2019/10/20:3000/12/12[pdat]) NOT (letter[pt] OR "case reports"[pt] OR cancer[tw] OR "neoplasms"[mh]) AND ((medline[Filter]) AND (2019/10/20:3000/12/12[pdat]))

Embase
('in situ':ti,ab,de,kw,tn,df,mn,dn,lnk OR 'clinical setting':ti,ab,de,kw,tn,df,mn,dn,lnk OR 'learning environment':ti,ab,de,kw,tn,df,mn,dn,lnk) AND ('resuscitation'/exp OR 'life support':ti,ab,de,kw,tn,df,mn,dn,lnk OR resuscitation:ti,ab,de,kw,tn,df,mn,dn,lnk OR 'cardiopulmonary resuscitation':ti,ab,de,kw,tn,df,mn,dn,lnk OR 'cpr':ti,ab,de,kw,tn,df,mn,dn,lnk) AND (training:ti,ab,de,kw,tn,df,mn,dn,lnk OR simulat*:ti,ab,de,kw,tn,df,mn,dn,lnk) AND [21-10-2019]/sd NOT ('letter'/it OR 'case report'/de OR cancer:ti,ab,de,kw,tn,df,mn,dn,lnk OR 'neoplasm'/exp) AND [medline]/lim

Cochrane (run in Search Manager; apply dates using filter)
("in situ" OR "clinical setting" OR "learning environment")
AND
([mh "Resuscitation»] OR [mh "Cardiopulmonary Resuscitation"] OR "resuscitation" OR "CPR")
AND
(training OR simulat*)
AND NOT (cancer or [mh "neoplasms"])

2022 Search Strategy: An EvUp was conducted for 2022. Database searched: PubMed, Embase, Cochrane, CINHAL. Date Search Completed: 26 October 2022. Literature search was from 9 Feb 2021 to 26 October 2022. The search identified 118 new articles, of which 2 articles were identified as relevant.
Search strategy refined by:
Sue Groshong, MLIS
Librarian | Library & Information Commons; Seattle Children's
sue.groshong@seattlechildrens.org

PubMed
("in situ"[tw] OR "clinical setting"[tw] OR "learning environment"[tw]) AND ("Resuscitation"[mh] OR "resuscitation"[tw] OR "Cardiopulmonary Resuscitation"[mh] OR "CPR"[tw]) AND (training[tw] OR simulat*[tw]) AND (2021/2/9:3000/12/12[pdat]) NOT (letter[pt] OR "case reports"[pt] OR cancer[tw] OR "neoplasms"[mh])

Embase
#1 ('in situ' OR 'clinical setting' OR 'learning environment') AND ('resuscitation'/exp OR 'life support' OR resuscitation OR 'cardiopulmonary resuscitation' OR 'cpr') AND (training OR simulat*) AND [09-02-2021]/sd NOT ('letter'/it OR 'case report'/de OR 'conference abstract'/it OR cancer OR 'neoplasm'/exp)

Cochrane Library

#1 (("in situ" OR "clinical setting" OR "learning environment") AND ([mh "Resuscitation"] OR [mh "Cardiopulmonary Resuscitation"] OR "resuscitation" OR "CPR") AND (training OR simulat*)) NOT (cancer OR [mh "Neoplasms"]) with Cochrane Library publication date from Feb 2021 to Dec 2022

Note: Search executed in full Cochrane Library (no database limits). Results returned by Cochrane Database of Systematic Reviews, Issue 10 of 12, October 2022, and Cochrane Central Register of Controlled Trials, Issue 10 of 12, October 2022.

CINAHL

S3 S1 NOT S2 AND Limiters - Published Date: 20210201-20221231

S2 PT (abstract OR case study OR letter) OR TX cancer OR (MH "Neoplasms+")

S1 TX ("in situ" OR "clinical setting" OR "learning environment") AND ((MH "Resuscitation+") OR TX (resuscitation OR CPR)) AND TX (training OR simulat*)

Summary of 2022 search results		
Database	**Date Searched**	**Results**
PubMed **(**1946 to Present)	26 Oct 2022	57
EMBASE.com (1974 to Present)	26 Oct 2022	75
Cochrane Library	26 Oct 2022	13
Cumulative Index to Nursing and Allied Health Literature (CINAHL, 1981 to Present)	26 Oct 2022	29
	TOTAL	**174**

Link to Article Titles and Abstracts (if available on PubMed):

PMID	Title	1st Author	Journal
35509680	The effect of a structured ECPR protocol aided by specific simulation training in a quaternary ECMO centre: A retrospective pre-post study	Read A	Resusc Plus
36192311	Intraoperative Code Blue: Improving Teamwork and Code Response Through Interprofessional, In Situ Simulation	Wu G	Jt Comm J Qual Patient Saf

Summary of Evidence Update:

Evidence Update Process for topics not covered by ILCOR Task Forces. This evidence update process is only applicable to PICOs which are *not* being reviewed as ILCOR systematic and scoping reviews.

Relevant Guidelines or Systematic Reviews: 0

Organisation (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations

RCT: 0

Study Acronym; Author; Year Published	Aim of Study; Study Type; Study Size (N)	Patient Population	Study Intervention (# patients) / Study Comparator (# patients)	Endpoint Results (Absolute Event Rates, P value; OR or RR; & 95% CI)	Relevant 2° Endpoint (if any); Study Limitations; Adverse Events

Nonrandomized Trials, Observational Studies: 2

Author; Year Published; 1st page number Study Acronym	Study Type/Design; Study Size (N)	Patient Population	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/Conclusion Comment(s)

Read; 2022, 100234, In-situ ECPR	Study Type: Pre-post	Inclusion Criteria: Patients of the St Vincent's Hospital, Sydney that had received ECPR from 2009 to 2020. Records where the cannulation was commenced during ongoing CPR.	1° endpoint: Primary: neurological outcome to hospital discharge, considering CPC score 1-2 as intact neurological outcome. Secondary: Time from CA to ECMO and utilization of ECPR	
			Outcome measures: Patients' records were retrospectively examined. Timeline and survival data were extracted and a CPC score for each survivor at discharge was determined by complete file review. Results: 25.9% of patients survived with 1-2 CPC score in the pre-intervention period versus 38.5% in the post-intervention period (no significant). Time from CA to ECMO decreased from 87 min (IQR 78–95) (pre-intervention) to 70 min (69–72) (post-intervention) in OHCA. A median ECPR utilization rate of 2 cases per year in the pre-intervention period and 7 cases per year in the post-intervention Period ($p=0.073$).	Conclusion: It was observed an association between the implementation of an ECPR simulation training program and a reduction in time from OHCA to ECMO flow in delivering ECPR in real patients.
Wu; 2022, 665; In-situ Intraoperative Code Blue.	Study Type: pre-post	Inclusion Criteria: interprofessional teams consisting of 21 perioperative nurses, 7 anesthesiologists, 7 surgical technologists, and 4 patient care technicians working in the operating room of a community hospital in New Jersey	1° endpoint: One hour-long interdisciplinary simulation training sessions consisted of a code blue scenario run twice; both times video recorded, retrospectively reviewed, and compared to each other.	
			Outcome measures: Technical skills were measured by "time-to-tasks"; nontechnical skills were assessed using the Team Emergency Assessment Measure (TEAM) instrument. Self-reported comfort in skills was collected before the simulation program and after completion of the training. Results: There was a significant ($p < 0.05$) decrease in time to compressions (by 14	Conclusion: in situ simulation training was associated with improvement in technical skills of individuals and teams, and improved teamwork.

			seconds, 53.5% improvement) and in time to defibrillation (by 49 seconds) between the two simulations. Significant improvements were noted in confidence levels of certain CPR-related technical skills. There were statistically significant improvements in TEAM scores in the two teams that performed lowest in the pre-debrief simulation (p < 0.05).	

Reviewer Comments (including whether meet criteria for formal review):

There were 118 new articles identified of which 2 were relevant to the PICOST.

- Read et al., (1) aimed to study the effect of the implementation of an in-situ simulation training program in neurologically intact survival of patients that received extracorporeal cardiopulmonary resuscitation (ECPR), time to extracorporeal membrane oxygenation (ECMO) and ECPR utilization. An ECPR-specific in situ simulation program was implemented in 2014-2015 in St Vincent's Hospital, Sydney, and two study periods were defined: 2009-2015 (pre-intervention) and 2016-2020 (post-intervention). Median time from cardiac arrest to ECMO flow was 87 min (IQR 78–95) in the pre-intervention period and 70 min (IQR 69–72) in the post-intervention period in OHCA. There was no observed association between the implementation of the simulation training program and time to ECMO flow in IHCA. No association was found between in-situ training and ECPR utilization (p=0.073). There was no association between the implementation of the ECPR simulation training program and neurologically intact survival (p = 0.288).

- Wu et al., (2) examined the impact of in situ interdisciplinary intraoperative code blue simulation training sessions on technical skills, nontechnical skills, and self-reported comfort using a pre (first simulation) and post (second simulation) study design. Results showed there was a 14 second decrease in time to compressions and a 49 second decrease in time to defibrillation between the two simulations (p < 0.05). There were significant improvements in TEAM scores in the two teams that performed lowest in the first simulation (p < 0.05). Significant improvements were noted in confidence levels of certain CPR-related technical skills.

Based on the limited additional evidence of this search, with no RCTs identified, this EvUp does not meet the criteria to trigger a formal systematic or scoping review.

Reference List

1. Read AC, Morgan S, Reynolds C, Breeding J, Scott S, Lowe DA, Newman S, Kennedy R, Buscher H. The effect of a structured ECPR protocol aided by specific simulation training in a quaternary ECMO centre: A retrospective pre-post study. Resusc Plus. 2022;10:100234. doi: 10.1016/j.resplu.2022.100234.
2. Wu G, Podlinski L, Wang C, Dunn D, Buldo D, Mazza B, Fox J, Kostelnik M, Defenza G. Intraoperative Code Blue: Improving Teamwork and Code Response Through Interprofessional, In Situ Simulation. Jt Comm J Qual Patient Saf. 2022;48:665-73. doi: 10.1016/j.jcjq.2022.08.011

Evidence Update Worksheet

EIT 6301 Cardiac Arrest Centers

Worksheet author(s): Joyce Yeung, Cristian Abelairas Gómez
Council: European Resuscitation Council
Date Submitted: December 2022

PICO / Research Question: Cardiac Arrest Centers (EIT 6301, former 624)
Population: Adults with attempted resuscitation after non-traumatic in-hospital (IHCA) or out-of-hospital cardiac arrest (OHCA).
Intervention: Care at a specialized cardiac arrest centre.
Comparator: Care in an institute not designated as a specialized cardiac arrest centre.
Outcomes: Primary outcomes were Survival at 30 days with favorable neurological outcome (CRITICAL) and Survival at hospital discharge with favorable neurological outcome (CRITICAL). Secondary outcomes were: Return of spontaneous circulation (ROSC) post hospital admission for patients with ongoing CPR (IMPORTANT), Survival at 30 days (CRITICAL) and Survival at hospital discharge (CRITICAL)
Study Designs: Randomised controlled trials (RCTs) and non-randomised studies (non-randomised controlled trials, interrupted time series, controlled before-and-after studies, cohort studies) were eligible for inclusion. Unpublished studies (e.g., conference abstracts, trial protocols) were excluded. Studies reporting paediatric cardiac arrests (≤18 years old) and cardiac arrest secondary to trauma were excluded.
Timeframe:
All years and all languages were included provided there was an English abstract. The literature search was updated on 13 Oct 2022

Additional Evidence Reviewer(s): Adam Boulton, Tasuku Matsuyama
Conflicts of Interest (financial/intellectual, specific to this question): None

Year of last full review: Systematic review search date 01 Aug 2018, Evidence update search date 01Feb 2021

Last ILCOR Consensus on Science and Treatment Recommendation:
We suggest that adult patients with non-traumatic OHCA cardiac arrest be cared for in CACs rather than in non-CACs (weak recommendation, very low certainty of evidence).
We cannot make a recommendation for or against regional triage by primary EMS transport of patients with OHCA to a CAC by primary EMS transport (bypass protocols) or secondary interfacility transfer to a CAC. The current evidence is inconclusive and confidence in the effect estimates is currently too low to support an EIT and ALS Task Force recommendation.
For patients with in-hospital cardiac arrest, we found no evidence to support an EIT and ALS Task Force recommendation.

For the subgroup of patients with shockable or non-shockable initial cardiac rhythm, the current evidence is inconclusive, and the confidence in the effect estimates is currently too low to support an EIT and ALS Task Force recommendation.

2018 Search Strategy:
Sample search strategy provided in Appendix of Yeung J, Matsuyama T, Bray J, Reynolds J, Skrifvars MB. Does care at a cardiac arrest centre improve outcome after out-of-hospital cardiac arrest? - A systematic review. Resuscitation. 2019;137:102-115.(1)

2022 Search Strategy: Developed by Samantha Johnson, University of Warwick
Ovid MEDLINE(R) ALL <1946 to 13Oct2022>
["Cardiac Care Facilities/" OR "Cardiology Service, Hospital/" OR "Regional Medical Programs/" OR (Heart attack Centre* or Heart Attack Center* or cardiac arrest centre* or cardiac arrest center*).ab,kf,ti.OR fifth link.ab,kf,ti. OR (cardiac resuscitation center* or cardiac resuscitation centre* or regional cardiac resuscitation).ab,kf,ti. OR (CRC or CRC*).ab,kf,ti. OR (regional system* or network or hospital volume or patient volume).ab,kf,ti. OR (Cardiac Receiving Center* or Cardiac Receiving Centre*).ab,kf,ti. OR (post cardiac arrest adj1 (care or treatment)).ab,kf,ti. OR (postcardiac arrest adj1 (care or treatment)).ab,kf,ti. OR (post resuscitation adj1 (care or treatment)).ab,kf,ti. OR (postresuscitation adj1 (care or treatment)).ab,kf,ti. OR "Cardiac Care Facilit*".ab,kf,ti. OR (Cardiac adj2 (Centre* or Center*)).ab,kf,ti. OR (Cardiology adj1 (Service or care) adj2 Hospital).ab,kf,ti. OR (Cardiovascular adj1 (Centre or Center)).ab,kf,ti. OR cardiac catheterisation laboratory.ab,kf,ti. OR (CAC or CACs).ab,kf,ti. OR Tertiary Care Centers/ OR (Tertiary adj1 (care or Center* or Centre*)).ab,kf,ti. OR Cardiac Arrest Registry.ab,kf,ti. OR ("Critical care medical center*" or "Critical care medical centre*").ab,kf,ti. OR ("critical care centre*" or "critical care center*").ab,kf,ti.] AND [heart arrest/ or out-of-hospital cardiac arrest/ OR cardiopulmonary resuscitation/ or advanced cardiac life support/ OR Death, Sudden, Cardiac/ OR Out of Hospital Cardiac Arrest.ab,kf,ti. OR OHCA.ab,kf,ti. OR return of spontaneous circulation.ab,kf,ti.OR ROSC.ab,kf,ti. OR ((heart or cardiac or cardiovascular) adj1 arrest).ab,kf,ti. OR asystole.ab,kf,ti. OR pulseless electrical activity.ab,kf,ti. OR Advanced Cardiac Life Support.ab,kf,ti. OR ACLS.ab,kf,ti. OR Ventricular Fibrillation/ OR (cardiopulmonary arrest or cardiopulmonary resuscitation).ab,kf,ti. OR (Cardio-pulmonary arrest or cardio-pulmonary resuscitation or CPR).ab,kf,ti. OR code blue.ab,kf,ti.] NOT OR Animals/ not (Animals/ and Humans/) OR (letter or comment or editorial).pt.]

Embase <1947 to 13Oct 2022>
[heart center/ OR cardiology service/ OR "Regional Medical Program*".ab,hw,ti. OR (Heart attack Centre* or Heart Attack Center* or cardiac arrest centre* or cardiac arrest center*).ab,hw,ti. OR "Cardiology Service*".ab,hw,ti. OR fifth link.ab,hw,ti. OR (cardiac resuscitation center* or cardiac resuscitation centre* or regional cardiac resuscitation).ab,hw,ti.
OR (CRC or CRC*).ab,hw,ti. OR (regional system* or network or hospital volume or patient volume).ab,hw,ti.OR (Cardiac Receiving Center* or Cardiac Receiving Centre*).ab,hw,ti. OR (post cardiac arrest adj1 (care or treatment)).ab,hw,ti. OR (postcardiac arrest adj1 (care or treatment)).ab,hw,ti. OR (post resuscitation adj1 (care or treatment)).ab,hw,ti. OR (postresuscitation adj1 (care or treatment)).ab,hw,ti. OR "Cardiac Care Facilit* ".ab,hw,ti. OR (Cardiac adj2 (Centre* or Center*)).ab,hw,ti. OR (Cardiology adj1 (Service or care) adj2 Hospital).ab,hw,ti. OR (Cardiovascular adj1 (Centre or Center)).ab,hw,ti. OR cardiac catheterisation laboratory.ab,hw,ti. OR (CAC or CACs).ab,hw,ti. OR tertiary care center/ OR (Tertiary adj1 (care or Center* or Centre*)).ab,hw,ti. OR Cardiac Arrest Registry.ab,hw,ti. OR ("Critical care medical center*" or "Critical care medical centre*").ab,hw,ti. OR ("critical care centre*" or "critical care center*").ab,hw,ti.]

AND [heart arrest/ or cardiopulmonary arrest/ or "out of hospital cardiac arrest"/ or sudden cardiac death/ OR cardiac life support.ab,hw,ti. OR OHCA.ab,hw,ti. OR "return of spontaneous circulation"/ OR ((heart or cardiac or cardiovascular) adj1 arrest).ab,hw,ti. OR asystole.ab,hw,ti. OR pulseless electrical activity.ab,hw,ti. OR ACLS.ab,hw,ti. OR heart ventricle fibrillation/ OR (cardiopulmonary arrest or cardiopulmonary resuscitation).ab,hw,ti. OR (Cardio-pulmonary arrest or cardio-pulmonary resuscitation or CPR).ab,hw,ti. OR code blue.ab,hw,ti.] NOT (Conference abstract or conference paper or conference review or book or editorial or letter).pt.]

Cochrane <search date 13 Oct 2022>
[MeSH [Cardiac Care Facilities] exp OR MeSH [Cardiology Service, Hospital] exp OR (Heart attack Centre* or Heart Attack Center* or cardiac arrest centre* or cardiac arrest center*):ti,kw,ab OR MeSH: [Regional Medical Programs] exp OR ("fifth link"):ti,kw,ab OR (cardiac resuscitation center* or cardiac resuscitation centre* or regional cardiac resuscitation):ti,kw,ab OR (regional system* or network or hospital volume or patient volume or Cardiac Receiving Center* or Cardiac Receiving Centre*):ti,kw,ab OR ("post cardiac arrest care" or "post cardiac arrest treatment"):ti,kw,ab OR (postcardiac arrest care or postcardiac arrest treatment):ti,kw,ab OR ("post resuscitation care" or "post resuscitation treatment"):ti,kw,ab OR (postresuscitation care or postresuscitation treatment):ti,kw,ab OR (Cardiac Care Facilit*):ti,kw,ab OR (Cardiac centre* or Cardiac center*):ti,kw,ab OR (Cardiovascular centre* or Cardiovascular center*):ti,kw,ab OR (cardiac catheterisation laboratory):ti,kw,ab OR MeSH: [Tertiary Care Centers] exp OR (Tertiary care or Tertiary center* or Tertiary centre*):ti,kw,ab OR (Cardiac Arrest Registry):ti,kw,ab OR   (Critical care medical center* or Critical care medical centre* or critical care centre* or critical care center*):ti,kw,ab] AND [MeSH: [Heart Arrest] exp OR MeSH: [Cardiopulmonary Resuscitation] exp OR (Hospital Cardiac Arrest or OHCA or return of spontaneous circulation or ROSC or asystole):ti,kw,ab OR ("heart arrest" or "cardiac arrest" or "cardiovascular arrest"):ti,kw,ab OR (pulseless electrical activity or cardiopulmonary arrest or cardiopulmonary resuscitation or Cardio-pulmonary arrest or cardio-pulmonary resuscitation or CPR or ACLS):ti,kw,ab OR MeSH: [Ventricular Fibrillation] exp]

Database searched:
OVID Medline, Embase, Cochrane
Date Search Completed:
13 Oct 2022
Search Results (Number of articles identified / number identified as relevant):
2855 articles identified and 8 articles identified as relevant.

Inclusion/Exclusion Criteria: Published randomized controlled trials (RCTs) and non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies) reporting data from adult patients were included.

Link to Article Titles and Abstracts (if available on PubMed):
Lipe 2018 https://pubmed.ncbi.nlm.nih.gov/30482128/
Storm 2019 https://pubmed.ncbi.nlm.nih.gov/31306259/
Goh 2022 https://pubmed.ncbi.nlm.nih.gov/35639377/
Yeo 2022 https://pubmed.ncbi.nlm.nih.gov/34927456/
Park 2019 https://pubmed.ncbi.nlm.nih.gov/30974187/
Jung 2022 https://pubmed.ncbi.nlm.nih.gov/35207304/

Tsuchida 2022 https://pubmed.ncbi.nlm.nih.gov/35794536/
Yoon 2022 https://pubmed.ncbi.nlm.nih.gov/34822934/

Summary of Evidence Update:
Evidence Update Process for topics not covered by ILCOR Task Forces
This evidence update process is only applicable to PICOs which are *not* being reviewed as ILCOR systematic and scoping reviews.

Relevant Guidelines or Systematic Reviews

Organisation (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations
Lipe et al, 2018(2)	Systematic review & meta-analysis	To evaluate the association between the destination hospital capability (cardiac resuscitation center or not) and resuscitation outcomes (survival and survival with a good neurologic outcome) for patients suffering from an OHCA	12 studies	Adult patients suffering from an OHCA transported to CAC seem to have better outcomes than their counterparts. It is reasonable to transport these patients directly to CAC (class IIa, level of evidence B-non-randomized). Future studies should further clarify how long a bypass time is tolerable for these patients, especially for the subpopulation of patients not having experienced prehospital ROSC.	NA
Storm et al, 2019(3)	Systematic review & meta-analysis	To test the hypothesis that the implementation of a structured care pathway following cardiac arrest would be associated with higher levels of functional independence when compared with standard care.	15 studies	Findings support a highly organized approach to postcardiac arrest care, in which a cluster of evidence-based interventions are delivered by a specialized interdisciplinary team. Overall low certainty of evidence, no definitive recommendations. Need for future research.	NA
Goh; 2022 (4)	Systematic review & meta-analysis	To assess the association of high-volume centers with survival and neurological outcomes in nontraumatic OHCA	16 studies	Survival to discharge or 30 days improved with treatment at high-volume centers, regardless of whether aORs (1.28 [95% CI, 1.00-1.64]) or crude ORs (1.43 [95% CI, 1.09-1.87]) were pooled. There was no association between center volume and good neurological outcomes at 30 days or hospital discharge in patients with OHCA (aOR, 0.96 [95% CI, 0.77-1.20]).	NA

| Yeo 2022 (5) | Systematic review & meta-analysis | To assess the impact of CACs on survival in out-of-hospital cardiac arrest according to varying definitions of CAC and prespecified subgroups | 36 studies | Survival with favorable neurological outcome significantly improved with treatment at CACs (aOR, 1.85 [95% CI, 1.52-2.26]), even when including high-volume centers (aOR, 1.50 [95% CI, 1.18-1.91]) or including improved-care centers (aOR, 2.13 [95% CI, 1.75-2.59]) as CACs. Survival significantly increased with treatment at CACs (aOR, 1.92 [95% CI, 1.59-2.32]), even when including high-volume centers (aOR, 1.74 [95% CI, 1.38-2.18]) or when including improved-care centers (aOR, 1.97 [95% CI, 1.71-2.26]) as CACs. The treatment effect was more pronounced in patients with shockable rhythm (P=0.006) and without prehospital ROSC (P=0.005). | NA |

RCT: None

Nonrandomized Trials, Observational Studies

Study Acronym; Author; Year Published	Study Type/Design; Study Size (N)	Patient Population Inclusion Criteria:	Primary Endpoint and Results (include P value; OR or RR; & 95% CI) - 1° endpoint	Summary/Conclusion Comment(s)
Specialised CAC vs non-specialised centres - OHCA				
Yoon 2022(6)	Post-hoc analysis using prospective registry data; 6935 patients	Adult EMS-treated patients with OHCA presumed cardiac aetiology, who achieved ROSC at the scene.	Interaction between pre-hospital re-arrest and transfer to CAC. Favourable neurological outcome (CPC 1-2): Reference: Re-arrest patients transferred to a non-CAC. 2.41 AOR (95% CI, 1.73–3.35) for prehospital re-arrest patients transferred to a CAC; 3.09 (95% CI, 2.33–4.10) for non-re-arrest patients transferred to a non-CAC; 11.07 (95% CI, 8.40–14.59) for non-re-arrest patients transferred to an CAC Survival to hospital discharge: Reference: Re-arrest patients transferred to a non-CAC. 2.74 AOR (95% CI, 2.09–3.61) for prehospital re-arrest patients	Transport to a CAC was beneficial to the clinical outcomes of patients who achieved prehospital ROSC after OHCA. The magnitude of that benefit was significantly modified by whether prehospital re-arrest had occurred.

			transferred to a CAC; 2.89 (95% CI, 2.28–3.6) for non-re-arrest patients transferred to a non-CAC; 13.04 (95% CI, 10.31–16.49) for non-re-arrest patients transferred to an CAC	
High volume vs low volume - OHCA				
Park; 2019 (7)	Post-hoc analysis using prospective registry data with propensity score matching; 11632 patients	Adult patients with EMS-treated OHCA of presumed cardiac aetiology who achieved ROSC in the ED	Effect of inter-hospital transfer in high-volume vs low-volume. Good neurologic outcome (CPC 1-2) at hospital discharge: Low-volume: Patients in the inter-hospital transfer group showed significantly better outcomes (AOR: 1.34; 95%CI: 1.07–1.67) High-volume: no significant differences between inter-hospital transfer and non-IHT groups (AOR: 0.84; 95%CI: 0.63–1.13) Survival to hospital discharge: Low-volume: Patients in the inter-hospital transfer group showed significantly higher rates of survival (AOR: 1.55; 95%CI: 1.30–1.86) High-volume: no significant differences between inter-hospital transfer and non-IHT groups (AOR: 0.94; 95%CI: 0.73–1.22)	Among adult OHCA patients who visited low-volume emergency departments, inter-hospital transfer was associated with better neurological outcomes and rates of survival. Inter-hospital transfer was not associated with better outcomes among patients who visited high-volume emergency departments.
Tsuchida; 2022 (8)	Post-hoc analysis using prospective registry data; 3632 patients	Adult with OHCA presumed cardiac aetiology. No ROSC at EMS arrival	Favourable neurological outcome (CPC 1-2) 30 days after CA: There was no advantage of middle- (AOR 0.989; 95% CI 0.562-1.741) and high-volume (AOR 1.504, 95% CI 0.919-2.463) hospitals over low volume hospitals. High-volume centers showed higher rates of favourable neurological outcomes than low-volume centers in OHCA patients with ROSC before arrival at the emergency department (AOR 1.346; 95% CI 0.660-2.748).	Number of OHCA patients received by the hospital did not significantly affect the prognosis of adult OHCA. It was beneficial in cardiac arrest patients who achieved ROSC before emergency department arrival.
Direct transport vs inter-hospital transfer - OHCA				

| Jung; 2022 (9) | Post-hoc analysis using prospective registry data; 95931 patients | Adult EMS-treated OHCA presumed cardiac etiology | Interaction between direct transport to CAC and urbanization level (metropolitan vs urban/rural).

Good neurological outcome (CPC 1-2):
Reference: Patients transported to non-CAC. 1.51 AOR (95% CI, 1.40–1.63) for patients transported to CAC in metropolitan areas; 1.98 (95% CI, 1.81–2.17) for patients transported to CAC in urban/rural areas. P < 0.01 for interaction.

Survival to discharge:
Reference: Patients transported to non-CAC.
1.63 AOR (95% CI, 1.48–1.80) for patients transported to CAC in metropolitan areas; 1.91 (95% CI, 1.71–2.14) for patients transported to CAC in urban/rural areas. P < 0.01 for interaction. | Direct transport of OHCA patients to cardiac arrest centers was associated with significantly higher survival and favorable neurological outcomes. OHCA occurring in urban/rural areas have even better clinical outcomes from direct transport to a CAC hospital comparing with metropolitan areas. |

Reviewer Comments (including whether meet criteria for formal review):
Our evidence update identified 2855 unique articles of which 8 were relevant to the PICO (4 systematic reviews and 4 observational studies). There was no randomized controlled trial identified.
The findings of identified systematic reviews reported improved outcomes for OHCA patients who were transported to CAC. One observational study reported improved survival and neurological outcome for patients who were transferred to CAC. A separate study reported that patients transported to CAC in mixed urban/rural area may have improved survival compared to those in metropolitan area. Two studies comparing high versus low volume hospitals reported conflicting results with one reporting better outcomes from high volume hospitals and one finding no difference in outcomes.
The new evidence will not change the 2020 treatment recommendation. EIT and ALS taskforce should consider updating the systematic review after the publication of randomized controlled trial in 2023 (A Randomised Trial of Expedited Transfer to a Cardiac Arrest Centre for Non-ST Elevation Out-of-hospital Cardiac Arrest (ARREST) - ClinicalTrials.gov identifier: NCT03872960).

Reference list

1.   Yeung J, Matsuyama T, Bray J, Reynolds J, Skrifvars MB. Does care at a cardiac arrest centre improve outcome after out-of-hospital cardiac arrest? - A systematic review. Resuscitation. 2019;137:102-15.

2.   Lipe D, Giwa A, Caputo ND, Gupta N, Addison J, Cournoyer A. Do Out-of-Hospital Cardiac Arrest Patients Have Increased Chances of Survival When Transported to a Cardiac Resuscitation Center? Journal of the American Heart Association. 2018;7(23):e011079.

3.   Storm C, Leithner C, Krannich A, Suarez JI, Stevens RD. Impact of Structured Pathways for Postcardiac Arrest Care: A Systematic Review and Meta-Analysis. Critical care medicine. 2019;47(8):e710-e6.

4.   Goh AXC, Seow JC, Lai MYH, Liu N, Man Goh Y, Ong MEH, et al. Association of High-Volume Centers With Survival Outcomes Among Patients With Nontraumatic Out-of-Hospital Cardiac Arrest: A Systematic Review and Meta-Analysis. JAMA network open. 2022;5(5):e2214639.

5.   Yeo JW, Ng ZHC, Goh AXC, Gao JF, Liu N, Lam SWS, et al. Impact of Cardiac Arrest Centers on the Survival of Patients With Nontraumatic OutofHospital Cardiac Arrest: A Systematic Review and Meta-Analysis. Journal of the American Heart Association. 2022;11(1):e023806.

6.   Yoon H, Ahn KO, Park JH, Lee SY. Effects of pre-hospital re-arrest on outcomes based on transfer to a heart attack centre in patients with out-of-hospital cardiac arrest. Resuscitation. 2022;170:107-14.

7.   Park JH, Lee SC, Shin SD, Song KJ, Hong KJ, Ro YS. Interhospital transfer in low-volume and high-volume emergency departments and survival outcomes after out-of-hospital cardiac arrest: A nationwide observational study and propensity score-matched analysis. Resuscitation. 2019;139:41-8.

8.   Tsuchida T, Ono K, Maekawa K, Hayamizu M, Hayakawa M. Effect of annual hospital admissions of out-of-hospital cardiac arrest patients on prognosis following cardiac arrest. BMC emergency medicine. 2022;22(1):121.

9.   Jung E, Ro YS, Park JH, Ryu HH, Shin SD. Direct Transport to Cardiac Arrest Center and Survival Outcomes after Out-of-Hospital Cardiac Arrest by Urbanization Level. Journal of clinical medicine. 2022;11(4).

Evidence Update Worksheet
FA 7311 Cervical Spinal Motion Restriction

Worksheet author(s): Vere Borra, Gustavo Flores, Wei-Tien Chang
Task Force: First Aid
Date Submitted to SAC rep for peer review and approval:
SAC rep: Nici Singletary/Jestin Carlson

PICOST / Research Question: *(Attach SAC representative approved completed PICOST template)*

Population	Adults and children with possible traumatic cervical spinal injury
Intervention	Does spinal motion restriction
Comparison	Compared with no spinal motion restriction or another type of spinal motion restriction
Outcomes	Any clinical outcome. *(preset text)*
Study Design	Randomized controlled trials (RCTs) and non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies) are eligible for inclusion. Unpublished studies (e.g., conference abstracts, trial protocols) are excluded. *(preset text)* *If it is anticipated that there will be insufficient studies from which to draw a conclusion, case series may be included in the initial search. The minimum number of cases for a case series to be included can be set by the TFSR team (default is ≥ 5).*
Timeframe	***New Scoping or Systematic Review search strategy:*** All years and all languages are included as long as there is an English abstract

Year of last full review: (*insert year where this PICOST was most recently reviewed*)
Last systematic review in 2015
Scoping review completed in 2019

Current ILCOR Consensus on Science and Treatment Recommendation for this PICOST:

CONSENSUS ON SCIENCE (2015):
(Semi)rigid collar (I) vs no collar (C)

For the critical outcome of "neurological injury" we have identified very low quality evidence (downgraded for risk of bias and imprecision) from 1 non-randomized study with 5138 motorcycle crash victims, showing no difference in neurological injury (no significant difference according to the paper, however we were unable to calculate the MD and CI, because the mean and SD of the intervention and control group are not reported).

For the critical outcome "complications (intracranial pressure)" we have identified low quality evidence from 5 non-randomized studies with 107 patients in total, showing increased intracranial pressure (MD (mm Hg) 4.69 95% CI [1.95; 7.43]; MD (mm H20) 20.48 95% CI [5.62; 35.33]). We identified low quality evidence from 1 additional non-randomized study with 42 healthy volunteers showing increased intracranial pressure (MD (Internal jugular vein cross-sectional area) 0.19 95% CI [0.05; 0.33]).
For the critical outcome "complications (tidal volume)" we have identified very low quality evidence (downgraded for risk of bias and imprecision) from 1 non-randomized study with 38 patients, showing no decrease in tidal volume (significant decrease according to the paper, however we were unable to calculate the CI because the SD of the intervention and control group not reported).

For the important outcome "cervical spine movement" we have identified low quality evidence from 1 non-randomized study with 18 head-injured children showing no benefit in terms of limiting flexion (MD -2.20 95% CI [-7.75 to 3.35]). For the same outcome we identified very low quality evidence (downgraded for indirectness) from 13 additional non-randomized studies with 457 cadavers or healthy volunteers showing benefit in terms of limiting flexion, extension, lateral bending, axial rotation and flexion/extension (flexion: MD -12.50 95% CI [-13.13; -11.87]; extension: MD -0.91 95% CI [-1.18; -0.64]; lateral bending: MD -1.99 95% CI [-2.33; -

1.65]; axial rotation: MD -4.73 95% CI [-5.16; -4.3]; flexion/extension: MD -19.13 95% CI [-19.89; -18.36]). Seven additional studies were not included in the final analysis, since data were lacking (mean and/or standard deviation of intervention and control group not reported).

For the important outcome "patient comfort" we have identified very low quality evidence (downgraded for indirectness and imprecision) from 1 non-randomized study with 26 healthy volunteers, showing no decrease or increase in patient comfort (MD -0.20 95% CI [-0.93; 0.53]).

We did not identify any evidence to address the important outcomes of "overall mortality", and "pain", and the less important outcome of "hospital length of stay".

Soft collar (I) vs no collar (C)

For the important outcome "cervical spine movement" we have identified very low quality evidence (downgraded for indirectness) from 3 non-randomized studies with 36 cadavers or healthy volunteers showing benefit in terms of limiting flexion and axial rotation (flexion: MD -3.04 95% CI [-5.64; -0.4]; axial rotation: MD -9.07 95% CI [-14.17; -3.96]). The same studies showed no benefit in terms of limiting extension, flexion/extension and lateral bending (extension: MD -1.63 95% CI [-4.75; 1.49]; flexion/extension: MD -8 95% CI [-21.88; 5.88]; lateral bending: MD -0.14 95% CI [-2.79; 2.52]).

We did not identify any evidence to address the critical outcomes of "neurological injury" and "complications", the important outcomes of "overall mortality", "pain", and "patient comfort", and the less important outcome of "hospital length of stay".

Sand bags and tape (I) vs no motion restriction (C)

For the important outcome "cervical spine movement" we have identified very low quality evidence (downgraded for indirectness) from 1 non-randomized studies with 25 healthy volunteers showing benefit in terms of limiting flexion, extension, axial rotation and lateral bending (flexion: MD -35.60 95% CI [-38.69; -32.51]; extension: MD -6 95% CI [-9.53; -2.47]; axial rotation: MD -73.30 95% CI [-75.99; -70.61]; lateral bending: MD -19.40 95% CI [-21.62; -17.18]).

We did not identify any evidence to address the critical outcomes of "neurological injury" and "complications", the important outcomes of "overall mortality", "pain", and "patient comfort", and the less important outcome of "hospital length of stay".

SCOPING REVIEW DISCUSSION (2019):
Similar to the 2015 CoSTR on cervical spinal motion restriction (Singletary 2015 S269, Zideman 2015 e225), the scoping review identified biomechanical and cohort studies (Schneider 2007 E1, Kim 2018 1, McGrath 2009 166) that report the ability to restrict cervical motion in varying amounts with the use of cervical collars. We also identified one case report (Lemzye 2011 532) and one small cohort study (March 2002 421) that identified a complication of worsening neurologic status, and a small prospective cohort study in healthy volunteers demonstrating a false positive tenderness with midline vertebral palpation following use of a cervical collar in combination with spinal motion restriction using a long backboard.

No studies were identified that directly addressed other outcomes such as neurological injury, survival, hospital length of stay, or additional outcomes such as the ability to correctly apply a cervical collar.
In Task Force discussions it was noted that the ability to properly apply a cervical collar is not a skill typically taught in first aid courses, although some large groups of first aid providers or first responders may receive specialized training and regular practice to allow them to use cervical collars, such as for sports-associated injuries. Task Force members representing multiple different countries and continents noted that cervical collars are no longer used routinely for trauma, other than for accidents where there is concern for high risk of cervical spinal injury. Additional concerns were expressed over the ability of a first aid provider to discriminate between high- or low-risk for spine injury. It was noted that criteria for determining high risk for cervical spine injury were reviewed in 2010 for ILCOR, but that other criteria have been developed by various organizations since then, and this topic of first aid recognition of high risk for c-spine injury may need a future scoping or systematic review.
Given these discussion points, combined with the limited additional evidence on spinal motion restriction identified in this review, the task force did not feel there was sufficient information to prompt new systematic reviews or the reconsideration of current resuscitation guidelines/treatment recommendations.

CURRENT TREATMENT RECOMMENDATION
We suggest against spinal motion restriction, defined as the reduction of or limitation of cervical spinal movement, by routine application of a cervical collar or bilateral sandbags (joined with 3-inch-wide cloth tape across the forehead) in comparison to no

cervical spine restriction in adults and children with blunt suspected traumatic cervical spinal injury (weak recommendation, very low quality of evidence).

Current Search Strategy (for an existing PICOST) included in the attached approved PICOST

Database searched: Medline Ovid

Time Frame: (existing PICOST) – updated from end of last search (please specify)
01 Jan 2019 – 20 October 2022

Search Results (Number of articles identified and number identified as relevant): 349 articles identified, 45 articles identified as relevant, 9 articles included.

Additionally identified references: 1 (Nutbeam 2022 1)

Summary of Evidence Update:
Relevant Guidelines or Systematic Reviews

Organization (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations
Cuthbertson 2020 406	Systematic review	What is appropriate spinal immobilization in resource-scarce environments?	14 articles were included. 1 scoping review and 13 references were case reports/narrative reviews, policy statements, retrospective observational studies, narrative literature reviews.	This systematic review identified a lack of definitive evidence on the utility or effect of spinal motion restriction or immobilization on patient outcomes in disasters. The majority of literature identified in this systematic review described spinal cord injury predominantly associated with earthquakes and blast-related events. The clinical benefit of spinal restriction or immobilization in disasters and across disaster types is unknown and requires further research and evaluation to enable recommendations for SI in RSEs after a mass-casualty incident, in low-middle income countries, complex humanitarian events, conflict zones, and	This systematic review will inform a subsequent Delphi study to develop recommendations and guidance for practice related to prehospital SI in disaster and humanitarian settings.

				with prolonged transport times.	
Habibi Arejan	Scoping review	1. Is SI necessary? If so, what is the optimal method of SI? 2. What are the optimal methods of movement, positioning and transport of patients with suspected traumatic spinal cord injury (TSCI)? 3. What is the optimal criteria for spinal clearance in patients with suspected TSCI? 4. To keep the airway open in a pre-hospital setting, what is the best way to position and immobilize patients with suspected cervical TSCI? 5. What is the role of PHC providers in providing PHC services for patients with suspected TSCI?	There were 42 studies selected for review based on the inclusion criteria: 18 articles regarding immobilization, 12 articles regarding movement, positioning and transport, 4 articles regarding spinal clearance, 3 articles regarding airway protection and 2 articles regarding the role of TSCI PHC providers. Some articles covered two topics: one article regarding movement, positioning and transport and airway protection, and two other articles regarding spinal clearance and the role of TSCI PHC providers.	Among the 18 studies that evaluated the Spinal Immobilization, five studies were supportive of SI, six studies opposed SI for penetrating spinal injuries, and one study was generally opposed to SI.	There is no definitive or uniform opinion about SI in patients with suspected TSCI. Recent studies have opposed immobilization in penetrating spinal injuries and are also controversial in blunt spine injuries.

RCT:

Study Acronym; Author; Year Published	Aim of Study; Study Type; Study Size (N)	Patient Population	Study Intervention (# patients) / Study Comparator (# patients)	Endpoint Results (Absolute Event Rates, P value; OR or RR; & 95% CI)	Relevant 2° Endpoint (if any); Study Limitations; Adverse Events
Hontaria Hernández 2019 36	**Study Aim:** Compare self-extraction with and without cervical collar in subjects at low risk	**Inclusion criteria** Healthy volunteers aged 46±6 y	**Intervention**: - Self-extraction with Stifneck (SN) collar	**1° endpoint:** Imbalance: SN vs AE: MD: 3.12°, 95%CI [-15.33;21.57], p=0.7234	**2° endpoint** Less misalignment (X, Y, Z axis), although not significant, during AE than with one of the collars. However, in a

	of cervical spine injuries **Study Type:** Simulation study (n = 16)		- Self-extraction with X-collar (XC) **Comparator:** Self-extraction (AE) without collar Participants had to get out of a vehicle starting from the driver's seat. Each participant performed the 3 procedures in 2 different vehicles: a low vehicle and high vehicle.	XC vs AE: MD: 5.95°, 95%CI [-10.98;22.87], p=0.4654	low vehicle, there is less deviation with SN (p=0.037) and in a high vehicle, there is less deviation with XC (p=0.045) **Study limitations** Study was carried out with healthy volunteers without cervical instability and in a simulated setting without the circumstances of a real accident (stress, stupor, environmental conditions,…). Small sample size, which consisted of healthcare personnel, and with greater knowledge and experience in cervical immobilization.
Porter 2019 412	**Study Aim:** Compare the effectiveness of a molded fleece jacket (improvised collar) with that of a standard cervical collar at limiting movement of the cervical spine in 3 different directions. **Study Type:** RCT, within subjects design (n=24)	**Inclusion criteria** Healthy volunteers aged 25-45 y with no history of cervical spine problems or prior injury.	**Intervention:** Fleece jacket cervical collar (n = 24) **Comparator:** Standard cervical collar (n = 24)	**1° endpoint:** Flexion extension (degree): 13±8 vs 14±9 (p>0.05) Rotation (degree): 19±17 vs 17±17 (p>0.05) Sideways movement (degree): 19±11 vs 19±12 (p>0.05)	**Adverse events:** Comfort: MD: 1.5, 95%CI [1.5;2.0] (p<0.001) **Limitations:** Small group of healthy volunteers without prior injuries, and results may not be generalizable to a wider population with true injuries. One investigator performed goniometry measurements; 2 or more investigator measurements would have potentially decreased bias by adding an interrelater reliability measurement. No baseline measurements

					without cervical collars applied were done. Two different providers applied the cervical collars, which could have introduced bias in collar application. The structure of the fleece cervical collar could have had variability due to the application process and density of material. We performed the measurements in the upright seated position for the best readings of the goniometer and to parallel a previous study on this topic, but we recognize that this method does not measure collar use in other conditions, such as supine positioning. A patient with a head injury could be agitated and thus actively moving the head, which was not tested by passive movements for flexion/extension and lateral movements.
Rahmatalla 2019 32	**Study Aim:** Compare the relative efficacy of immobilization systems in limiting involuntary movements of the cervical spine using a dynamic simulation model. **Study Type:** RCT, within subjects design (n=16)	**Inclusion criteria** Healthy adult males with no history of chronic musculoskeletal disorder or allergic reaction to adhesives.	**Intervention:** - Cot stretcher + collar - LSB with collar and head blocks - Vacuum mattress (VM) with collar - Long Spine Board (LSB) immobilization: 2 straps crisscrossing over the chest and one strap each over the	**1° endpoint:** All configurations tested decreased cervical rotation and flexion/extension relative to the cot alone. However, the LSB and VM were significantly more effective in decreasing cervical rotation than the cervical collar, and the LSB decreased rotation more than the VM in augmented rides. The LSB and	**Limitations** Subjects were healthy, conscious adult males within the normal range for height and weight. Thus, results may not be generalizable to all adults who are part of the transported patient population. Moreover, results should not be generalized to pediatric patients, as they have physical

| | | | pelvis and lower femur, and with blocks and straps to immobilize the head.
- Vacuum mattress (VM) has a series of seven straps that cross over the body.

Comparison:
- Cot stretcher alone

All interventions were tested in different rides (ambulance, helicopter, augmented ride) | VM, but not the cervical collar, significantly limited cervical lateral bend relative to the cot alone. | characteristics and needs that may require different immobilization methods.
Ride-files were created from a single set of real-world data using a single ambulance and helicopter model. To increase generalizability, however, a variety of road conditions and legal speeds were utilized when collecting the ambulance data, and the helicopter ride-file was compiled from various stages of flight. |

Nonrandomized Trials, Observational Studies

Study Acronym; Author; Year Published	Study Type/Design; Study Size (N)	Patient Population	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/Conclusion Comment(s)
Asha 2021 19	**Study Type:** Retrospective chart review	**Inclusion Criteria:** All patients evaluated for potential traumatic cervical spine injury in the ED. Interventions used: Soft collar applied in ED (n=636); Prehospital rigid collar changed to soft collar in ED (n=497); Remained in rigid collar (n=268); no collar (n=582)	**1° endpoint:** New neurological deficit after arrival in ED: Soft collar vs no collar: 6/1133 vs 0/582; OR 6.72, 95%CI [0.38;119.43], p=0.19 Rigid collar vs no collar: 3/268 vs 0/582, OR 15.36, 95%CI [0.79;298.38], p=0.07 Soft vs rigid collar: 6/1133 vs 3/268; OR 0.47, 95%CI [0.12;1.89], p=0.29	The use of soft foam collars in patients at risk for a cervical spine injury does not appear to increase the risk for secondary spinal cord injury.
Chen 2022 3492	**Study Type:** Retrospective cohort study	**Inclusion criteria** Prehospital immobilization, which was defined	**1° endpoint:** Favorable functional outcomes: aOR 1.06; 95%CI 0.62-1.81; p=0.826	Prehospital spinal immobilization was not associated with favorable functional outcomes in traumatic patients with SI; however,

		a the neck collar and/or backboard use. Using scoop stretcher is also immobilized group (n=438). Other immobilization tools such as pelvic binder, femur traction splint, extremity splint and bandaging were classified as non-immobilized group (n=321).		subgroup analysis revealed that it may be beneficial for patients with cervical SI without traumatic brain injury. We suggest that paramedics should be more judicious when determining the presence of a cervical SI and should apply full spine immobilization if possible.
Clemency 2021 708	**Study Type:** Retrospective before-after study	**Inclusion criteria:** Patients who were transported by EMS to a single Level I trauma-designated hospital with spine or spinal cord injury due to blunt trauma. Patients arriving at the trauma center from January 1, 2013 – December 31, 2014, were designated as the Spinal Immobilization (SI) group (n=549). SI includes the use of a backboard. Patients arriving at the trauma center from January I, 2015 – December 31, 2017, were designated as the Spinal Motion Restriction (SMR) group (n=623). SMR aims to limit the movement of the spine but does not necessitate the use of the long spine board.	**1° endpoint:** Significant disability: OR 0.775, 95% CI 0.443-1.359; p=0.374	Significant disability rates were not found to be statistically different for SI versus SMR protocols when accounting for age, sex, MOI, and highest level of spinal injury.
Eisner 2022 726	**Study Type:** Non-inferiority trial (non-randomized study)	**Inclusion criteria:** 30 healthy young-adult subjects with no history of spinal	**1° endpoint:** The c-collar method yielded the greatest restriction of motion in all categories,	Our findings suggest folded towels may provide adequate c-spine immobilization of extension

		injury were recruited. Median age 22, 20 females, 10 males. Interventions: - Towel immobilization - Cervical collar (Laerdal) - Pre-sized foam immobilizer (OTC professional Orthopedic) Control: No immobilization	followed in order by the towel, foam brace, and control (p < 0.01). Participants had a significantly higher range of motion when rotating right compared to left in all sitting conditions except when immobilized with a towel (p < 0.01). The towel immobilization protocol showed the greatest bilateral consistency across all conditions for both rotation and lateral flexion.	and rotation compared to c-collars. This low-cost method should be used in combination with backboards to deliver affordable and effective prehospital spinal cord injury management in resource-limited settings of LMICs.
Nutbeam 2022 1	**Study type**: Non-randomized study	**Inclusion criteria:** 6 healthy volunteers without previous knowledge of extrication, and with no back or neck conditions that may be exacerbated by extrication. Anterio-posterior (AP) movement was measured after application of a cervical collar. For each participant, data for 10 cervical collar applications were collected (= 60 applications in total). Movement was assessed during collar application, and during self-extrication with and without collar.	**1° endpoint:** The mean maximal AP movement associated with collar application was 2.3 mm with a total AP travel of 4.9 mm. There is no clinically important difference between cumulative travel across collar application and self-extrication (with collar) when compared to self-extrication without a collar.	'Travel' is a useful metric in understanding total movement in biomechanical research. Total travel is similar across self-extricating healthy volunteers with and without a collar. We suggest 'travel' is collected and reported in future biomechanical studies in this and related areas of research. It remains appropriate to apply a cervical collar to self-extricating casualties when the clinical target is that of movement minimization.

Reviewer Comments: *(including whether this PICOST should have a systematic or scoping review)*

Evidence Update Worksheet – 9 Jan 2021

This evidence update yielded 10 new studies regarding spinal motion restriction. One systematic review (Cuthbertson 2020 406) looked at spinal immobilization in resource-scarce environments and concluded that the clinical benefit of spinal restriction or immobilization in disasters and across disaster types is unknown. A scoping review (Habibi Arejan 2022 1309) identified 18 studies of which some were supportive of spinal immobilization, while others opposed spinal immobilization for penetrating spinal injuries. Additionally, three RCTs were identified. One study (Hontaria Hernández 2019 36) investigated self-extraction from a vehicle without a cervical collar or with two different types of collars. The study showed no difference between self-extraction with or without a cervical collar. The second RCT (Rahmatalla 2019 32) showed, in a simulated setting, that the long spine board and the vacuum mattress were more effective in limiting cervical movement than the cervical collar. In a third RCT, Porter et al (Porter 2019 412) compared the use of an improvised fleece jacket collar with a commercial cervical collar, showing no difference between both collar types. In addition, a non-inferiority trial (Eisner 2022 726) suggested that folded towels may provide adequate C-spine immobilization of extension and rotation compared to C-collars.

A non-randomized study (Nutbeam 2022 1) indicated that total travel is similar across self-extricating healthy volunteers with and without a collar.

Furthermore, a retrospective chart review (Asha 2021 19) did not show an increased risk of secondary spinal cord injury after use of soft foam collars. A retrospective cohort study (Chen 2022 3492) showed that prehospital spinal immobilization was not associated with favorable functional outcomes at discharge in traumatic patients; however, it may be favorable in patients with cervical spinal injury without traumatic brain injury. Finally, a retrospective before-after study (Clemency 2021 708) did not find a significant difference in disability rates, when comparing a spinal motion restriction protocol with a spinal immobilization protocol.

Given this limited additional information on spinal motion restriction identified in this evidence update, the task force did not feel there was sufficient information to pursue a systematic review or the reconsideration of current treatment recommendations.

Reference list: *(List by ILCOR ref standard (last name first author, year of publication, first page number) and insert hyperlink to all articles identified as relevant (if available on PubMed)*

Asha SE, Curtis K, Healy G, Neuhaus L, Tzannes A, Wright K. Neurologic outcomes following the introduction of a policy for using soft cervical collars in suspected traumatic cervical spine injury: A retrospective chart review. Emerg Med Australas. 2021 Feb;33(1):19-24. doi: 10.1111/1742-6723.13646. Epub 2020 Oct 9. PMID: 33037781.

Chen HA, Hsu ST, Shin SD, Jamaluddin SF, Son DN, Hong KJ, Tanaka H, Sun JT, Chiang WC; PATOS Clinical Research Network. A multicenter cohort study on the association between prehospital immobilization and functional outcome of patients following spinal injury in Asia. Sci Rep. 2022 Mar 3;12(1):3492. doi: 10.1038/s41598-022-07481-0. PMID: 35241763; PMCID: PMC8894344.

Clemency BM, Natalzia P, Innes J, Guarino S, Welch JV, Haghdel A, Noyes E, Jordan J, Lindstrom HA, Lerner EB. A Change from a Spinal Immobilization to a Spinal Motion Restriction Protocol was Not Associated with an Increase in Disabling Spinal Cord Injuries. Prehosp Disaster Med. 2021 Dec;36(6):708-712. doi: 10.1017/S1049023X21001187. Epub 2021 Nov 3. PMID: 34728007.

Cuthbertson JL, Weinstein ES. Spinal Immobilization in Disasters: A Systematic Review. Prehosp Disaster Med. 2020 Aug;35(4):406-411. doi: 10.1017/S1049023X20000680. Epub 2020 May 29. PMID: 32466810.

Eisner ZJ, Delaney PG, Pine H, Yeh K, Aleem IS, Raghavendran K, Widder P. Evaluating a novel, low-cost technique for cervical-spine immobilization for application in resource-limited LMICs: a non-inferiority trial. Spinal Cord. 2022 Aug;60(8):726-732. doi: 10.1038/s41393-022-00764-3. Epub 2022 Feb 22. PMID: 35194169.

Habibi Arejan R, Asgardoon MH, Shabany M, Ghodsi Z, Dehghan HR, Sohrabi Asl M, Ostadrahimi H, Vaccaro AR, Rahimi-Movaghar V; Evaluating prehospital care of patients with potential traumatic spinal cord injury: scoping review. Eur Spine J. 2022 May;31(5):1309-1329. doi: 10.1007/s00586-022-07164-4. Epub 2022 Mar 21. PMID: 35312863.

Hontoria Hernández MI, Gordillo Martín R, Serrano Martínez FJ, Alonso Ibáñez L, Carazo Díaz C, Prieto Merino D, Sánchez-Arévalo Morato S, Dixon M, Pardo Ríos M, Juguera Rodríguez L. Self-extraction with and without a cervical collar: a biomechanical simulation study. Emergencias. 2019 Feb;31(1):36-38. PMID: 30656871.

Nutbeam T, Fenwick R, May B, Stassen W, Smith J, Shippen J. Maximum movement and cumulative movement (travel) to inform our understanding of secondary spinal cord injury and its application to collar use in self-extrication. Scand J Trauma Resusc Emerg Med. 2022 Jan 15;30(1):4. doi: 10.1186/s13049-022-00992-9. PMID: 35033151; PMCID: PMC8760812.

Porter A, Difrancesca M, Slack S, Hudecek L, McIntosh SE. Improvised vs Standard Cervical Collar to Restrict Spine Movement in the Backcountry Environment. Wilderness Environ Med. 2019 Dec;30(4):412-416. doi: 10.1016/j.wem.2019.07.002. Epub 2019 Nov 6. PMID: 31706730.

Rahmatalla S, DeShaw J, Stilley J, Denning G, Jennissen C. Comparing the Efficacy of Methods for Immobilizing the Cervical Spine. Spine (Phila Pa 1976). 2019 Jan 1;44(1):32-40. doi: 10.1097/BRS.0000000000002749. PMID: 29916958.

Evidence Update Worksheet
FA 7334: Hemostatic Agents for Life-threatening External Bleeding

Worksheet author(s): Therese Djarv
Task Force: First Aid
Date Submitted to SAC rep for peer review and approval: October 2022
SAC rep: E. Singletary

PICOST / Research Question: *(Attach SAC representative approved completed PICOST template)*

Please note that there are two PICOST for this question and it is closely connected to a mega-PICO on bleeding and the use of touniquets.

FA7334 (Previously FA769; in ILCORs master-excel spread sheet) -In patients with severe, life-threatening external bleeding (P), does the application of topical hemostatic dressings plus standard first aid (I), compared with standard first aid alone (C), change overall mortality, vital signs, hemostasis, complications, blood loss, major bleeding, incidence of cardiac arrest (O)?

Closely related PICO:
FA7334 (in SR published in COSTR and ILCOR.com):
Population: Adults and children with severe, life-threatening external bleeding in out-of-hospital settings. Bleeding from both compressible and non-compressible external sites were included.
Intervention: All bleeding control methods applicable for use by trained or untrained first aid providers including manufactured or improvised tourniquets, hemostatic dressings or agents, cryotherapy, direct (manual) pressure, pressure points, pressure dressings or bandages or elevation of the injured area. Manufactured tourniquets included windlass-style or elastic, with single or double application. Hemostatic dressing includes all types from improvised pieces of cloths to ready-to-use compression bandages.
Comparators: Studies with comparators of bleeding control methods are included, as well as observational cohorts with a single bleeding control technique which in an observational meta-analysis may allow comparison of one technique against another.
Outcomes:
Mortality due to bleeding (Critical)
Cessation of bleeding / achieving hemostasis (Critical)
Time to achieving hemostasis (Critical)
Mortality from any cause (Important)
Decrease in bleeding (Important)
Complications/adverse effects (e.g. wound infection, limb loss, re-bleeding, pain related to an intervention) (Important)

Year of last full review: (*insert year where this PICOST was most recently reviewed***)**
2020 SR
Charlton NP, Swain JM, Brozek JL, Ludwikowska M, Singletary E, Zideman D, Epstein J, Darzi A, Bak A, Karam S, Les Z, Carlson JN, Lang E, Nieuwlaat R. Control of Severe, Life-Threatening External Bleeding in the Out-of-Hospital Setting: A Systematic Review.
Prehosp Emerg Care. 2021 Mar-Apr;25(2):235-267.PMID: 32208060

Singletary EM, Zideman DA, Bendall JC, et al. 2020 International Consensus on First Aid Science With Treatment Recommendations. *Circulation*. 2020;142(16_suppl_1):S284-S334. doi:10.1161/CIR.0000000000000897

Singletary EM, Zideman DA, Bendall JC, et al. 2020 International Consensus on First Aid Science With Treatment Recommendations. *Resuscitation*. 2020;156:A240-A282. doi:10.1016/j.resuscitation.2020.09.016

Current ILCOR Consensus on Science and Treatment Recommendation for this PICOST:
Please note that there are many related TR for PICOST on bleeding and this EvUP only focus on hemostatic dressing.

(2020 –SR):
We suggest that first aid providers use a hemostatic dressing with direct pressure as opposed to direct pressure alone for severe, life-threatening external bleeding (weak recommendation, very low certainty of evidence).

For the treatment of severe, life-threatening external bleeding by first aid providers, due to very limited data and very low confidence in effect estimates, we are unable to recommend the use of any one specific type of hemostatic dressing compared with another.

Current Search Strategy (for an existing PICOST) included in the attached approved PICOST:
PubMed: (Search Completed: August 12, 2022)
((((((((((("hemorrhage"[MeSH Terms] OR "hemorrhage"[All Fields] OR "bleeding"[All Fields]) OR ("haemorrhage"[All Fields] OR "hemorrhage"[MeSH Terms] OR "hemorrhage"[All Fields] OR Combat [title] OR trauma [title] OR "penetrating trauma"[All
Fields])))) OR ((("bandages"[MeSH Terms] OR "bandages"[All Fields]) OR bandages'[All Fields]) AND (("military medicine"[MeSH Terms] OR ("military"[All
Fields] AND "medicine"[All Fields]) OR "military medicine"[All Fields]) OR ("emergency medicine"[MeSH Terms] OR ("emergency"[All Fields] AND "medicine"[All
Fields]) OR "emergency medicine"[All Fields] OR "emergency medical services"[MeSH Terms])))) OR "blood coagulation/drug effects"[Mesh Terms]) AND
((((((("hemostatics"[Pharmacological Action] OR "hemostatics"[MeSH Terms] OR "hemostatics"[All Fields] OR ("haemostatic"[All Fields] AND "agent"[All Fields])
OR "haemostatic agent"[All Fields]) OR ("haemostatics"[All Fields] OR "hemostatics"[Pharmacological Action] OR "hemostatics"[MeSH Terms] OR "hemostatics"
[All Fields]) OR hemostatic techniques[All Fields]) AND (("administration, topical"[MeSH Terms] OR ("administration"[All Fields] AND "topical"[All Fields]) OR
"topical administration"[All Fields] OR ("topical"[All Fields] AND "administration"[All Fields])) OR local[All Fields] OR ("emergency medicine"[MeSH Terms] OR
("emergency"[All Fields] AND "medicine"[All Fields]) OR "emergency medicine"[All Fields]) OR ("military medicine"[MeSH Terms] OR ("military"[All Fields] AND
"medicine"[All Fields]) OR "military medicine"[All Fields]))) OR ("bandages"[MeSH Terms] OR "bandages"[All Fields])) OR ((hemcon[All Fields] OR quikclot[All
Fields] OR Celox[Title/Abstract] OR (bound[All Fields] AND state[All Fields]) OR (combat[All Fields] AND gauze[All Fields]) OR (quikclot[All Fields] AND
advanced[All Fields] OR "sponge"[All Fields])) OR (combat[All Fields] AND gauze[All Fields]) OR QCG[Title/Abstract] OR QCX[Title/Abstract] OR (hemcon[All
Fields] AND chitoflex[All Fields]) OR HCF[Title/Abstract] OR (hemcon[All Fields] AND chitogauze[All Fields]) OR HCG[Title/Abstract] OR ("chitosan"[MeSH
Terms] OR "chitosan"[All Fields]) OR (celow[All Fields] AND gauze[All Fields]) OR CEL[Title/Abstract] OR (modified[All Fields] AND rapid[All Fields] AND

deployment?[All Fields] AND hemostat[All Fields]) OR mRDH[Title/Abstract] OR ("zeolites"[MeSH Terms] OR "zeolites"[All Fields] OR "zeolite"[All Fields]))) AND
("administration, topical"[MeSH Terms] OR ("administration"[All Fields] AND "topical"[All Fields]) OR "topical administration"[All Fields] OR "topical"[All Fields])
OR (bandages[All Fields] OR bandages'[All Fields])) AND (("mortality"[Subheading] OR "mortality"[All Fields] OR "mortality"[MeSH Terms]) OR ("mortality"
[Subheading] OR "mortality"[All Fields] OR "survival"[All Fields] OR "survival"[MeSH Terms]) OR outcome[All Fields] OR (("wound healing"[MeSH Terms] OR
("wound"[All Fields] AND "healing"[All Fields]) OR "wound healing"[All Fields]) OR wound healing,[All Fields] OR ("wound healing"[MeSH Terms] OR ("wound"
[All Fields] AND "healing"[All Fields]) OR "wound healing"[All Fields] OR ("wound"[All Fields] AND "healings"[All Fields]) OR "wound healings"[All Fields])) OR
(("haemostasis"[All Fields] OR "hemostasis"[MeSH Terms] OR "hemostasis"[All Fields]) OR haemostatsis[All Fields] OR "survival rate"[MeSH Terms] OR "Injury
severity scale"[All Fields] OR "war"[MeSH Terms] OR "resuscitation"[MeSH Terms] OR "Hemorrhage control"[All Fields] or "burns" [All Fields])))))))

New Search strategy: (for a new PICOST should be outlined here as per Evidence Update Process)- NA
Database searched: Medline, PubMed
Time Frame: (existing PICOST) – updated from end of last search (please specify): November 22, 2019
Time Frame: (new PICOST) – at the discretion of the Task Force (please specify): NA
Date Search Completed: 12 August 2022
Search Results (Number of articles identified and number identified as relevant):
Total: 2093
Time frame 1 november 2019- 12 August 2022: 304

Summary of Evidence Update:
No new relevant articles were found.

Relevant Guidelines or Systematic Reviews
One article was closely related but might out of the scope of first aid anyhow.

Organization (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations
Firmino F, Villela-Castro DL, Santos JD, Conceição de Gouveia Santos VL.J 2021	Systematic review	"In patients with MFWs resulting because of breast cancer (P), what are the topical treatments employed (I) to control tumor	6	Fifty-six patients were exposed to 11 types of topical treatments using calcium alginate, surgical hemostats, adrenaline, nonadherent dressings, silver	Although studies have promoted positive results of topical hemostasis, scientific evidence is still weak and arises from studies with poor methodological quality.

Evidence Update Worksheet – 9 Jan 2021

		wound bleeding (O)?"		nitrate, modified Mohs Paste, and 10% formalin. There were no reports of significant adverse effects.	

Reviewer Comments: *(including whether this PICOST should have a systematic or scoping review*)
No SR or ScR is needed for now, but this topic seems very active with many new articles from both animal studies, laboratory studies and clinical updates or reviews. Therefore, an evidence update might be needed yearly.

Out of the 2093 hits, 17 abstracts were reviewed. Most of them were about hemostatic control during/after surgery for spinal cord or malignant breast cancer wounds. Many were animal studies or descriptions of chitosan-based sponges for uncontrolled bleeding in the hospital setting.

Some clinical updates or reviews (not meta-analysis) were also found. They might be good to read just to get into the topic:
Tompeck AJ, Gajdhar AUR, Dowling M, Johnson SB, Barie PS, Winchell RJ, King D, Scalea TM, Britt LD, Narayan M.J A comprehensive review of topical hemostatic agents: The good, the bad, and the novel. Trauma Acute Care Surg. 2020 Jan;88(1):e1-e21.PMID: 31626024 Review.

Huang L, Liu GL, Kaye AD, Liu H. Advances in Topical Hemostatic Agent Therapies: A Comprehensive Update Adv Ther. 2020 Oct;37(10):4132-4148. Epub 2020 Aug 19.PMID: 32813165 Review.

Malik A, Rehman FU, Shah KU, Naz SS, Qaisar S. Hemostatic strategies for uncontrolled bleeding: A comprehensive update.
J Biomed Mater Res B Appl Biomater. 2021 Oct;109(10):1465-1477. Epub 2021 Jan 28.PMID: 33511753

One animal study was also interesting to read:
Welch M, Barratt J, Peters A, Wright C.J Use of Topical Hemostatic Dressings in an Extended Field Care Model.
Spec Oper Med. 2021 Winter;21(4):63-65.PMID: 34969128

Closely related to the topic is how to teach first aid providers to stop the bleed, one RCT was found on this topic:
Chen S, Li J, DiNenna MA, Gao C, Chen S, Wu S, Tang X, He J. Comparison of two teaching methods for stopping the bleed: a randomized controlled trial. BMC Med Educ. 2022 Apr 14;22(1):281.PMID: 35421954

Reference list: *(List by ILCOR ref standard (last name first author, year of publication, first page number) and insert hyperlink to all articles identified as relevant (if available on PubMed)*

Firmino F, 2021.1278. Topical Management of Bleeding From Malignant Wounds Caused by Breast Cancer: A Systematic Review - PubMed (nih.gov)