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## 2022 Evidence Update Worksheet

**Worksheet author(s):** Federico Semeraro / Theresa Olasveengen

**Task Force:** BLS Task Force

**Date Submitted:** Jan 21<sup>th</sup> 2022

**Worksheet ID:** BLS 342 Barrier Devices

### PICO / Research Question:

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)?

**Outcomes:** Lower infection rates, quality of ventilation

**Type (intervention, diagnosis, prognosis):** Intervention

**Additional Evidence Reviewer(s):** Theresa M. Olasveengen

**Conflicts of Interest (financial/intellectual, specific to this question):** None

**Year of last full review:** 2010 / 2015 / **New question:** 2005

### Last ILCOR Consensus on Science and Treatment Recommendation:

Treatment Recommendation

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).

### 2010/2015 Search Strategy:

Database(s): Ovid MEDLINE(R) ALL 1946 to February 15, 2021

Search Strategy:

#	Searches	Results
1	Cardiopulmonary Resuscitation/	18097
2	Infectious Disease Transmission, Patient-to-Professional/	4905
3	1 and 241	
4	Respiration, Artificial/	50511
5	2 and 440	
6	5 not 3	39
7	3 or 6	80
8	Respiratory Protective Devices/	2207
9	1 and 85	
10	9 not 7	3
11	8 and 420	
12	masks/	5126

13	11 not 7	17
14	7 or 13 97	
15	12 and 2	174
16	15 not 14	167
17	16 or 14	264
18	1 and 12	79
19	18 not 17	74
20	17 or 19	338

**2019 Search Strategy:** Same as above

**Database searched:** Medline

**Date Search Completed:** Jan 20<sup>th</sup> 2022

**Search Results (Number of articles identified /number identified as relevant):** 384/0 new (4 in 2020 EvUp)

**Inclusion/Exclusion Criteria:** No exclusion criteria were applied to the search strategy. For the article review only studies whose title or abstract stated the article directly related to disease transmission during CPR or that compared effectiveness in ventilation using barrier devices were further evaluated.

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

<https://pubmed.ncbi.nlm.nih.gov/32325096/>

<https://pubmed.ncbi.nlm.nih.gov/33039225/>

<https://pubmed.ncbi.nlm.nih.gov/24773395/>

<https://pubmed.ncbi.nlm.nih.gov/21330044/>

**Summary of Evidence Update:**

**Evidence Update Process for topics not covered by ILCOR Task Forces**

1. 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**

Organisation (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations
Couper 2020	Systematic review	Three questions: (1) aerosol generation associated with key interventions; (2) risk of airborne infection transmission associated with key	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	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.

		interventions; and (3) the effect of different personal protective equipment strategies.		from manikin 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.	
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**RCT:**

<b>Study Acronym; Author; Year Published</b>	<b>Aim of Study; Study Type; Study Size (N)</b>	<b>Patient Population</b>	<b>Study Intervention (# patients) / Study Comparator (# patients)</b>	<b>Endpoint Results (Absolute Event Rates, P value; OR or RR; &amp; 95% CI)</b>	<b>Relevant 2° Endpoint (if any); Study Limitations; Adverse Events</b>
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	Surf lifeguards	Intervention: Mouth-to-face-shield	Thirty surf lifeguards (mean (SD) age: 25.1 (4.8) years; 21 male, 9	Author conclusion: Mouth-to-face-shield ventilation increases

Adelborg 2011	<p>mouth-to-face-shield ventilation and mouth-to-pocket-mask ventilation by surf lifeguards in a manikin</p> <p>A randomised crossover comparison of mouth-to-pocket and bag-mask ventilation to</p>	Surf lifeguards	<p>Control: Mouth-to-pocket-mask</p> <p>Intervention: 1. Mouth-to-pocket-mask ventilation</p>	<p>female) were randomly assigned to perform 2 x 3 min of 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, <math>p &lt; 0.0001</math>). 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%)), <math>p = 0.0002</math>. 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, <math>p = 0.006</math>). No differences in inspiratory times were observed between mouth-to-face-shield ventilation and mouth-to-pocket-mask ventilation</p> <p>A total of 60 surf lifeguards were included (67% male, 33% female, mean age 25 years).</p>	<p>interruptions in chest compressions, reduces the proportion of effective ventilations and decreases delivered tidal volumes compared with mouth-to-pocket-mask ventilation.</p> <p>Author conclusion: MMV reduces interruptions in chest compressions and produces a higher</p>
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	mouth-to-mouth ventilation by surf lifeguards in a manikin		2. Bag-mask-ventilation  Control: Mouth-to-mouth	Interruptions in chest compressions were significantly reduced 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.	proportion of effective ventilations during lifeguard CPR. This suggests that CPR quality is improved using MMV compared to MPV and BMV.
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### Nonrandomized Trials, Observational Studies: None

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

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 2021 were related to CPR. No need for full review.

	<b>Approval Date</b>
<b>Evidence Update coordinator</b>	
<b>ILCOR board</b>	

**\*Once approval has been made by Evidence Update coordinator, worksheet will go to ILCOR Board for acknowledgement.**

### **Reference list**

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.

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**2022 Evidence Update Worksheet**

**Worksheet author(s):** Julie Considine

**Task Force:** BLS Task Force

**Date Submitted:** January 2022

**Worksheet ID:** BLS 343 Chest compression rate

**PICO / Research Question:**

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 PCO<sub>2</sub>) 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. Literature search updated to February 2021.

**Additional Evidence Reviewer(s):** N/A

**Conflicts of Interest (financial/intellectual, specific to this question):** Nil

**Year of last full review:** 2015

**Last ILCOR Consensus on Science and Treatment Recommendation:** Taskforce Insights (2019)

This scoping review demonstrated that the majority of studies focused on a single chest compression component, whereas a number of studies suggest the presence of confounding interactions that prompt caution when evaluating any chest compression component in isolation.

The majority of the studies identified in this review were focused on out-of-hospital cardiac arrest highlighting a major gap in research in the in-hospital context.

This scoping review has not identified sufficient new evidence to prompt new systematic review.

The information from the studies identified was considered insufficient to alter existing recommendations

## 2019 Search Strategy:

### PubMed

(((((“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 (((((((((((((((((((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 (((((((((((((((((((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]))

#### Embase

('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 '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 ('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

#### Cochrane

([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 ([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 ([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 or centimetres:ab,ti or centimeters:ab,ti or depress:ab,ti or relaxation:ab,ti

**2020 Search Strategy:** as above

**Database searched:** Medline, Embase, Cochrane

**Date Search Completed:** January 2022

**Search Results (Number of articles identified / number identified as relevant):** 2

**Inclusion/Exclusion Criteria:** Unpublished studies or studies published in abstract form only, manikin studies, animal studies, and studies that did not specifically address the PICO questions related to CC rate, CC depth, chest wall recoil, and leaning were excluded.

**Link to Article Titles and Abstracts (if available on PubMed):** N/A

#### **Summary of Evidence Update:**

No new papers related to this PICOST have been identified since the 2019 scoping review.

#### **Evidence Update Process for topics not covered by ILCOR Task Forces**

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:**

Author, year	Country	Study design	Study period	Population	Intervention/exposure	Control/reference	Outcomes	Results	Comment
Nichol, 2021	United States and Canada	Retrospective cohort study	January 2007 and May 2015	Adults, EMS-treated non-traumatic OHCA treated using a	Compression depth of >51 mm or 38-51mm	Compression depth of <38mm	ROSC at ED arrival, survival to discharge	Compression depth > 51mm associated with higher risk-adjusted odds of ROSC at ED arrival	High-risk of bias. Models also adjust

				Zoll monitor/ defibrillator (n=5547)	Compression rate per 10/min			(AOR 1.21, 95% CI: 1.01, 1.47) but not survival to hospital discharge (AOR 1.25, 95% CI: 0.91, 1.71). Increasing compression rate not associated with either outcome.	for CPR fraction.
Vestergaard, 2021	Denmark	Denmark	December 2011 and November 2014	IHCA at a single centre (n=189)	Compression rate 100-120	Compression rate <100 or >120	ROSC and 30-day, 1-, 3-, and 5-year survival	Compression rate 100-120 associated with higher 30-day survival (AOR 2.04, 95% CI: 1.30, 3.18) and 3-Year survival (AOR 2.50, 95% CI: 1.23–5.08), but no effect on ROSC was observed.	High risk of bias. Models also adjust for CPR fraction.

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

Two additional observational studies were identified since the previous evidence update. The findings of these studies appear are consistent with those reported in the 2019 scoping review and 2015 ILCOR BLS CoSTR.

	<b>Approval Date</b>
<b>Evidence Update coordinator</b>	
<b>ILCOR board</b>	

**\*Once approval has been made by Evidence Update coordinator, worksheet will go to ILCOR Board for acknowledgement.**

**Reference list:**

Vestergaard LD, Lauridsen KG, Krarup NHV, Kristensen JU, Andersen LK, Løfgren B. Quality of Cardiopulmonary Resuscitation and 5-Year Survival Following in-Hospital Cardiac Arrest. Open Access Emerg Med. 2021 Dec 16;13:553-560. doi: 10.2147/OAEM.S341479. PMID: 34938129; PMCID: PMC8687881.

Nichol G, Daya MR, Morrison LJ, Aufderheide TP, Vaillancourt C, Vilke GM, Idris A, Brown S. Compression depth measured by accelerometer vs. outcome in patients with out-of-hospital cardiac arrest. Resuscitation. 2021 Oct;167:95-104. doi: 10.1016/j.resuscitation.2021.07.013. Epub 2021 Jul 29. PMID: 34331984.

## APPENDIX 1: SEARCH STRATEGY

### 1. MEDLINE

#### ***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 or centimetres:ab,ti or centimeters:ab,ti or depress:ab,ti or relaxation:ab,ti

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## 2022 Evidence Update Worksheet

**Worksheet author(s):** Giuseppe Ristagno

**Task Force:** BLS Task Force

**Date Submitted:** January 11<sup>st</sup> 2022

**Worksheet ID:** BLS 345 Rhythm Check

**PICO / Research Question:** Should checking the cardiac rhythm immediately after defibrillation vs. immediate resumption of chest compressions with delayed check of the cardiac rhythm be used in cardiac arrest?

**Outcomes:** Critical: Survival with good neurological function (i.e. at hospital discharge, 1 month, 6 months, 1 year), survival (i.e. hospital discharge, 1 month, 6 months, 1 year survival). Important: short term survival (return of spontaneous circulation – ROSC, hospital admission), rates of recurrence of fibrillation/re-fibrillation), CPR quality parameters (i.e. compression fraction).

**Type (intervention, diagnosis, prognosis):** Checking the cardiac rhythm immediately after defibrillation

**Additional Evidence Reviewer(s):** Raffo Escalante, Theresa Olasveengen

**Conflicts of Interest (financial/intellectual, specific to this question):** None

**Year of last full review:** 2019 **New question:** N.A.

**Last ILCOR Consensus on Science and Treatment Recommendation:** For the critical outcome of «survival with favorable neurologic outcome at discharge», we identified low-certainty evidence (downgraded for serious risk of bias and indirectness) from 1 RCT enrolling 415 OHCA showing no benefit for interrupting chest compressions to check rhythm immediately after shock delivery (RR, 0.89; 95% CI, 0.70–1.15) (Beesems 2016, 1) and a very-low-certainty evidence (downgraded for serious risk of bias, indirectness, and imprecision) from 3 observational studies enrolling 763 OHCA showing a harmful effect for interrupting chest compressions to check rhythm immediately after shock delivery (RR, 0.62; 95% CI, 0.51–0.75) (Kellum 2006, 335; Rea 2006, 2760; Bobrow 2008, 1158).

For the critical outcome of «survival to hospital discharge», we identified low-certainty evidence (downgraded for serious risk of bias and indirectness) from 2 RCTs enrolling 1260 OHCA showing no benefit for interrupting chest compressions to check rhythm immediately after shock delivery (RR, 0.89; 95% CI, 0.72–1.10) (Jost 2010, 1614; Beesems 2016, 1) and very-low-certainty evidence (downgraded for serious risk of bias and indirectness) from 3 observational studies enrolling 3094 OHCA showing a harm effect for checking rhythm immediately after defibrillation (RR, 0.55; 95% CI, 0.45–0.67) (Kellum 2006, 335; Rea 2006, 2760; Bobrow 2008, 1158).

For the important outcome of «survival to hospital admission», we identified low-certainty evidence (downgraded for serious risk of bias and indirectness) from 2 RCTs enrolling 1260 victims of OHCA showing no benefit for interrupting chest compressions to check rhythm immediately after shock delivery (RR, 1.02; 95% CI, 0.91–1.14) (Jost 2010, 1614; Beesems 2016, 1).



For the important outcome of «ROSC», we identified very-low-certainty evidence (downgraded for serious risk of bias and indirectness) from 2 observational studies enrolling 2969 victims of OHCA showing a harm effect for interrupting chest compressions to check rhythm immediately after shock delivery (RR, 0.69; 95% CI, 0.61–0.78) (Rea 2006, 2760; Bobrow 2008, 1158).

For the important outcome of «recurrence of VF», we identified a very-low-certainty (downgraded for serious risk of bias, indirectness, and imprecision) evidence from 2 RCTs, enrolling 551 OHCA showing no benefit for interrupting chest compressions to check rhythm immediately after shock delivery (RR, 1.08; 95% CI, 0.95–1.22) (Berdowski 2010, 72; Beesems 2016, 1).

In addition, for the important outcome «chest compression fraction», data from 3 RCTs enrolling 1412 OHCA showed a harm effect for interrupting chest compressions to check rhythm immediately after shock delivery (Jost 2010, 1614; Berdowski 2010, 72; Beesems 2016, 1).

We suggest against the checking of cardiac rhythm immediately after defibrillation. Weak recommendation / very-low certainty evidence

**2010/2015 Search Strategy:** ("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])

**2019 Search Strategy:** ("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])

**Database searched:** Pubmed

**Date Search Completed:** Jan 11<sup>st</sup> 2022

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

- Previous search update – Feb 14<sup>th</sup> 2021: 20 article identified/0 relevant
- Since last above search: 10 articles / 1 reviewed / 0 relevant

**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. Animal/lab studies, mathematical models, simulation and manikin studies, algorithm studies for rhythm analysis recognition with no outcome data, unpublished studies (e.g., conference abstracts, trial protocols) and reviews were excluded.

**Link to Article Titles and Abstracts (if available on PubMed):** N.A.

**Summary of Evidence Update:** No new relevant articles were found. Update review for 2022 not needed.

**Evidence Update Process for topics not covered by ILCOR Task Forces**

1. 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**

Organisation (if relevant); Author;	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations
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Year Published					
ILCOR; Olasveengen T; 2020	Systematic review	Timing of Rhythm Check (BLS 345: SysRev)	6	The meta-analysis of the RCTs did not demonstrate any differences between immediate rhythm analysis and immediate compressions, but unadjusted analysis of observational data suggested that immediate compressions were associated with better outcomes	We suggest immediate resumption of chest compressions after shock delivery for adults in cardiac arrest in any setting (weak recommendation, very-low-certainty evidence)

**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
	<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: N.A.**

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 meet criteria for formal review):**

	<b>Approval Date</b>
<b>Evidence Update coordinator</b>	
<b>ILCOR board</b>	

**\*Once approval has been made by Evidence Update coordinator, worksheet will go to ILCOR Board for acknowledgement.**

**Reference list:**

Olasveengen TM, Mancini ME, Perkins GD, Avis S, Brooks S, Castrén M, Chung SP, Considine J, Couper K, Escalante R, Hatanaka T, Hung KKC, Kudenchuk P, Lim SH, Nishiyama C, Ristagno G, Semeraro F, Smith CM, Smyth MA, Vaillancourt C, Nolan JP, Hazinski MF, Morley PT; Adult Basic Life Support Collaborators. Adult Basic Life Support: International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. Resuscitation. 2020 Nov;156:A35-A79. doi: 10.1016/j.resuscitation.2020.09.010. Epub 2020 Oct 21. PMID: 33098921; PMCID: PMC7576327.

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## **2022 Evidence Update Worksheet**

**Worksheet author(s):** Theresa M. Olasveengen

**Task Force:** BLS TF

**Date Submitted:** January 2022

**Worksheet ID:** 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

Outcome: 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.

### **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;

Coronary perfusion pressure;

Cardiac output (O)

**Type (intervention, diagnosis, prognosis):** Intervention

**Additional Evidence Reviewer(s):** Maaret Castrén

**Conflicts of Interest (financial/intellectual, specific to this question):** no conflicts to declare

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

### **Last ILCOR Consensus on Science and Treatment Recommendation:**

We suggest pausing chest compressions every 2 minutes to assess the cardiac rhythm (weak recommendation, low-certainty evidence).

### **2010/2015 Search Strategy:**

("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])

## 2020 Search Strategy:

Same as above

**Database searched:** PubMed

**Date Search Completed:** 11 January 2022

**Search Results (Number of articles identified / number identified as relevant):** (From 1 January 2021 to 11 January 2022 -48 identified/ 0 relevant)

**Inclusion/Exclusion Criteria:**

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

## Summary of Evidence Update:

### Evidence Update Process for topics not covered by ILCOR Task Forces

1. 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:** None

**RCT:** None

**Nonrandomized Trials, Observational Studies:** None

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

No study identified for full text review in the specified period.

	<b>Approval Date</b>
<b>Evidence Update coordinator</b>	
<b>ILCOR board</b>	

**\*Once approval has been made by Evidence Update coordinator, worksheet will go to ILCOR Board for acknowledgement.**

**Reference list**

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## 2022 Evidence Update Worksheet

### Public access AED programs

**Worksheet author(s):** Sung Phil Chung

**Task Force:** BLS Task Force

**Date Submitted:** 2021 Dec

**Worksheet ID:** 347 Public access AED Programs

**PICO / Research Question:** 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

**Additional Evidence Reviewer(s):**

**Conflicts of Interest (financial/intellectual, specific to this question):** None

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

### Last ILCOR Consensus on Science and Treatment Recommendation:

We recommend the implementation of public-access defibrillation programs for patients with OHCA.  
(Strong recommendation, low-certainty evidence)

### 2010/2015 Search Strategy:

**PubMed** ("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 resuscitate\*[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])

**2021 Search Strategy:** same as above

**Database searched:** PubMed, Embase, Cochrane Library

**Date Search Completed:** 2021 Jan 1 to 2021 Dec 18

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

PubMed: 229 articles identified / 5 selected for full-text review / 1 article identified as relevant.

#### **Inclusion/Exclusion Criteria:**

The public access AED is defined as defibrillation with onsite AED attempted by bystander layperson in the OHCA setting. Both patients with no AED use (CPR only group) and those who received defibrillation by first responders (ex, policeman) or paramedics were all included to control group because we considered them as one of several forms of traditional EMS response. This meta-analysis also includes "before vs after comparison study" or "early vs late comparison study" which compare before or early period of PAD implementation with after or late period in the community.

The studies with overlapping population were excluded in the analysis. Studies with irrelevant population, intervention, outcome, study design, and lack of information were excluded.

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

Shibahashi K, Sakurai S, Kobayashi M, Ishida T, Hamabe Y. Effectiveness of public-access automated external defibrillators at Tokyo railroad stations. *Resuscitation*. 2021 Jul;164:4-11.

**Aim:** To investigate the effectiveness of public-access automated external defibrillators (AEDs) at Tokyo railroad stations.

**Methods:** We analysed data from a population-based registry of out-of-hospital cardiac arrests in Tokyo, Japan (2014-2018). We identified patients aged  $\geq 18$  years who experienced bystander-witnessed cardiac arrest due to ventricular fibrillation of presumed cardiac origin at railroad stations. The primary outcome was survival at 1 month after cardiac arrest with favourable neurological outcomes (cerebral performance category 1-2).

**Results:** Among 280 eligible patients who had bystander-witnessed cardiac arrest and received defibrillation at railroad stations, 245 patients (87.5%) received defibrillation using public-access AEDs and 35 patients (12.5%) received defibrillation administered by emergency medical services (EMS). Favourable neurological outcomes at 1 month after cardiac arrest were significantly more common in the group that received defibrillation using public-access AEDs (50.2% vs. 8.6%; adjusted odds ratio: 11.2, 95% confidence interval: 1.43-88.4) than in the group that received defibrillation by EMS. Over a 5-year period, favourable neurological outcomes at 1 month after cardiac arrest of 101.9 cases (95% confidence interval: 74.5-129.4) were calculated to be solely attributable to public-access AED use. The incremental cost-effectiveness ratio to gain

one favorable neurological outcome obtained from public-access AEDs at railroad stations was lower than that obtained from nationwide deployment (48.5 vs. 2133.4 AED units).

Conclusion: Deploying public-access AEDs at Tokyo railroad stations presented significant benefits and cost-effectiveness. Thus, it may be prudent to priorities metropolitan railroad stations in public-access defibrillation programs.

### Summary of Evidence Update:

#### Evidence Update Process for topics not covered by ILCOR Task Forces

1. 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:** not reported

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:** not reported

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

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)
Shibahashi 2021	Retrospective cohort study N=280 (2014-2018)	Adult bystander-witnessed OHCA due to VF of presumed cardiac origin at railroad stations in Tokyo	<b>Outcome:</b> CPC 1 or 2, Survival at 1-month, and ROSC <b>Results:</b> CPC 1 or 2 at 1 month was better in PAD group (adjusted OR: 11.2, 95% CI: 1.43-88.4), 1-month survival (adjusted	PAD program at Tokyo railroad stations presented significant benefits and cost-

			OR: 8.4, 1.8-39.2) and ROSC (adjusted OR: 7.2, 1.9-27.7).	effectiveness (ICER value: 48.5).
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**Reviewer Comments (including whether meet criteria for formal review):**

The 2021 CoSTR review included 1 RCT and 31 observational studies for this PICO. An observational study was added after the 2020 review. The study favored public access defibrillation. Therefore, the previous treatment recommendation should be maintained. We recommend the implementation of public-access defibrillation programs for patients with OHCA. (Strong recommendation, low-certainty evidence)

	<b>Approval Date</b>
<b>Evidence Update coordinator</b>	
<b>ILCOR board</b>	

**\*Once approval has been made by Evidence Update coordinator, worksheet will go to ILCOR Board for acknowledgement.**

**Reference list**

1. Shibahashi K, Sakurai S, Kobayashi M, Ishida T, Hamabe Y. Effectiveness of public-access automated external defibrillators at Tokyo railroad stations. Resuscitation. 2021 Jul;164:4-11.

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## **2022 Evidence Update Worksheet**

**Worksheet author(s):** Chika Nishiyama

**Task Force:** BLS Task Force

**Date Submitted:** January/9/2022

**Worksheet ID:** BLS 348 Check for circulation during BLS

### **PICO / Research Question:**

Among adults and children who are in cardiac arrest in any setting (P), interruption of CPR to check circulation (I), no interruption of CPR (C), change outcomes (O)

T: Search completed on January 5, 2022

### **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

**Type (intervention, diagnosis, prognosis):** intervention

**Additional Evidence Reviewer(s):** N/A

**Conflicts of Interest (financial/intellectual, specific to this question):** N/A

**Year of last full review:** 2015

Note: BLS TF performed the Evidence update in 2021.

### **Last ILCOR Consensus on Science and Treatment Recommendation:**

Consensus on Science (2015):

Of the 654 articles found during the search, and a follow-up search performed in early 2015 identifying a potential additional 112 studies, none were found to relate to the specific question.

Treatment Recommendation (2015):

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.

### **2015 Search Strategy:**

(((((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]))

## 2022 Search Strategy:

Based on the 2015 search strategies, BLS TF rerun literature review between 1 Jan 2021 to 31 December 2021.

## Database searched:

Pubmed

## Date Search Completed:

5 January 2022

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

56 articles were identified, but no article was related.

## Inclusion/Exclusion Criteria:

### Inclusion Criteria

Studies according to PICO components, human data only

### Exclusion Criteria

No control group.

Rhythm analysis only (recording or during CPR)

Only other techniques used to assess presence of circulation (plethysmography, arterial pressure monitoring, ETCO<sub>2</sub>, NIRS, ultrasound etc).

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

No

## Summary of Evidence Update:

### Evidence Update Process for topics not covered by ILCOR Task Forces

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

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

**RCT:**

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

**Nonrandomized Trials, Observational Studies**

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

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

There is no new research to suggest the need for scoping reviews or systematic reviews. Some relevant papers showing the effectiveness of ultrasound to check for circulation were identified.

	<b>Approval Date</b>
<b>Evidence Update coordinator</b>	
<b>ILCOR board</b>	

\*Once approval has been made by Evidence Update coordinator, worksheet will go to ILCOR Board for acknowledgement.

**Reference list**

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## 2022 Evidence Update Worksheet

**Worksheet author(s): Anthony Lagina**

**Task Force:** BLS Task Force

**Date Submitted:** 04.01.2022

**Worksheet ID:** BLS 349 Rescuer fatigue in CC only CPR

### PICO / Research Question:

**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 2 2022 .

**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: 02.01.2022**

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

**Pubmed (95 records)**

Cardiopulmonary resuscitation OR CPR AND fatigue  
 Cardiopulmonary resuscitation OR CPR AND quality  
 Chest compression AND fatigue  
 Chest compression AND quality  
 Chest compression AND continuous

**Embase (4 records)**

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.

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

<https://pubmed.ncbi.nlm.nih.gov/34825237/>

<https://pubmed.ncbi.nlm.nih.gov/33578597/>

<https://pubmed.ncbi.nlm.nih.gov/32976224/>

**Summary of Evidence Update:**

**Evidence Update Process for topics not covered by ILCOR Task Forces**

1. This evidence update process is only applicable to PICO's which are *not* being reviewed as ILCOR systematic and scoping reviews.

Reference	Methods	Participants	Intervention	Comparisons	Outcomes
Dong 2021	Prospective crossover study	30 laypersons 18-65	Variable compression to pause time(s) 1) CCC, 10-min CCC; (2) 4+6, 4-min CCC + 6-min of 10-s pause after 60-s compressions; (3) 2+8 (10/60), 2-min CCC + 8-min of 10-s pause after 60-s compressions; (4)	<b>CPR quality</b> (depth, rate, hands-off duration, chest compression fraction (CCF)) <b>fatigue indicators</b> (heart rate, blood pressure, rating of perceived exertion (RPE))	All resting methods reduced the trend of declining compression depth and the trend of increasing RPE while maintaining CCF of more than 86%. In methods with different rest-start points, the 2+8 method showed no difference in overall CPR quality or fatigue, but better CPR quality of every minute than 4+6 method. In methods with different rest-compression



			5/30, 2-min CCC + 8-min of 5-s pause after 30-s compressions; (5) 3/15, 2-min CCC + 8-min of 3-s pause after 15-s compressions		ratios, the 3/15 method showed the best CPR quality and the highest heart rate increment.
Dong Hun Kim 2021	prospective randomized simulation study	90 volunteer paramedic students	3 rest groups: 2 min 1min 45 seconds 1 min 30 seconds 5 cycles of CO-CPR	CPR quality, physiological variations, and hemodynamic variations	chest compression depth all maintained depth rate maintained no fatigue differences between groups
Baldi 2021	Multicenter RCT Manikin 8 min OHCA	2154 consecutive layperson following bls/aed course participants	Variable compression to pause time(s) 30c2s 50c5s 100c10s CCC	Percentage of correct depth CC CC fraction (% of time where CC were given)	Correct depth 30c2s, 96%; 50c5s, 96% 100c10s, 92% compression only, 79%; P=0.006). significant difference for 30c2s (P= 0.023) and for 50c5s(P= 0.003) versus compression only. There was a higher chest compression fraction in the compression-only group and a

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

No clinical studies were identified that actually addressed the criteria set out in the PICOST (fatigue in rescuers providing standard CPR vs compression only CPR). Simulation studies on manikins were identified investigation resting frequency during CO-CPR, 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. Future investigation about rest duration and frequency during CO-CPR should be considered in parallel with increased recommendations for CO-CPR during pandemic.

Prior studies suggesting additional factors such as wearing a face mask might and other protective devices influence fatigue during CPR. (Tian 2020) While not specifically searched for, future reviews will consider broadening the scope of this PICOST.

	<b>Approval Date</b>
<b>Evidence Update coordinator</b>	
<b>ILCOR board</b>	

**\*Once approval has been made by Evidence Update coordinator, worksheet will go to ILCOR Board for acknowledgement.**

### **Reference list**

1: Dong X, Zhou Q, Lu Q, Sheng H, Zhang L, Zheng ZJ. Different Resting Methods in Improving Laypersons Hands-Only Cardiopulmonary Resuscitation Quality and Reducing Fatigue: A Randomized Crossover Study. *Resusc Plus*. 2021 Nov 12;8:100177. doi: 10.1016/j.resplu.2021.100177. PMID: 34825237; PMCID: PMC8605240.

2: Kim DH, Lee SM, Kim GM, Lee KW, Ko SH, Oh YJ, Seo YW, Lee SH, Jang TC. Comparison of the effects of shortening rest intervals on the quality of cardiopulmonary resuscitation, physiological parameters, and hemodynamic parameters in well-trained rescuers: Randomized simulation study. *Medicine (Baltimore)*. 2021 Feb 12;100(6):e24666. doi: 10.1097/MD.00000000000024666. PMID: 33578597.

3: Baldi E, Contri E, Burkart R, Borrelli P, Ferraro OE, Paglino M, Pugliesi M, Barbati C, Bertaia D, Tami C, Lopez D, Boldarin S, Dénéréaz S, Terrapon M, Cortegiani A; and the MANI-CPR investigators. A Multicenter International Randomized Controlled Manikin Study on Different Protocols of Cardiopulmonary Resuscitation for Laypeople: The MANI-CPR Trial. *Simul Healthc*. 2021 Aug 1;16(4):239-245. doi: 10.1097/SIH.0000000000000505. PMID: 32976224.

Format:

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## 2022 Evidence Update Worksheet

**Worksheet author(s):** Olasveengen

**Task Force:** BLS Task Force

**Date Submitted:** 04.01.2022

**Worksheet ID:** 353 Harm from CPR to victims not in arrest

### PICO / Research Question:

**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.

**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 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]))

**2020 Search Strategy:** Pubmed search as above.

Additional search in Embase:

- 1 heart arrest/ or resuscitation/ or heart ventricle fibrillation/
- 2 Cardiopulmonary Resuscitation.mp. or exp resuscitation/
- 3 thorax compressions.mp.
- 4 chest compressions.mp.
- 5 basic life support.mp.
- 6 Basic Cardiac Life Support.mp.
- 7 1 or 2 or 3 or 4 or 5 or 6
- 8 Thoracic Injuries.mp. or thorax injury/
- 9 (Wounds and Injuries).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]
- 10 Abdominal Injuries.mp. or abdominal injury/
- 11 rupture/ or Rupture.mp.
- 12 tension pneumothorax/ or pneumothorax/ or Pneumothorax.mp.
- 13 Respiratory Aspiration.mp. or acid aspiration/
- 14 pain/co, dm [Complication, Disease Management]
- 15 Complications.mp. or complication/
- 16 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15
- 17 bystander.mp.
- 18 lay rescuer.mp.
- 19 first responder.mp.
- 20 layperson.mp. or layperson/
- 21 lay person.mp.
- 22 17 or 18 or 19 or 20 or 21
- 23 22 and 16 and 7

**Database searched:** Pubmed

**Date Search Completed:** 04.01.2022

**Search Results (Number of articles identified / number identified as relevant):** 0/23

**Inclusion/Exclusion Criteria:** Animal studies, conference abstracts, trial protocols

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

No new studies

**Summary of Evidence Update:**

**Evidence Update Process for topics not covered by ILCOR Task Forces**

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 since systematic review in 2020:**

<b>Study Acronym; Author; Year Published</b>	<b>Study Type/Design; Study Size (N)</b>	<b>Patient Population</b>	<b>Primary Endpoint and Results (include P value; OR or RR; &amp; 95% CI)</b>	<b>Summary/Conclusion Comment(s)</b>
Deliliga 2019	<u><b>Study Type:</b></u>  Observational study/ Case series	<u><b>Inclusion Criteria:</b></u>  88 cardiac arrest cases autopsied	<u><b>1° endpoint:</b></u>  Injuries resulting from the application of CPR	26.7% had rib fractures 17.4% had sternal fractures Number of fractures was 7.86 (4.11 on the right side and 4.75 on the left side). 16% of the cases were found to be mild, 48% were moderate, and 35% of the cases were severe.
Rowland D 2020	Case report		Injury during mechanical chest compression	Description of case: Seven minutes after AM-CPR application, the patient had absent right-sided breath sounds and ventilations were more difficult. Needle decompression was performed with an audible release of air. A chest tube was placed by an EMS physician and roughly 400 mL of blood were immediately returned. At the next 2-minute pulse check, ROSC was noted, and the patient was transported to the hospital.

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

The Basic Life Support Task Force did not find the results of the two case series/case reports sufficient to challenge current guidelines and warrant a full review.

	<b>Approval Date</b>
<b>Evidence Update coordinator</b>	
<b>ILCOR board</b>	

**\*Once approval has been made by Evidence Update coordinator, worksheet will go to ILCOR Board for acknowledgement.**

## Reference list

Deliliga A, Chatzinikolaou F, Koutsoukis D, Chrysovergis I, Voultos P. Cardiopulmonary resuscitation (CPR) complications encountered in forensic autopsy cases. *BMC Emerg Med*. 2019 Feb 28;19(1):23. doi: 10.1186/s12873-019-0234-5.

Haley KB, Lerner EB, Pirrallo RG, Croft H, Johnson A, Uihlein M. The frequency and consequences of cardiopulmonary resuscitation performed by bystanders on patients who are not in cardiac arrest. *Prehosp Emerg Care*. 2011;15:282–287. doi: 10.3109/10903127.2010.541981

Moriwaki Y, Sugiyama M, Tahara Y, Iwashita M, Kosuge T, Harunari N, Arata S, Suzuki N. Complications of bystander cardiopulmonary resuscitation for unconscious patients without cardiopulmonary arrest. *J Emerg Trauma Shock*. 2012;5:3–6. doi: 10.4103/0974-2700.93094

Rowland D, Vryhof N, Overton D, Mastenbrook J. Tension Hemopneumothorax in the Setting of Mechanical CPR during Prehospital Cardiac Arrest. *Prehosp Emerg Care*. 2020 Apr 14:1-7. doi: 10.1080/10903127.2020.1743800. Online ahead of print.

Tanaka Y, Nishi T, Takase K, Yoshita Y, Wato Y, Taniguchi J, Hamada Y, Inaba H. Survey of a protocol to increase appropriate implementation of dispatcher-assisted cardiopulmonary resuscitation for out-of-hospital cardiac arrest. *Circulation*. 2014;129:1751–1760. doi: 10.1161/CIRCULATIONAHA.113.004409

White L, Rogers J, Bloomingdale M, Fahrenbruch C, Culley L, Subido C, Eisenberg M, Rea T. Dispatcher-assisted cardiopulmonary resuscitation: risks for patients not in cardiac arrest. *Circulation*. 2010;121:91–97. doi: 10.1161/CIRCULATIONAHA.109.872366

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## 2022 Evidence Update Worksheet

**Worksheet author(s):** Federico Semeraro

**Task Force:** BLS Task Force

**Date Submitted:** 04.01.2022

**Worksheet ID:** 354 Harm to rescuers from CPR

### PICO / Research Question:

**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 November 1<sup>st</sup>, 2019.

**Outcomes:** Any harm to rescuer

**Type (intervention, diagnosis, prognosis):** Intervention

**Additional Evidence Reviewer(s):** Theresa M. Olasveengen

**Conflicts of Interest (financial/intellectual, specific to this question):** None

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

### Last ILCOR Consensus on Science and Treatment Recommendation:

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.

### 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))

**2020 Search Strategy:** Same as above

**Database searched:** Pubmed,

**Date Search Completed:** 04.01.2022

**Search Results (Number of articles identified / number identified as relevant): 89 / 2**

**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/33489737/>

**Summary of Evidence Update:**

**Evidence Update Process for topics not covered by ILCOR Task Forces**

1. 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: 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)
Chen 2020	Qualitative study to explore the experiences of rescuers (n=9)	Lay rescuers who had performed CPR and AED in public locations in Taiwan	Event-to-interview duration was within 1 year (n = 4) and 1-2 years (n = 5). (1) the lay rescuers possessed helping traits and high motivation;	Author conclusion: This study provides valuable information on strategies to increase layperson CPR rates and effectiveness in CPR training. Measures should be taken to



			(2) the lay rescuers reported certain aspects of rescue reality that differed much from prior training and expectations, including difficulty in the depth of chest compression, and uncertainties in real emergency situations; (3) the lay rescuers gained positive personal fulfillment in sharing their experience and receiving positive feedback from others, and were willing to help next time, although they experienced a short-term negative psychological impact from the event.	increase layperson's confidence and situation awareness, reduce training-reality discrepancy, build up a support system to avoid negative psychological effects, and prepare lay rescuers for the next resuscitation.
Wight 2021	Unclear number of "rescuers"	Twenty patients undergoing elective cardioversion	Only three of the ten measurements assessing current passing through a rescuer's arms had detectable current and each was of low magnitude. All measurements were well below the maximum IEC recommendations of 3.5 mA RMS and 5.0 mA peak.	Polyethylene may facilitate safe HOD even after long durations of compressions. Current looping through a rescuer's arms is likely of insignificant magnitude.
Andelius 2021	7334 of 9574 citizen responders that were dispatched answered the question regarding physical injury.	A survey was sent to all activated citizen responders	No injury was reported by 99.3% (7281) of the responders. Being at risk of physical injury was reported by 0.3% (24), whereas 0.4% (26) reported an injury (25 minor injuries and 1 severe injury [ankle fracture]). When following up on nonresponders (2472), we reached 99.1% (2449). No one reported acquired injuries, and only 1 reported being at risk of injury.	We found low risk of physical injury reported by volunteer citizen responders dispatched to out-of-hospital cardiac arrest. Risk of injury should be considered and monitored as a safety measure in citizen responder programs.

### Reviewer Comments (including whether meet criteria for formal 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.

	<b>Approval Date</b>
<b>Evidence Update coordinator</b>	
<b>ILCOR board</b>	

**\*Once approval has been made by Evidence Update coordinator, worksheet will go to ILCOR Board for acknowledgement.**

### **Reference list**

Chen HH, Chiang WC, Hsieh MJ, Lee CH, Yuan ZF, Lin HY, Chew LF, Huang EP, Yang CW, Liao SC, Lin CW, Lee MN, Ma MH. Experiences and Psychological Influences in Lay Rescuers Performing Bystander Cardiopulmonary Resuscitation: A Qualitative Study. J Acute Med. 2020 Dec 1;10(4):138-148. doi: 10.6705/j.jacme.202012\_10(4).0002.

Wight JA, Bigham TE, Hanson PR, Zahid A, Iravanian S, Perkins PE, Lloyd MS. Hands-on defibrillation with safety drapes: Analysis of compressions and an alternate current pathway. Am J Emerg Med. 2021 Dec 3;52:132-136. doi: 10.1016/j.ajem.2021.11.044.

Andelius L, Malta Hansen C, Tofte Gregers MC, Kragh AMR, Køber L, Gislason GH, Kjær Ersbøll A, Torp-Pedersen C, Folke F. Risk of Physical Injury for Dispatched Citizen Responders to Out-of-Hospital Cardiac Arrest. J Am Heart Assoc. 2021 Jul 20;10(14):e021626. doi: 10.1161/JAHA.121.021626.

**\*\*CONFIDENTIAL DO NOT DISTRIBUTE\*\***

## 2022 Evidence Update Worksheet

**Worksheet author(s):** Giuseppe Ristagno

**Task Force:** BLS Task Force

**Date Submitted:** 11<sup>st</sup> January 2022

**Worksheet ID:** BLS 357 Hand position during compressions

**PICO / Research Question:** BLS 357 Hand position during compressions

**Outcomes:** Any clinical outcome. 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. Physiological outcomes, such as blood pressure, coronary perfusion pressure, or ETCO<sub>2</sub>, also were considered important.

**Type (intervention, diagnosis, prognosis):** Delivery of chest compressions on the lower half of the sternum.

**Additional Evidence Reviewer(s):**

**Conflicts of Interest (financial/intellectual, specific to this question):** None

**Year of last full review:** 2019 **New question:** N.A.

**Last ILCOR Consensus on Science and Treatment Recommendation:** 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 ( $114 \pm 51$  mm Hg compared with  $95 \pm 42$  mm Hg) and ETCO<sub>2</sub> ( $11.0 \pm 6.7$  mm Hg compared with  $9.6 \pm 6.9$  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 ETCO<sub>2</sub> 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.

This treatment recommendation (below) is unchanged from 2015. We suggest performing chest compressions on the lower half of the sternum on adults in cardiac arrest (weak recommendation, very-low-certainty evidence).

**2019 Search Strategy:** ("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])

**Database searched:** Pubmed

**Date Search Completed:** January 11<sup>st</sup>, 2022

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

- Previous Search update - Feb 14<sup>th</sup>, 2021: 40 articles identified / 2 relevant (systematic reviews on pediatric population)
- Since the above last search: 25 articles identified / 0 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.

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

- <https://pubmed.ncbi.nlm.nih.gov/32707697/>
- <https://pubmed.ncbi.nlm.nih.gov/32516929/>

**Summary of Evidence Update:** No compelling clinical data suggesting the need to change the recommended hand placement for performing chest compressions were identified. Update systematic review for 2021 is not needed.

**Evidence Update Process for topics not covered by ILCOR Task Forces**

1. 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

Organisation (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations
ILCOR; Olasveengen 2020	Systematic review	Hand Position During Compressions (BLS 357: SysRev)	3	absence of compelling clinical data suggesting the need to change the recommended hand placement for performing chest compressions	We suggest performing chest compressions on the lower half of the sternum on adults in cardiac arrest (weak recommendation, very-low-certainty evidence).
Chang 2020	Systematic review on infants	2-thumb (TT) vs 2-finger (TF) CPR techniques	13	TT technique was associated with higher proportion of adequate compression	n.a.

				depth (Mean difference (MD): 19.99%; 95% Confidence interval (CI): 9.77 to 30.22; $p < 0.01$ ) than the TF technique.	
Chang 2020	Systematic review on infants	2-thumb (TT) vs 2-finger (TF) CPR techniques	12	The TT technique was associated with deeper chest-compression depth (mean difference: 4.71 mm; 95% confidence interval: 3.61 to 5.81; $p < 0.001$ ) compared with the TF technique. The TF technique was better in terms of the proportion of complete chest recoil (mean difference: -11.73%; 95% confidence interval: -20.29 to -3.17; $p = 0.007$ ).	n.a.

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
	<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: N.A.**

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

**Reviewer Comments (including whether meet criteria for formal review):** The 2 systematic reviews identified are from the same authors (Chang et al) and at a first look seem to report the same data (same articles included). No new articles have been identified over the last year.

The Basic Life Support Task Force did not find the results sufficient to challenge current guidelines and warrant a full review.

	<b>Approval Date</b>
<b>Evidence Update coordinator</b>	
<b>ILCOR board</b>	

**\*Once approval has been made by Evidence Update coordinator, worksheet will go to ILCOR Board for acknowledgement.**

**Reference list:**

Olasveengen TM, Mancini ME, Perkins GD, Avis S, Brooks S, Castrén M, Chung SP, Considine J, Couper K, Escalante R, Hatanaka T, Hung KKC, Kudenchuk P, Lim SH, Nishiyama C, Ristagno G, Semeraro F, Smith CM, Smyth MA, Vaillancourt C, Nolan JP, Hazinski MF, Morley PT; Adult Basic Life Support Collaborators. Adult Basic Life Support: International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. Resuscitation. 2020 Nov;156:A35-A79. doi: 10.1016/j.resuscitation.2020.09.010. Epub 2020 Oct 21. PMID: 33098921; PMCID: PMC7576327.

Chang CY, Hou YT, Chien YJ, Chen YL, Lin PC, Chen CS, Wu MY. Two-Thumb or Two-Finger Technique in Infant Cardiopulmonary Resuscitation by a Single Rescuer? A Meta-Analysis with GOSH Analysis. Int J Environ Res

Public Health. 2020 Jul 19;17(14):5214. doi: 10.3390/ijerph17145214. PMID: 32707697; PMCID: PMC7400494.

Chang CY, Lin PC, Chien YJ, Chen CS, Wu MY. Analysis of Chest-Compression Depth and Full Recoil in Two Infant Chest-Compression Techniques Performed by a Single Rescuer: Systematic Review and Meta-Analysis. Int J Environ Res Public Health. 2020 Jun 5;17(11):4018. doi: 10.3390/ijerph17114018. PMID: 32516929; PMCID: PMC7312068.

**\*\*CONFIDENTIAL DO NOT DISTRIBUTE\*\*****2022 Evidence Update Worksheet****Worksheet author(s):** Theresa M. Olasveengen**Task Force:** BLS Task Force**Date Submitted:** 18 Jan 2022**Worksheet ID:** BLS 359 Dispatcher instructions**PICO / Research Question:** Does dispatcher-assisted cardiopulmonary resuscitation (CPR) instructions using continuous chest compressions vs. standard CPR instructions improve survival in adult out-of-hospital cardiac arrest?**Outcomes:** survival from cardiac arrest**Type (intervention, diagnosis, prognosis):** Intervention – Dispatcher assisted CPR instructions using continuous chest compressions**Additional Evidence Reviewer(s):** Not applicable**Conflicts of Interest (financial/intellectual, specific to this question):** None to declare**Year of last full review:** 2010 / 2015 / **New question:** 2017**Last ILCOR Consensus on Science and Treatment Recommendation:**

We recommend that dispatchers provide chest compression–only CPR instructions to callers for adults with suspected out-of-hospital cardiac arrest (OHCA) (strong recommendation, low-quality evidence).

**2017 Search Strategy:**

Medline:

- 
- 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

## **2020 Search Strategy: Same as above**

**Database searched:** Medline

**Date Search Completed:** 18 Jan 2022

### **Search Results (Number of articles identified / number identified as relevant):**

823 Citations reviewed in title and abstract screening

8 selected for full text review

0 articles relevant

**Inclusion/Exclusion Criteria:** Studies which include a comparison of continuous chest compressions instructions to standard CPR instructions in dispatch

**Link to Article Titles and Abstracts (if available on PubMed):** Not applicable

## **Summary of Evidence Update:**

### **Evidence Update Process for topics not covered by ILCOR Task Forces**

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

## Non-randomized Trials, Observational Studies: None

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

No new studies or randomized trials available comparing dispatcher instructions of CCC to standard CPR so would not recommend a formal review at this time.

Previous evidence update identified two studies (Riva 2020 and Hatakeyama 2020) included data on number of cases with continuous chest compressions and standard CPR were performed but these were not stratified by whether it was via dispatcher instructions or independent bystander choice.

The Basic Life Support Task Force did not find the results of the three simulation manikin studies sufficient to challenge current guidelines and warrant a full 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

Hatakeyama T et al. Effectiveness of dispatcher instructions-dependent or independent bystander cardiopulmonary resuscitation on neurological survival among patients with out-of-hospital cardiac arrest. J Cardiol. 2020 Mar;75(3):315-322.

Riva G et al. Survival after dispatcher-assisted cardiopulmonary resuscitation in out-of-hospital cardiac arrest. Resuscitation. 2020 Dec; 157:195-201.

**\*\*CONFIDENTIAL DO NOT DISTRIBUTE\*\*****2022 Evidence Update****Worksheet author(s):** Peter J. Kudenchuk, MD**Task Force:** BLS Task Force**Date Submitted:** 12/7/2021**Worksheet ID:** BLS 360 EMS Chest compression-only vs. conventional CPR**PICO / 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)?**Outcomes:** Not specified by PICOST, but evaluated for evidence of return of spontaneous circulation, admission alive to hospital, survival to hospital discharge, and survival with favorable neurological outcome**Type (intervention, diagnosis, prognosis):** Intervention**Additional Evidence Reviewer(s):** NA**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:** 2020

- We recommend that EMS providers perform CPR with 30 compressions to 2 breaths (30:2 ratio) or continuous chest compressions with positive pressure ventilation 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)

**2010/2015 Search Strategy:** NA**2019 Search Strategy:** Same terms and database as that used for 2020 Guidelines**Database searched:** KSU search strategy (same terms and database as for 2020 Guidelines) that was provided by Dr. Olasveengen for covering the dates 1/1/2020-1/28/21. A subsequent search covering articles published in 2021 through 11/30/21 used the broad search terms “(resuscitation or CPR) and (chest compression or ventilation or mouth-to-mouth) and (2021)” and performed within PubMed database.**Date Search Completed:** 1/1/2020- 1/28/2021; and 1/1/2021-11/30/21**Search Results (Number of articles identified / number identified as relevant):** 815 articles retrieved from search → only 1 indirectly relevant to EMS arena and did not provide outcome data. The subsequent search (1/1/2021 – 11/30/21) retrieved 2607 articles none of which (even given the broad categories of the search) were relevant to the PICO. Thus in total only 1 article found between the search periods of 1/1/2020 – 11/30/2021.

**Inclusion/Exclusion Criteria:** **Inclusion** - Manikin and clinical studies addressing adult resuscitation  
**Link to Article Titles and Abstracts (if available on PubMed):** See reference list below.

### Summary of Evidence Update:

#### Evidence Update Process for topics not covered by ILCOR Task Forces

1. 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
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	<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)
Ventilation by Chest Compressions; Vanwulpen; 2021	<u>Study Type:</u>  Observational (10 patients, 5 female, median	<u>Inclusion Criteria:</u> Adult, endotracheally intubated,	<u>1° endpoint:</u> Inspiratory tidal volume generated by first 30 manual chest compressions following intubation (without	Median inspiratory tidal volume generated by manual chest compressions without ventilation was 20 mL (IQR 13, 28 mL) which

	age 64 yrs, median compressions 111/min, median depth 5.6 cm.	nontraumatic out-of-hospital cardiac arrest	simultaneous manual ventilation)	were judged inadequate to provide adequate alveolar ventilation.
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**Reviewer Comments (including whether meet criteria for formal review):** Only a single relevant study was identified during the specified time window. This study indirectly addressed provision of chest compressions with ventilation versus chest compressions alone in intubated patients. Its finding was that the tidal volume generated by chest compressions in an open airway is insufficient to provide alveolar ventilation, suggesting that chest compressions alone do not adequately ventilate patients. The study did not address arterial blood gas content, EtCO<sub>2</sub>, ventilation in the non-intubated patient (although this would be expected to be either no different or resulting in lower tidal volumes if there is airway occlusion), or clinical outcome. As such, the data would support the provision of manual ventilation during the course of EMS CPR in order to achieve volumes sufficient to support alveolar ventilation, but does not permit further extrapolation from this information. In sum, the interim evidence does not provide sufficient information to alter 2020 Guideline recommendations.

	<b>Approval Date</b>
<b>Evidence Update coordinator</b>	
<b>ILCOR board</b>	

**\*Once approval has been made by Evidence Update coordinator, worksheet will go to ILCOR Board for acknowledgement.**

### Reference list

Vanwulpen M, Wolfskeil M, Duchatelet C, Hachimi-Idrissi S. Do manual chest compressions provide substantial ventilation during prehospital cardiopulmonary resuscitation? Am J Emerg Med 2021;39:129-131.

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## 2022 Evidence Update Worksheet

**Worksheet author(s):** Chika Nishiyama

**Task Force:** BLS Task Force

**Date Submitted:** January/9/2022

**Worksheet ID:** BLS 362 Compression-ventilation ratio

### PICO / Research Question:

Adults and children with OHCA (P), Any compression-to-ventilation ratio other than 30:2 (I), Compression-to-ventilation ratio of 30:2 (C), change outcomes (O)

T: Search completed on January/5/2022

### Outcomes:

The primary outcome was favourable neurological outcomes, measured by cerebral performance or a modified Rankin Scale.

Secondary outcomes were Survival to hospital admission, survival to any time interval within hospital, survival to discharge, survival to 30 days, survival to any time interval after 30 days functional survival;

Return of spontaneous circulation (ROSC); quality of life as measured by any indicator or score.

**Type (intervention, diagnosis, prognosis):** intervention

**Additional Evidence Reviewer(s):** N/A

**Conflicts of Interest (financial/intellectual, specific to this question):** N/A

**Year of last full review:** 2017

Note: KSU performed the systematic review in 2017 and the BLS TF performed the Evidence update in 2021.

### Last ILCOR Consensus on Science and Treatment Recommendation:

Consensus on Science (2017):

The 30:2 CV ratio was compared with a different CV ratio in 2 observational cohort studies that generated very-low-quality evidence for the critical outcome of favourable neurological function (Olasveengen TM et al. Resuscitation 2009;80:407–11, Kudenchuk PJ et al. Circulation 2012;125:1787–94). In a meta-analysis of these studies, the 30:2 CV ratio demonstrated benefit for favourable neurological function (RR, 1.34[95% CI, 1.02–1.76]; RD, 1.72 percentage points [95% CI, 0.52–2.91]) compared with the CV ratio of 15:2. The quality of evidence was downgraded for serious indirectness because these studies were before-and-after investigations that evaluated the bundle-of-care interventions implemented after the “2005 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations,” (International Liaison Committee on Resuscitation. Part 2: adult basic life support: 2005 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. Resuscitation 2005;67:187–201, International Liaison Committee on Resuscitation. Part 2: adult basic life support: 2005 International Consensus on

Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. *Circulation* 2005;112(suppl):III-5–16), in which the change in CV ratio was just 1 aspect. Seven observational cohort studies provided very-low-quality evidence for the critical outcome of survival. (Olasveengen TM et al. *Resuscitation* 2009;80:407–11, Kudenchuk PJ et al. *Circulation* 2012;125:1787–94, Steinmetz J et al. *Acta Anaesthesiol Scand* 2008;52:908–13, Garza AG et al. *Circulation* 2009;119:2597–605, Sayre MR et al. *Prehosp Emerg Care* 2009;13:469–77, Robinson S et al. *Resuscitation* 2010;81:1648–51, Deasy C et al. *Resuscitation* 2011;82:984–8). The quality of evidence was downgraded for serious indirectness because the CV ratio was not the only aspect evaluated in these studies. In a meta-analysis of 6 cohort studies, the survival rate was higher in the group of patients who received 30:2 CPR compared with the group who received 15:2 CPR (RR, 1.37 [95% CI, 1.19–1.59]; RD, 2.48 percentage points [95% CI, 1.57–3.38]). (Olasveengen TM et al. *Resuscitation* 2009;80:407–11, Kudenchuk PJ et al. *Circulation* 2012;125:1787–94, Steinmetz J et al. *Acta Anaesthesiol Scand* 2008;52:908–13, Sayre MR et al. *Prehosp Emerg Care* 2009;13:469–77, Robinson S et al. *Resuscitation* 2010;81:1648–51, Deasy C et al. *Resuscitation* 2011;82:984–8). One retrospective cohort showed improved survival with the 50:2 CV ratio compared with the 15:2 ratio (RR, 1.96 [95% CI, 1.28–2.99]; RD, 21.48 percentage points [95% CI, 6.90–36.06]) (Garza AG et al. *Circulation* 2009;119:2597–605). The quality of evidence was downgraded for serious risk of bias and indirectness. Risk of bias included high risk that the cohorts were not comparable on the basis of design or analysis and moderate risk of inadequate follow-up. The study was also considered indirect because of its before-and-after design potentially evaluating several changes to practice.

#### Treatment Recommendation (2017):

We suggest a CV ratio of 30:2 compared with any other CV ratio in patients with cardiac arrest (weak recommendation, very-low-quality evidence).

#### 2017 Search Strategy:

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 ("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

## 2022 Search Strategy:

Based on the 2017 search strategies, BLS TF rerun literature review between 1 Jan 2021 to 31 December 2021.

1 exp Cardiopulmonary Resuscitation/ 20458  
 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. 24187  
 3 Resuscitation/ 27543  
 4 limit 3 to yr=1978-1991 6668  
 5 1 or 2 or 4 38123  
 6 mt.fs. 4070645  
 7 method\$.tw. 7241171  
 8 6 or 7 9632628  
 9 5 and 8 20319  
 10 randomized controlled trial.pt. 555133  
 11 (randomized or placebo).mp. 1004057  
 12 clinical trial.pt. 533117  
 13 Comparative Study.pt. 1906184  
 14 cross-over studies/ 52463  
 15 controlled clinical trial.pt. 94628



16 (time adj series).tw. 37243  
 17 (pre test or pretest or (posttest or post test)).tw. 32805  
 18 random allocation/ 106384  
 19 (controlled adj before).tw. 1399  
 20 exp epidemiologic studies/ 2855247  
 21 ((case\* adj3 control\*) or (case adj3 comparison\*) or control group\*).tw.671645  
 22 or/10-21 5659671  
 23 9 and 22 9226  
 24 (control\$ or compar\$ or random\$).tw. 8934470  
 25 9 and 24 8698  
 26 23 or 25 12060  
 27 animals/ not humans/ 4905488  
 28 26 not 27 10721  
 29 (editorial or letter).pt. 1756902  
 30 28 not 29 10563  
 31 ("18334691" or "19660833" or "16564776" or "18374452" or "20370759" or "26550795").ui. 6  
 32 30 or 31 10563  
 33 comment.pt.946599  
 34 32 not 33 10552  
 35 limit 34 to yr="2021" 1035

#### **Database searched:**

Ovid MEDLINE(R) and Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations

#### **Date Search Completed:**

5 January 2022

#### **Search Results (Number of articles identified / number identified as relevant):**

1,035 articles were identified, but no article was related.

#### **Inclusion/Exclusion Criteria:**

##### **Inclusion Criteria**

RCTs and non randomised studies (non-RCTs, interrupted time series, controlled before-and-after studies, cohort studies).

##### **Exclusion Criteria**

Study designs without a comparator group (eg, case series, cross-sectional studies), reviews, and pooled analyses.

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

No

#### **Summary of Evidence Update:**

**Evidence Update Process for topics not covered by ILCOR Task Forces**

1. 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

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:

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 (including whether meet criteria for formal review):

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

	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**

**\*\*CONFIDENTIAL DO NOT DISTRIBUTE\*\***

## 2022 Evidence Update Worksheet

**Worksheet author(s):** Olasveengen

**Task Force:** BLS Task Force

**Date Submitted:** 04.01.2022

**Worksheet ID:** 363 CPR prior to defibrillation

### PICO / Research Question:

**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 search updated to Feb 14<sup>th</sup> 2021.

**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 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).

### 2010/2015 Search Strategy:

(((((("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]))))

**2020 Search Strategy:** Pubmed search as above.

**Database searched:** Pubmed

**Date Search Completed:** 04.01.2022

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

**Inclusion/Exclusion Criteria:** Animal studies, conference abstracts, trial protocols

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

None

**Summary of Evidence Update:**

**Evidence Update Process for topics not covered by ILCOR Task Forces**

1. 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:** None

**RCT:** None

**Nonrandomized Trials, Observational Studies:** None

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

No new evidence was identified. Observational studies exploring AMSA and EtCO<sub>2</sub> guided defibrillation might be relevant for ALS.

	<b>Approval Date</b>
<b>Evidence Update coordinator</b>	
<b>ILCOR board</b>	

**\*Once approval has been made by Evidence Update coordinator, worksheet will go to ILCOR Board for acknowledgement.**

**Reference list**

**\*\*CONFIDENTIAL DO NOT DISTRIBUTE\*\***

**2022 Evidence Update Worksheet**

**Worksheet author(s):** Julie Considine

**Task Force:** BLS Task Force

**Date Submitted:** January 2022

**Worksheet ID:** BLS 366 Chest compression depth

**PICO / Research Question:**

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 PCO<sub>2</sub>) 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. Literature search updated to February 2021.

**Additional Evidence Reviewer(s):** N/A

**Conflicts of Interest (financial/intellectual, specific to this question):** Nil

**Year of last full review:** 2015

**Last ILCOR Consensus on Science and Treatment Recommendation:** Taskforce Insights (2019)

This scoping review demonstrated that the majority of studies focused on a single chest compression component, whereas a number of studies suggest the presence of confounding interactions that prompt caution when evaluating any chest compression component in isolation.

The majority of the studies identified in this review were focused on out-of-hospital cardiac arrest highlighting a major gap in research in the in-hospital context.

This scoping review has not identified sufficient new evidence to prompt new systematic review.

The information from the studies identified was considered insufficient to alter existing recommendations

## 2019 Search Strategy:

### PubMed

(((((“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 (((((((((((((((((((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 (((((((((((((((((((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]))

#### Embase

('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 '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 ('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

#### Cochrane

([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 ([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 ([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 or centimetres:ab,ti or centimeters:ab,ti or depress:ab,ti or relaxation:ab,ti

**2020 Search Strategy:** as above

**Database searched:** Medline, Embase, Cochrane

**Date Search Completed:** 15 February 2021

**Search Results (Number of articles identified / number identified as relevant):** 2

**Inclusion/Exclusion Criteria:** Unpublished studies or studies published in abstract form only, manikin studies, animal studies, and studies that did not specifically address the PICO questions related to CC rate, CC depth, chest wall recoil, and leaning were excluded.

**Link to Article Titles and Abstracts (if available on PubMed):** N/A

#### **Summary of Evidence Update:**

No new papers related to this PICOST have been identified since the 2019 scoping review.

#### **Evidence Update Process for topics not covered by ILCOR Task Forces**

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:**

Author, year	Country	Study design	Study period	Population	Intervention/exposure	Control/reference	Outcomes	Results	Comment
Nichol, 2021	United States and Canada	Retrospective cohort study	January 2007 and May 2015	Adults, EMS-treated non-traumatic OHCA treated using a	Compression depth of >51 mm or 38-51mm	Compression depth of <38mm	ROSC at ED arrival, survival to discharge	Compression depth > 51mm associated with higher risk-adjusted odds of ROSC at ED arrival	High-risk of bias. Models also adjust

				Zoll monitor/ defibrillator (n=5547)	Compression rate per 10/min			(AOR 1.21, 95% CI: 1.01, 1.47) but not survival to hospital discharge (AOR 1.25, 95% CI: 0.91, 1.71). Increasing compression rate not associated with either outcome.	for CPR fraction.
Vestergaard, 2021	Denmark	Denmark	December 2011 and November 2014	IHCA at a single centre (n=189)	Compression rate 100-120	Compression rate <100 or >120	ROSC and 30-day, 1-, 3-, and 5-year survival	Compression rate 100-120 associated with higher 30-day survival (AOR 2.04, 95% CI: 1.30, 3.18) and 3-Year survival (AOR 2.50, 95% CI: 1.23–5.08), but no effect on ROSC was observed.	High risk of bias. Models also adjust for CPR fraction.

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

Two additional observational studies were identified since the previous evidence update. The findings of these studies appear are consistent with those reported in the 2019 scoping review and 2015 ILCOR BLS CoSTR.

	<b>Approval Date</b>
<b>Evidence Update coordinator</b>	
<b>ILCOR board</b>	

**\*Once approval has been made by Evidence Update coordinator, worksheet will go to ILCOR Board for acknowledgement.**

**Reference list:**

Nichol G, Daya MR, Morrison LJ, Aufderheide TP, Vaillancourt C, Vilke GM, Idris A, Brown S. Compression depth measured by accelerometer vs. outcome in patients with out-of-hospital cardiac arrest. Resuscitation. 2021 Oct;167:95-104. doi: 10.1016/j.resuscitation.2021.07.013. Epub 2021 Jul 29. PMID: 34331984.

Vestergaard LD, Lauridsen KG, Krarup NHV, Kristensen JU, Andersen LK, Løfgren B. Quality of Cardiopulmonary Resuscitation and 5-Year Survival Following in-Hospital Cardiac Arrest. Open Access Emerg Med. 2021 Dec 16;13:553-560. doi: 10.2147/OAEM.S341479. PMID: 34938129; PMCID: PMC8687881.

## APPENDIX 1: SEARCH STRATEGY

### 1. MEDLINE

#### ***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 or centimetres:ab,ti or centimeters:ab,ti or depress:ab,ti or relaxation:ab,ti

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## **2022 Evidence Update Worksheet**

**Worksheet author(s):** Ziad Nehme

**Task Force:** BLS Task Force

**Date Submitted:** 11 January 2022

**Worksheet ID:** BLS 367 Chest wall recoil

### **PICO / Research Question:**

**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 PCO<sub>2</sub>) were ranked 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.

**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 February 2021.

**Additional Evidence Reviewer(s):** N/A

**Conflicts of Interest (financial/intellectual, specific to this question):** Nil

**Year of last full review:** 2015

### **Last ILCOR Consensus on Science and Treatment Recommendation: Taskforce Insights (2019)**

This scoping review demonstrated that the majority of studies focused on a single chest compression component, whereas a number of studies suggest the presence of confounding interactions that prompt caution when evaluating any chest compression component in isolation.

The majority of the studies identified in this review were focused on out-of-hospital cardiac arrest highlighting a major gap in research in the in-hospital context.

This scoping review has not identified sufficient new evidence to prompt new systematic review.

The information from the studies identified was considered insufficient to alter existing recommendations

### **2019 Search Strategy:**

PubMed



(((((“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 (((((((((((((((((((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 (((((((((((((((((((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]))

## Embase

('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 '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 ('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

## Cochrane

([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 ([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 ([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 or centimetres:ab,ti or centimeters:ab,ti or depress:ab,ti or relaxation:ab,ti

**2021 Search Strategy:** as above – limited to 2021-to 10 January 2022

**Database searched:** PubMed only

**Date Search Completed:** 10 January 2022

**Search Results (Number of articles identified / number identified as relevant):** Nil

**Inclusion/Exclusion Criteria:** Unpublished studies or studies published in abstract form only, manikin studies, animal studies, and studies that did not specifically address the PICO questions related to CC rate, CC depth, chest wall recoil, and leaning were excluded.

**Link to Article Titles and Abstracts (if available on PubMed):** N/A

**Summary of Evidence Update:**

Two observational studies addressing the PICO have been identified since the 2020 Evidence update. These studies are detailed below:

## Evidence Update Process for topics not covered by ILCOR Task Forces

1. 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: None

## RCT: None

## Nonrandomized Trials, Observational Studies:

Author, year	Country	Study design	Study period	Population	Intervention/exposure	Control/reference	Outcomes	Results	Comment
Nichol, 2021	United States and Canada	Retrospective cohort study	January 2007 and May 2015	Adults, EMS-treated non-traumatic OHCA treated using a Zoll monitor/defibrillator (n=5547)	Compression depth of >51 mm or 38-51mm  Compression rate per 10/min	Compression depth of <38mm	ROSC at ED arrival, survival to discharge	Compression depth > 51mm associated with higher risk-adjusted odds of ROSC at ED arrival (AOR 1.21, 95% CI: 1.01, 1.47) but not survival to hospital discharge (AOR 1.25, 95% CI: 0.91, 1.71). Increasing compression rate not associated with either outcome.	High-risk of bias. Models also adjust for CPR fraction.
Vestergaard, 2021	Denmark	Denmark	December 2011 and November 2014	IHCA at a single centre (n=189)	Compression rate 100-120	Compression rate <100 or >120	ROSC and 30-day, 1-, 3-, and 5-year survival	Compression rate 100-120 associated with higher 30-day survival (AOR 2.04, 95% CI: 1.30, 3.18) and 3-Year survival (AOR 2.50, 95% CI: 1.23–5.08), but no effect on ROSC was observed.	High risk of bias. Models also adjust for CPR fraction.

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

Two additional observational studies were identified since the previous evidence update. The findings of these studies appear are consistent with those reported in the 2019 scoping review and 2015 ILCOR BLS CoSTR.

	<b>Approval Date</b>
<b>Evidence Update coordinator</b>	
<b>ILCOR board</b>	

**\*Once approval has been made by Evidence Update coordinator, worksheet will go to ILCOR Board for acknowledgement.**

**Reference list:**

Nichol G, Daya MR, Morrison LJ, Aufderheide TP, Vaillancourt C, Vilke GM, Idris A, Brown S. Compression depth measured by accelerometer vs. outcome in patients with out-of-hospital cardiac arrest. Resuscitation. 2021 Oct;167:95-104. doi: 10.1016/j.resuscitation.2021.07.013. Epub 2021 Jul 29. PMID: 34331984.

Vestergaard LD, Lauridsen KG, Krarup NHV, Kristensen JU, Andersen LK, Løfgren B. Quality of Cardiopulmonary Resuscitation and 5-Year Survival Following in-Hospital Cardiac Arrest. Open Access Emerg Med. 2021 Dec 16;13:553-560. doi: 10.2147/OAEM.S341479. PMID: 34938129; PMCID: PMC8687881.

## APPENDIX 1: SEARCH STRATEGY

### 1. MEDLINE

#### ***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 or centimetres:ab,ti or centimeters:ab,ti or depress:ab,ti or relaxation:ab,ti



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## 2022 Evidence Update Worksheet

**Worksheet author(s):** Gavin Perkins

**Task Force:** BLS Task Force

**Date Submitted:** 4 January 2022

**Worksheet ID:** BLS 368 Foreign body airway obstruction

### 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 ( $\geq 5$  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.

PROSPERO Registration CRD42019154784

**Additional Evidence Reviewer(s):** Keith Couper

**Conflicts of Interest (financial/intellectual, specific to this question):**

Nil

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

### Last ILCOR Consensus on Science and Treatment Recommendation:

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).

## **2010/2015 Search Strategy:**

**2021 Search Strategy: See below Date Search Completed: 27 January 2021**

**Database searched: Medline, Cochrane, Embase**

**2022 Search Strategy: See below Date Search Completed: 5 January 2022**

**Database searched: Medline, Cochrane, Embase**

## **Search Results (Number of articles identified / number identified as relevant):**

**Medline 34/1**

**Cochrane 15/0**

**Embase 21/0**

**Inclusion/Exclusion Criteria: As above**

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

<https://pubmed.ncbi.nlm.nih.gov/32949674/>

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7793855/>

<https://pubmed.ncbi.nlm.nih.gov/31745894/>

<https://pubmed.ncbi.nlm.nih.gov/33036850/>

<https://pubmed.ncbi.nlm.nih.gov/33600858/>

## **Summary of Evidence Update:**

### **Evidence Update Process for topics not covered by ILCOR Task Forces**

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

Organisation (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations
ILCOR  Couper 2020	<u>Systematic review</u>	<u>As above</u>	<u>69</u>	For all interventions and associated outcomes, evidence certainty was very low. Early removal of FBAO by bystanders was associated with improved neurological survival (odds ratio 6.0, 95% confidence interval 1.5 to 23.4). Identified evidence showed that key interventions (back blows, abdominal thrusts, chest thrusts/compressions, Magill forceps, manual removal of obstructions from the mouth, suction-based airway clearance devices) are effective in relieving FBAO. We identified reports of harm in relation to back blows, abdominal thrusts, chest thrusts/compressions, and blind finger sweeps.	<u>As above</u>

RCT:

Nil

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>	
Bhanderi 2020	Case series	<ul style="list-style-type: none"> <li>Care home management and staff involved in choking incident completed and returned PMCF form</li> <li>Care home management and staff consent to allow the research team access to site</li> <li>Care home staff able and</li> </ul>	<p>FBAO removal</p> <p>Airway clearance device successful at removal of FBAO in 26/27 cases (96% (95% CI 81.0% to 99.9%))</p> <p>Adverse events:</p> <p>Mouth bleeding reported in 2 out of 4 interviews. One case probably related, the other case causation uncertain.</p>	<p>Case series reporting on 27 cases of use of airway clearance device.</p> <p>Retrospective design, use limited to nursing homes. Data obtained from Post Market Clinical Follow-Up (PMCF) Forms.</p> <p>Independent research funded by the device manufacturer</p>

		<p>willing to participate in semi-structured interviews</p> <ul style="list-style-type: none"> <li>• Care home consent to allow the research team access to incident report book/system.</li> <li>• Exclusion Criteria</li> <li>• Care home lack of consent to participate</li> <li>• Care home staff did not consent to participate.</li> </ul>		
Gutierrez 2020	Case report			Case report of gastric perforation after abdominal thrust
Pawlukiewicz 2020	Case report			Cholesterol embolization syndrome resulting in ischaemic leg of person providing abdominal thrusts.
Norii 2021	Case series	<p>Multi-center Observational Choking Investigation retrospective registry (MOCHI-retro) from 2014 to 2019 searched for cases with reported vacuum cleaner use.</p> <p>8 cases (2.1%) identified</p>	<p>Successful FBAO removal</p> <p>3/8 (37.5%)</p> <p>Favourable neurological outcome</p> <p>3/8 (37.5%)</p> <p>Adverse events</p>	

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

2020 – 1 new case series (27 cases) post market surveillance report of suction based airway clearance device. Two case reports describing injuries following abdominal thrusts.

2021 – single new case series identified which describes 8 cases of the use of a vacuum cleaner to clear FBAO

Two case series excluded as conference abstracts out of scope for this review. [Brody 2021 S9; Gal 2021 412]

In sufficient new evidence to warrant updating current systematic review and CoSTR.

	<b>Approval Date</b>
<b>Evidence Update coordinator</b>	
<b>ILCOR board</b>	

**\*Once approval has been made by Evidence Update coordinator, worksheet will go to ILCOR Board for acknowledgement.**

**Reference list**

1: Couper K, Abu Hassan A, Ohri V, Patterson E, Tang HT, Bingham R, Olasveengen T, Perkins GD; International Liaison Committee on Resuscitation Basic and Paediatric Life Support Task Force Collaborators. Removal of foreign body airway obstruction: A systematic review of interventions. Resuscitation. 2020 Nov;156:174-181. doi: 10.1016/j.resuscitation.2020.09.007. Epub 2020 Sep 16. PMID: 32949674.

2.Pawlukiewicz AJ, Merrill DR, Griffiths SA, Frantz G, Bridwell RE. Cholesterol embolization and arterial occlusion from the Heimlich maneuver. Am J Emerg Med. 2021 May;43:290.e1-290.e3. doi: 10.1016/j.ajem.2020.09.079. Epub 2020 Sep 30. PMID: 33036850.

3. Gutierrez A, Strickland M. Gastric Perforation After Abdominal Thrusts for Choking: a Case of Heimlich Harm. *J Gastrointest Surg.* 2020 Jul;24(7):1704-1706. doi: 10.1007/s11605-019-04451-2. Epub 2019 Nov 19. PMID: 31745894.
- 4.: Bhanderi BG, Palmer Hill S. Evaluation of DeChoker, an Airway Clearance Device (ACD) Used in Adult Choking Emergencies Within the Adult Care Home Sector: A Mixed Methods Case Study. *Front Public Health.* 2020 Dec 9;8:541885. doi: 10.3389/fpubh.2020.541885. PMID: 33425826; PMCID: PMC7793855.
5. Norii T, Igarashi Y, Braude D, Sklar DP. Airway foreign body removal by a home vacuum cleaner: Findings of a multi-center registry in Japan. *Resuscitation.* 2021 May;162:99-101. doi: 10.1016/j.resuscitation.2021.02.006. Epub 2021 Feb 15. PMID: 33600858.

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## 2022 Evidence Update Worksheet

**Worksheet author(s):** Takanari Ikeyama

**Task Force:** BLS Task Force

**Date Submitted:** 2022/01/15

**Worksheet ID:** 370 Firm surface for CPR

### **PICO / 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:** Survival, survival with a favourable neurological outcome, ROSC, CPR quality

**Type (intervention, diagnosis, prognosis):** Intervention

**Additional Evidence Reviewer(s):**

**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:**

**2010/2015 Search Strategy:**

**2019 Search Strategy:**

**Database searched:** PubMed

**Date Search Completed:** 2022/01/15

**Search Results (Number of articles identified / number identified as relevant):**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) are eligible for inclusion. Randomised manikin / simulation / cadaver studies will only be included if insufficient human studies are identified. Unpublished studies (e.g., conference abstracts, trial protocols), non-randomised manikin / simulation / cadaver studies, animal studies, experimental / lab models, mathematical models, narrative reviews, editorials and opinions with no primary data were excluded.

**Timeframe:** 5<sup>th</sup> Feb 2021 to 15<sup>th</sup> Jan 2022

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

<https://pubmed.ncbi.nlm.nih.gov/34893397/>

<https://pubmed.ncbi.nlm.nih.gov/34185864/>

<https://pubmed.ncbi.nlm.nih.gov/33884701/>

**Summary of Evidence Update:**

**Evidence Update Process for topics not covered by ILCOR Task Forces**



1. 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

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:

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
Effect of a backboard on chest compression quality during in-hospital adult cardiopulmonary resuscitation: A randomised, single-blind, controlled trial using a manikin model: Cuvelier Z; 2021	<b>Study Aim:</b> To evaluate the effect of a backboard on compression depth, rate and chest recoil performed by nurses <b>Study Type:</b> Single-blinded, randomised, controlled, manikin study (n=120)	<b>Inclusion Criteria:</b> self-learning nurses retrained to achieve a minimal combined compression score (depth target 50-60mm, AND release target ≤5mm AND compression target 100-120bpm) at baseline	<b>Intervention:</b> backboard <b>Comparison:</b> No backboard	<b>1° endpoint:</b> 47.5%(backboard) vs 41.0%(control) (p=0.475) achieved combined compression score of ≥ 70%	<b>Study Limitations:</b> Manikin study, high drop-out rate (158/278)

<b>Efficacy of Chest Compressions Performed on Patients in Dental Chairs Versus on the Floor: Shimizu Y; 2021</b>	<p><b><u>Study Aim:</u></b> to investigate the characteristics of chest compressions performed in dental chairs with 2 different structural support designs (DC-A, DC-B) and on the floor</p> <p><b><u>Study Type:</u></b> Single-blinded, randomised, controlled, manikin study (n=44)</p>	<p><b><u>Inclusion Criteria:</u></b> sixth-year dentistry students with CPR training at the dental school</p>	<p><b><u>Intervention:</u></b> floor</p> <p><b><u>Comparison:</u></b> 2 different structural support designs (DC-A, DC-B)</p>	<p><b><u>1° endpoint:</u></b> The percentage of net chest compression depths <math>\geq 5</math> cm for each group were <math>1 \pm 8\%</math> (DC-A), <math>8 \pm 22\%</math> (DC-B), and <math>32 \pm 38\%</math> (floor) (<math>p \leq 0.001</math>, ANOVA)</p>	<p><b><u>Study Limitations:</u></b> Manikin study</p>
<b>Effect of a dynamic mattress on chest compression quality during cardiopulmonary resuscitation; Torsy T; 2021</b>	<p><b><u>Study Aim:</u></b> To examine the effect of an inflated dynamic overlay mattress on chest compression quality during CPR and to explore the predictive effect of health care providers' anthropometric factors, hand positioning and mattress type on chest compression frequency and depth.</p>	<p><b><u>Inclusion Criteria:</u></b> Nursing students</p>	<p><b><u>Intervention:</u></b> viscoelastic foam mattress (relatively hard)</p> <p><b><u>Comparison:</u></b> inflated dynamic overlay mattress on top of a viscoelastic foam mattress (softer)</p>	<p><b><u>1° endpoint:</u></b> The mean difference in chest compression depth deeper by 2.86 mm (<math>P = .043</math>) in intervention group.</p>	<p><b><u>Study Limitations:</u></b> Manikin study</p>

	<b><u>Study Type:</u></b> Single-blinded, randomised, controlled, manikin study (N = 70)				
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#### 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)
	<b><u>Study Type:</u></b>	<b><u>Inclusion Criteria:</u></b>	<b><u>1° endpoint:</u></b>	

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

Three additional manikin RCTs identified, evaluating CPR quality with a backboard, (Cuvelier 2021 103164) on a dentist chair (2021 85) and on a dynamic mattress. (Torsy 2021). No need for new systematic review.

	<b>Approval Date</b>
<b>Evidence Update coordinator</b>	
<b>ILCOR board</b>	

**\*Once approval has been made by Evidence Update coordinator, worksheet will go to ILCOR Board for acknowledgement.**

## Reference list

Cuvelier Z, Houthoofd R, Serraes B, Haentjens C, Blot S, Mpotos N. Effect of a backboard on chest compression quality during in-hospital adult cardiopulmonary resuscitation: A randomised, single-blind, controlled trial using a manikin model. *Intensive Crit Care Nurs.* 2021 Dec 7;103164. doi: 10.1016/j.iccn.2021.103164

Shimizu Y, Sadamori T, Saeki N, Mukai A, Doi M, Oue K, Yoshida M, Irifune M. Efficacy of Chest Compressions Performed on Patients in Dental Chairs Versus on the Floor. *Anesth Prog.* 2021 Jun 1;68(2):85-89. doi: 10.2344/anpr-68-01-07.

Torsy T, Deswarte W, Karlberg Traav M, Beeckman D. Effect of a dynamic mattress on chest compression quality during cardiopulmonary resuscitation. *Nurs Crit Care.* 2021 Apr 21. doi: 10.1111/nicc.12631.

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## 2022 Evidence Update Worksheet BLS 372 and BLS 547

**Worksheet author(s):** Peter J. Kudenchuk, MD

**Task Force:** BLS

**Date Submitted:** 12/7/2021

**Worksheet ID:** BLS 372 and BLS 547 HO-CPR

**PICO / Research Question:** 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.

**Type (intervention, diagnosis, prognosis):** Intervention

**Additional Evidence Reviewer(s):** NA

**Conflicts of Interest (financial/intellectual, specific to this question):** None

**Year of last full review: 2010 / 2015 / New question:** thru November 2021

**Last ILCOR Consensus on Science and Treatment Recommendation:** 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)

**2010/2015 Search Strategy:** NA

**2019 Search Strategy:** Same terms and database as that used for 2020 Guidelines

**Database searched:** KSU search strategy (same terms and database as for 2020 Guidelines) that was provided by Dr. Olasveengen for covering the dates 1/1/2020-1/28/21. A subsequent search covering articles published in 2021 through 11/30/21 used the broad search terms “(resuscitation or CPR) and (chest compression or ventilation or mouth-to-mouth) and (2021)” within PubMed.

**Date Search Completed:** 1/1/2020- 1/28/2021; and 1/1/2021 - 11/30/2021.

**Search Results (Number of articles identified / number identified as relevant):** The original search (through 1/1/2020-1/28/2021) produced 815 articles only a few of which were relevant to the PICOST → 1 “trial

sequence analysis review” assessed survival outcome; 1 evaluated 30 day neurological outcome; 2 evaluated bystander CPR quality in manikin. A subsequent search (1/1/2021-11/30/2021) retrieved 2607 articles most of which (given the broad categories of the search) were not relevant to the PICOST, yielding → 1 meta-analysis that evaluated ROSC, survival to hospital admission, survival to hospital discharge and survival to hospital discharge with CPC 1-2; 1 observational study evaluated ROSC, survival to hospital discharge and 30 day survival; 1 observational study that evaluated 1 month survival and 1 month neurologically intact survival (CPC 1-2); and 1 randomized CPR training trial.

Thus the inclusive search spanning 1/1/2020 – 11/30/2021 produced a total of 8 relevant articles.

**Inclusion/Exclusion Criteria:** **Inclusion** - Manikin and clinical studies addressing adult resuscitation  
**Link to Article Titles and Abstracts (if available on PubMed):** See reference list below

### Summary of Evidence Update:

#### Evidence Update Process for topics not covered by ILCOR Task Forces

1. This evidence update process is only applicable to PICO(s) which are *not* being reviewed as ILCOR systematic and scoping reviews.
2. New information provides additional insights but not sufficient to change 2020 recommendations.

### 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
Ivan; 2020	Bystander chest compression only versus standard resuscitation in out-of-hospital cardiac arrest	BLS 372 and BLS 547	3 (addressed Hallstrom, Rea and Svensson randomized trials)	Updated systematic review and meta-analysis of randomized human trials between 1985-2019 addressing the question identified 3 such trials. Pooled results from these 3 trials found a risk ratio of 1.21 (1.01, 1.46) favoring chest	Current randomized trial evidence is insufficient to establish the superiority of one CPR method over the other.

				compression-only CPR over conventional CPR. However trial sequence analysis determined combined trial results had a risk of type 1 error of 10-30% and were therefore inconclusive. An additional 1300 patients would be needed in future randomized trials to establish conclusive results.	
Bielski; 2021	Meta-analysis of conventional CPR vs chest compression only bystander CPR in adults	BLS 372 and BLS 547	3 randomized controlled trials; 12 nonrandomized studies. One of these nonrandomized studies was erroneously included as it addressed EMS not bystander CPR and in addition did not strictly address CC-only CPR without ventilation in that treatment arm.	Survival to hospital discharge (SHD) with std CPR 10.2% vs 9.3% CCC (OR = 1.04; 95% CI: 0.93–1.16; p = 0.46). SHD with good neurological outcome by (CPC 1 or 2) std CPR 6.5% vs. 5.8% CCC (OR = 1.00; 95% CI: 0.84–1.20; p = 0.98). Prehospital return of spontaneous circulation	No significant differences in resuscitation outcome with standard CPR (std CPR) versus chest compression only CPR (CCC).

				(ROSC) std CPR 15.9% vs 14.8% CCC (OR = 1.13; 95% CI: 0.91–1.39; p = 0.26). Survival to hospital admission with ROSC std CPR 29.5% vs 28.4% CCC (OR = 1.20; 95% CI: 0.89– 1.63; p = 0.24).	
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**RCT:**

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

**Randomized non-clinical trials**

<b>Study Acronym; Author; Year Published</b>	<b>Aim of Study; Study Type; Study Size (N)</b>	<b>Patient Population</b>	<b>Study Intervention (# patients) / Study Comparator (# patients)</b>	<b>Endpoint Results (Absolute Event Rates, P value; OR or RR; &amp; 95% CI)</b>	<b>Relevant 2° Endpoint (if any); Study Limitations; Adverse Events</b>
Adequate CPR performance by bystanders with various pauses	<u><b>Study Aim:</b></u> Determine whether incorporating intentional	n= 517 laypersons trained in BLS/AED and randomized	<u><b>Intervention:</b></u> 3 CPR protocols of 30 chest compressions	<u><b>1° endpoint:</b></u> Primary endpoint was % of CC with adequate depth; secondary	Pauses (potentially for breaths) may result in higher CC with correct depth but at expense of



between chest compressions vs continuous chest compressions; Baldi; 2020	<p>interruptions of different frequency and duration improves layperson CPR quality compared to compression-only CPR</p> <p><b><u>Study Type:</u></b> Randomized manikin trial comparing 3 CPR protocols of 30 chest compressions (CC) with 2 second pause; 50 CC with 5 second pause and 100 CC with 10 second pause conducted for 8 minutes in 517 laypersons, using Laerdal REsusc Anne QCPR manikin.</p>	1:1:1:1 to the various CPR protocols (n=129-130 per group)	<p>(CC) with 2 second pause; 50 CC with 5 second pause and 100 CC with 10 second pause conducted for 8 min</p> <p><b><u>Comparison:</u></b> Endpoint measures evaluated between each CPR strategy</p>	<p>endpoints chest compression fraction (CCFx%), compression rate, interruptions &gt; 10 seconds and correct hand position.</p> <p><b><u>Results:</u></b> Adequate depth 30cc:2s 96%; 50cc:5s 96%; 100cc:10s 92%; CCC 79% (p=0.006). Compared to CCC vs 30cc:2s p=0.023; CCC vs 50cc:5s p=0.003; CCC vs 100cc:10s p=0.07. Higher CCFx% in CCC group (p&lt;0.001) and higher rate pauses &gt;10 sec in 100cc:10s. NSD in CC rate or leaning/recoil or hand position.</p>	chest compression fraction. However study did not take the “work of breaths” into account – which could have altered reported outcomes. Thus findings are non-definitive for interposed breathing versus continuous chest compression CPR on CPR metrics.
Flow-chart assisted CPR using standard versus continuous chest compression CPR; Rossler; 2020	<p><b><u>Aim:</u></b> Chest compressions more correctly delivered in flowchart-assisted resuscitation using standard CPR than chest compression-only algorithm.</p> <p><b><u>Study type:</u></b> Randomized manikin trial</p>	84 adult laypersons randomized to flow-chart assisted standard vs chest compression only CPR (n=41 per group) for 5 minute period.	<p><b><u>Intervention:</u></b> Standard versus chest compression only CPR. CPR quality assessed by Laerdal Skill Reporting System.</p>	<p><b><u>1° endpoint:</u></b> Total number of CCs achieving correct depth 5-6 cm; secondary endpoints included hands-off-time, time to administration of CCs, total number of CCs, relative number of correct CCs (by depth), CCs &gt; 5 cm,</p>	The findings suggest no difference in CPR quality between the two CPR strategies apart from shorter hands-off time. Limitation of trial was manikin-based and relatively small in size to detect

				<p>average compression rate.</p> <p><b>Results:</b> Total number of “correct” (5-6 cm depth) CCs did not differ between the two groups; neither did average depth of CC, number of CCs &gt;5 cm, CC rate per minute, recoil, time to exhaustion or level of exhaustion. Total hands off time was shorter in the chest compression-only group than in standard CPR group.</p>	<p>differences (underpowered).</p>
<p>Comparison of long-term effects chest compression-only vs conventional CPR training on CPR skills in police officer responders; Cho; 2021</p>	<p><b>Aim:</b> Compare the quality of CPR skills immediately after and 3 months after training.</p> <p><b>Study type:</b> Randomized training trial</p>	<p>n= 119 police officers randomized to a training program including theoretical education, chest compressions practice and AED operation training (n=59); vs the addition of pocket mask ventilations practice (n=60)</p>	<p><b>Intervention:</b> Standard versus chest compression only CPR. CPR training, with subsequent skills reassessment</p>	<p><b>1° endpoint:</b> Evaluation of chest compression rate, depth, rate, recoil and chest compression position immediately post training and at 3 months.</p> <p><b>Results:</b> Good quality skills without differences between groups immediately after training. At 3 months post training overall skill performance (multiple linear</p>	<p>Immediate post training CPR skills were comparable in police trained in CCC vs conventional CPR, but favored CCC training at 3 months. Chest compression-only CPR training results in better retained CPR skills than conventional CPR training.</p>

				regression analysis) was 28.15% higher in the CC-only training module recipients.	
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### 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)
Standard vs chest compression only CPR by bystanders in non-asphyxial and asphyxial cardiac arrest; Javaudin; 2020	<b>Study Type:</b> Observational n=8541 OHCA; n=6742 non-asphyxial including n=5904 of cardiac etiology and 1799 asphyxial.	<b>Inclusion Criteria:</b> Adult, nontraumatic OHCA that were bystander witnessed with bystander CPR prior to EMS arrival	<b>1° outcome measure:</b> 30 day neurological outcome (CPC $\leq$ 2) stratified by asphyxia, non-asphyxial and cardiac causes.	No significant difference in 30 day neurological status between the two CPR methods.
Standard vs chest compression only CPR by bystanders from European Registry of Cardiac Arrest. Wnent; 2021	<b>Study Type:</b> Observational n=5884 OHCA; n=1362 standard CPR n=4044 CCC; n=478 unknown.	<b>Inclusion Criteria:</b> Adult, nontraumatic OHCA where type of CPR by bystanders could be differentiated	<b>Outcome measures:</b> ROSC, survival to hospital discharge; 30 day survival mainly in adults (1-3% were <19 yrs old). ROSC achieved in 26% CC vs 35% with Full CPR (difference 8.6%; 95% CI 5.7%, 11.5%; $p < 0.001$ ). Survival to hospital discharge 8% CC only vs 13% in standard CPR; adjusted odds ratio (age, sex, location, cause, rhythm, time on scene, witnessed and country) 1.46 (95% CI 1.17, 1.83) favored full CPR.	Adjusted survival outcome favored standard CPR
Instruction in conventional	<b>Study Type:</b>	<b>Inclusion Criteria:</b>	<b>Outcome measures:</b>	Nationwide population based study found

CPR (30:2) versus chest compression-only CPR by dispatchers in adults with bystander-witnessed out of hospital cardiac arrest. Goto; 2021	Observational n=24,947 adult bystander-witnessed OHCA; n=2169 standard CPR n=22,778 CCC with propensity matching.	Adult, bystander-witnessed OHCA who received dispatch CPR instructions, which was discretionary as to type (conventional vs chest compression only). Propensity matching was performed in 4,338 patients (2,169 patients in each treatment group)	Before propensity matching 1 month survival outcome observed in 11.3% conventional vs 10.5% CC only CPR (p=0.37) and 1 month CPC 1-2 in 7.5% conventional vs 5.8% CC only CPR (p<0.01). After propensity matching, 1 month survival in 11.3% vs 10.9% (p=0.74) and 1 month CPC 1-2 in 7.5% vs 5.7% (p<0.05) in conventional vs CC only CPR groups respectively. Adjusted OR pre-propensity matching for 1 month survival 1.09 (0.93, 1.28), p=0.28; for 1 month CPC 1-2 1.39 (1.14, 1.70) p<0.01 favoring conventional CPR. Adjusted OR post-propensity matching for 1 month survival 0.98 (0.79, 1.21) p=0.87 and 1 month CPC1-2 1.34 (1.01, 1.79) p<0.05 favoring conventional CPR.	conventional CPR with 30:2 ventilation ratio was associated with significantly improved neurologically intact survival with pre and post propensity score matching; but not in 1 month survival.
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**Reviewer Comments (including whether meet criteria for formal review):** Of the 8 articles reviewed between 1/1/2020 and 11/30/2021:

- Two manikin trials addressed CPR quality with interrupted versus continuous chest compression CPR. One found improved chest compression depth when there were interposed pauses (simulating when ventilations might be interposed) at the expense of a lower chest compression fraction. The other did not find definitive differences in CPR quality between the two approaches apart from a shorter “hands off period” with continuous compression CPR.
- One randomized trial comparing CC-only versus standard CPR training among police officers found better CPR skills performance at 3 months among those trained in CC-only.
- Reassessment of the pooled results from 3 randomized clinical trials were inconclusive of a benefit of one CPR strategy over the other.

- A large observational study observed no difference in 30 day neurological outcome between the differing CPR strategies regardless of whether the arrest was due to asphyxia, non-asphyxial or cardiac causes.
- A meta-analysis covering 3 randomized controlled trials (Hallstrom 2000, Rea 2010, Svensson 2010) and 12 nonrandomized studies (dated 2001-2021) found no significant differences in immediate, short-term or long-term outcomes between conventional CPR and chest-compression only by bystanders.
- However, 2 additional large observational studies observed significantly improved survival (1 study) and neurologically favorable survival (1 study).
- Of note, the recent search also uncovered 2 observational studies comparing a conventional versus continuous chest compression dispatch-assisted CPR approach in the pediatric population (outside the scope of this PICOST). The findings from these two studies suggested that dispatcher-assisted conventional CPR resulted in a higher neurologically intact survival compared to dispatch-assisted compression only CPR. In one of these studies outcomes between the two CPR approaches did not differ when cardiac arrest presented as a shockable rhythm as well as under other conditions, suggesting outcomes could differ depending on the circumstances surrounding the cardiac arrest.

Taken together, these findings (particularly those of the two large observational studies in adults) encourage continued tracking of this body of literature and possible consideration of a future formal review should more evidence accrue challenging the current practice of dispatch-assisted continuous chest compression CPR. For now, the interim information is insufficient to change 2020 recommendations in adults, which has been based on randomized trials, and allows for either chest compression only CPR or chest compressions with ventilation depending on the skill and willingness of providers.

	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

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Hallstrom A, Cobb L, Johnson E, Copass M. Cardiopulmonary resuscitation by chest compression alone or with mouth-to-mouth ventilation. N Engl J Med. 2000;342(21):1546–53.

Rea TD, Fahrenbruch C, Culley L, Donohoe RT, Hambly C, Innes J, Bloomingdale M, Subido C, Romines S, Eisenberg MS. CPR with chest compression alone or with rescue breathing. *N Engl J Med*. 2010;363(5):423–33.

Svensson L, Bohm K, Castrén M, Pettersson H, Engerström L, Herlitz J, Rosenqvist M. Compression-only CPR or standard CPR in out-of-hospital cardiac arrest. *N Engl J Med*. 2010;363(5):434–42.

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Rosler B, Goschin J, Malezcek M, Priinger F, Thell R, Mittlbock M, Schebesta K. Providing the best chest compression quality: Standard CPR versus chest compressions only in a bystander resuscitation model. *Plos One*; 2020 <http://doi.org/10.1371/journal.pone.0.228702>.

Bielski K, Smereka J, Chmielewski J, Pruc M, Chirico F, Gasecka A, Litvinova N, Jaguszewski MJ, Nowak-Starz G, Rafique Z, Peacock FW, Szarpak L. Meta-analysis of chest compression-only versus conventional cardiopulmonary resuscitation by bystanders for adult with out-of-hospital cardiac arrest. *Cardiology J* 2021; DOI: 10.5603/CJ.a2021.0115 DOI: 10.5603/CJ.a2021.0115

Wnent J, Tjelmeland I, Lefering R, Koster RW, Maurer H, Masterson S, Herlitz J, Böttiger BW, Ortiz FR, Perkins GD, Bossaert L, Moertl M, Mols P, Hadibegovic I, Truhlar A, Salo A, Baert V, Nagy E, Cebula G, Raffay V, Trenkler S, Markota A, Stroömsöe A, Graßner JT. To ventilate or not to ventilate during bystander CPR - A EuReCa TWO analysis. *Resuscitation*. 2021; 166:101-9.

Goto Y, Funada A, Maeda T, Goto Y. Dispatcher instructions for bystander cardiopulmonary resuscitation and neurologically intact survival after bystander-witnessed out-of-hospital cardiac arrests: A nationwide, population-based observational study. *Crit Care* 2021;25:408 <https://doi.org/10.1186/s13054-021-03825-w>

Cho BJ, Kin SR. Comparison of long-term effects between chest compression-only CPR training and conventional CPR training on CPR skills among police officers. *Healthcare* 2021;9:34. <https://doi.org/10.3390/healthcare9010034>

Pediatric studies (outside the scope of the current PICOST):

Goto Y, Funada A, Maeda T, Goto Y. Dispatcher-assisted conventional cardiopulmonary resuscitation and outcomes for paediatric out-of-hospital cardiac arrests. *Resuscitation* 2021 <https://doi.org/10.1016/j.resuscitation.2021.10.003>

Naim MY, Griffis HM, Berg RA, Bradley RN, Burke RV, Markenson D, McNally BF, Nadkarni VM, Song L, Vellano K, Vetter V, Fossano JW. Compression-only versus rescue-breathing cardiopulmonary resuscitation after pediatric out-of-hospital cardiac arrest. *J Am Coll Cardiol* 2021;78:1042-52.

**\*\*CONFIDENTIAL DO NOT DISTRIBUTE\*\*****2022 Evidence Update Worksheet****Worksheet author(s):** Olasveengen**Task Force:** BLS Task Force**Date Submitted:** 04.01.2022**Worksheet ID:** BLS 373 Analysis of rhythm during chest compression**PICO / Research Question:****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  $\geq 5$  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 Feb 14, 2020.**Outcomes:** Any survival and CPR quality metrics.**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 suggest against the routine use of artifact-filtering algorithms for analysis of electrocardiographic rhythm during CPR (weak recommendation, very-low-certainty evidence).

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).

**2010/2015 Search Strategy:**

((((((((((("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]))))

**2020 Search Strategy:** Same**Database searched:** Pubmed**Date Search Completed:** 04.01.2022**Search Results (Number of articles identified / number identified as relevant):** 2**Inclusion/Exclusion Criteria:** Animal studies and unpublished studies (e.g., conference abstracts, trial protocols) are excluded.**Link to Article Titles and Abstracts (if available on PubMed):**<https://pubmed.ncbi.nlm.nih.gov/33460749/><https://pubmed.ncbi.nlm.nih.gov/33524490/>**Summary of Evidence Update:****Evidence Update Process for topics not covered by ILCOR Task Forces**

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**

<b>Study Acronym; Author; Year Published</b>	<b>Study Type/Design; Study Size (N)</b>	<b>Patient Population</b>	<b>Primary Endpoint and Results (include P value; OR or RR; &amp; 95% CI)</b>	<b>Summary/Conclusion Comment(s)</b>
De Graaf 2021	<u>Study Type:</u>  Observational (before and after) (n=890)	<u>Inclusion Criteria:</u>  Cardiac arrest victims treated by Amsterdam Police and Fire Fighters between 2016-2017 (control) and 2018-2019 (intervention).	<u>1° endpoint:</u>  Sensitivity of the intervention AED was 96%, (LCL 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%, $P < 0.001$ ).	CONCLUSION: Compared to conventional AEDs, cprINSIGHT leads to a significantly shorter pre-shock pause and a significant increase in CCF.
Didon 2021	Observational (n=2916)	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).	"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

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

The last title screening performed last year identified two observational studies evaluating analysis during compressions in clinical settings. These are the first two clinical studies identified, and this topic should therefore be prioritized for full systematic review.

	<b>Approval Date</b>
<b>Evidence Update coordinator</b>	
<b>ILCOR board</b>	

**\*Once approval has been made by Evidence Update coordinator, worksheet will go to ILCOR Board for acknowledgement.**

### **Reference list**

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.

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.

**\*\*CONFIDENTIAL DO NOT DISTRIBUTE\*\*****2022 Evidence Update Worksheet****Worksheet author(s):** Christopher M Smith**Task Force:** BLS Task Force**Date Submitted:** 11<sup>th</sup> January 2022**Worksheet ID:** BLS 374 Alternative compression techniques**PICO / Research Question:**

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 favourable 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>

**Outcomes:**

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

**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:****Last ILCOR Consensus on Science and Treatment Recommendation:**

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 bradycardia 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 (2019) Search Strategy:**

### **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

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

There were 23 included studies (cough CPR n=4; percussion pacing n=4; precordial thump n=16), of which one study reported on both cough CPR and precordial thump.

**Inclusion/Exclusion Criteria:**

We included RCTs, non-randomised studies, case series with at least five cases. We considered papers in all languages provided there was an English language abstract available for review.

We excluded unpublished studies, conference abstracts, manikin or simulation studies, narrative reviews, editorials or opinions with no primary data, animal studies and experimental / lab models

We set no time limits on our searches

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

Niemann J.T., Rosborough J., Hausknecht M., Brown D., Criley J.M. Cough-CPR: documentation of systemic perfusion in man and in an experimental model: a "window" to the mechanism of blood flow in external CPR. Crit Care Med. 1980;8:141-6

Caldwell G., Millar G., Quinn E. Simple mechanical methods for cardioversion: Defence of the precordial thump and cough version. Br Med J (Clin Res Ed). 1985;291:627-30.

Petelenz T., Iwinski J., Chlebowczyk J., Czyz Z., Flak Z., Fiutowski L., et al. Self-administered cough cardiopulmonary resuscitation (c-CPR) in patients threatened by MAS events of cardiovascular origin. Wiad Lek. 1998;51:326-36.

Marozsán I., Albared J.L., Szatmáry L.J. Life-threatening arrhythmias stopped by cough. Cor Vasa. 1990;32:401-8

Percussion Pacing

Klumbies A., Paliege R., Volkmann H. Mechanical emergency stimulation in asystole and extreme bradycardia. Z Gesamte Inn Med. 1988;43:348-52.

Scherf D., Bornemann C. Thumping of the precordium in ventricular standstill. Am J Cardiol. 1960;5:30-40.

Iseri L.T., Allen B.J., Baron K., Brodsky M.A. Fist pacing, a forgotten procedure in bradyasystolic cardiac arrest. Am Heart J. 1987;113:1545-50.

Paliege R., Volkmann H., Klumbies A. The first as pace maker for the heart. Investigations about mechanical emergency pacing of the heart. Deut Gesundheitswes. 1982;37:1094-100

## Precordial Thump

Caldwell G., Millar G., Quinn E. Simple mechanical methods for cardioversion: Defence of the precordial thump and cough version. *Br Med J (Clin Res Ed)*. 1985;291:627-30.

Nehme Z., Andrew E., Bernard S.A., Smith K. Treatment of monitored out-of-hospital ventricular fibrillation and pulseless ventricular tachycardia utilising the precordial thump. *Resuscitation*. 2013;84:1691-6.

Pellis T., Kette F., Lovisa D., Franceschino E., Magagnin L., Mercante W.P., et al. Utility of pre-cordial thump for treatment of out of hospital cardiac arrest: a prospective study. *Resuscitation*. 2009;80:17-23.

Gertsch M., Hottinger S., Hess T. Serial chest thumps for the treatment of ventricular tachycardia in patients with coronary artery disease. *Clin Cardiol*. 1992;15:181-8.

Rajagopalan R.S., Appu K.S., Sultan S.K., Jagannadhan T.G., Nityanandan K., Sethuraman S. Precordial thump in ventricular tachycardia. *J Assoc Physicians India*. 1971;19:725-9.

Miller J., Tresch D., Horwitz L., Thompson B.M., Aprahamian C., Darin J.C. The precordial thump. *Ann Emerg Med*. 1984;13:791-4.

Haman L., Parizek P., Vojacek J. Precordial thump efficacy in termination of induced ventricular arrhythmias. *Resuscitation*. 2009;80:14-6.

Amir O., Schliamser J.E., Nemer S., Arie M. Ineffectiveness of precordial thump for cardioversion of malignant ventricular tachyarrhythmias. *Pacing Clin Electrophysiol*. 2007;30:153-6.

Nejima J. Clinical features and treatment of ventricular tachycardia associated with acute myocardial infarction. *Nihon Ika Daigaku Zasshi*. 1991;58:40-9.

Volkman H., Klumbies A., Kuhnert H., Paliege R., Dannberg G., Siegert K. Terminating ventricular tachycardias by mechanical cardiac pacing by means of precordial thumps. *Z Kardiologie*. 1990;79:717-24.

Miller J., Addas A., Akhtar M. Electrophysiology studies: Precordial thumping patients paced into ventricular tachycardia. *J Emerg Med*. 1985;3:175-9.

Cotoi S., Moldovan D., Carasca E. Precordial thump in the treatment of cardiac arrhythmias (electrophysiologic considerations). *Physiologie*. 1980;17:285-8.

Morgera T., Baldi N., Chersevani D., Medugno G., Camerini F. Chest thump and ventricular tachycardia. *Pacing Clin Electrophysiol*. 1979;2:69-75.

Befeler B. Mechanical stimulation of the heart. Its therapeutic value in tachyarrhythmias. *Chest*. 1978;73:832-8.

Rahner E., Zeh E. Regulation of ventricular tachycardia with precordial fist blow. Med Welt. 1978;29:1659-63.

Pennington J.E., Taylor J., Lown B. Chest thump for reverting ventricular tachycardia. N Engl J Med. 1970;283:1192-5

### Summary of Evidence Update:

Searches were previously updated on 16<sup>th</sup> February 2021.

For **current** update (11<sup>th</sup> January 2022) MEDLINE, EMBASE and Cochrane library searches were limited 2021-current (so there will be some overlap with 2021 update) and the Cochrane search covered the period February 2021 – present.

### Evidence Update Process for topics not covered by ILCOR Task Forces

1. This evidence update process is only applicable to PICO's which are *not* being reviewed as ILCOR systematic and scoping reviews.

### The searches returned:

MEDLINE: 109 articles

EMBASE: 209 articles

Cochrane: 60 articles

There were no new articles for consideration after title and abstract review. (Our published systematic review appeared in MEDLINE and EMBASE searches).

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

This does NOT meet criteria for formal review at this point.

	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

No new papers identified



## BLS546 Tidal volumes and ventilation rates 2022 Evidence Update Worksheet

**Worksheet author:** Nicholas J Johnson

**Task Force:** BLS Task Force

**Date Submitted:** January 6, 2022

**Worksheet ID:** BLS 546 Tidal volumes and ventilation rates

**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

**Last 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)***

##### **Consensus on Science**

*In 3 human studies (LOE 5174–176), tidal volumes of 600 mL using room air were sufficient to maintain oxygenation and normocarbida 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*

### Treatment Recommendation

*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.*

## **2010 Search Strategy**

Database: All EBM Reviews - Cochrane DSR, ACP Journal Club, DARE, CCTR, CMR, HTA, and NHSEED Search Strategy:

- 1 exp heart arrest/ (738)
- 2 exp cardiopulmonary resuscitation/ (326)
- 3 ventilation.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw] (8538)
- 4 bag-valve-mask.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw] (35)
- 5 artificial respiration.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw] (26)
- 6 assisted ventilation.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw] (357)
- 7 manual ventilation.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw] (47)
- 8 [tidal volume](#).mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw] (1270)
- 9 (1 or 2) and (3 or 4 or 5 or 6 or 7 or 8) (89)

(4 potentially relevant studies identified from 89 possible papers; 2 papers finally relevant to the question)

MEDLINE (via OVID SP): Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations, Ovid MEDLINE(R) Daily and Ovid MEDLINE(R) <1950 to Present> Search Strategy:

- 1 exp heart arrest/ (25324)
- 2 exp cardiopulmonary resuscitation/ (7526)
- 3 exp Intermittent Positive-Pressure Ventilation/ or exp Ventilation/ or ventilation.mp. or exp Pulmonary Ventilation/ (98645)
- 4 artificial respiration.mp. or exp Respiration, Artificial/ (48175)
- 5 exp Respiration, Artificial/ or exp Positive-Pressure Respiration/ or assisted ventilation.mp. (48591)
- 6 exp Respiration, Artificial/ or manual ventilation.mp. or exp Positive-Pressure Respiration/ (47755)
- 7 [tidal volume.mp. or exp Tidal Volume/](#) (11725)
- 8 exp Respiration, Artificial/ or exp Masks/ or bag-valve-mask.mp. or exp Resuscitation/ (80053)
- 9 (1 or 2) and (3 or 4 or 5 or 6 or 8) and 7 (148)

(24 potentially relevant papers found from 149 possible papers; 2 papers finally relevant to the question in addition to the 2 above (total 4))

EMBASE (via OVID SP): Database: EMBASE <1980 to 2009 May 29> Search Strategy:

- 1 exp heart arrest/ (16339)
- 2 exp cardiopulmonary resuscitation/ (24914)

3 exp Intermittent Positive-Pressure Ventilation/ or exp Ventilation/ or ventilation.mp. or exp Pulmonary Ventilation/ (84755)

4 artificial respiration.mp. or exp Respiration, Artificial/ (55116)

5 exp Respiration, Artificial/ or exp Positive-Pressure Respiration/ or assisted ventilation.mp. (59865)

6 exp Respiration, Artificial/ or manual ventilation.mp. or exp Positive-Pressure Respiration/ (54980)

7 [tidal volume.mp. or exp Tidal Volume/](#) (9716)

8 exp Respiration, Artificial/ or exp Masks/ or bag-valve-mask.mp. or exp Resuscitation/ (82306)

9 (1 or 2) and (3 or 4 or 5 or 6 or 8) and 7 (274)

30 potentially relevant papers from 274 possible papers; 4 papers finally relevant to the question in addition to 3 of the the 4 above (total 8).

## **2021 Search Strategy**

### **PubMed (31 December 2009 – 15 February 2021)**

#### **Tidal Volume search** (Date limited 31 December 2009 – 16 February 2021)

(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=200

#### **Ventilation rate search** (Date limited 31 December 2009 – 16 February 2021)

(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=396

**Database searched:** PubMed (31 December 2009 – 16 February 2021)

**Date Search Completed:** 16 February 2021

#### **Search Results (Number of articles identified / number identified as relevant):**

**Tidal volume:** 200 retrieved / 16 full-text retrieved and reviewed / no studies relevant

**Ventilation rate:** 396 retrieved / 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):**

**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**

1. This evidence update process is only applicable to PICO's which are *not* being reviewed as ILCOR systematic and scoping reviews.

**TIDAL VOLUME**

200 studies identified, 16 full texts reviewed, none were found to be relevant (4 x mechanical ventilation (intubated), 1 x post-ROSC, 3 x narrative reviews, 7 x no clinical outcomes)

NO RELEVANT STUDIES

**VENTILATION RATE**

NO RELEVANT STUDIES

**2022 Search Strategy**

**PubMed (31 December 2020– 4 January 2022)**

**Tidal Volume search** (Date limited 31 December 2020– 4 January 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=1

**Ventilation rate search** (Date limited 31 December 2020– 4 January 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=396

**Database searched:** PubMed (31 December 2020– 4 January 2022)

**Date Search Completed:** 4 January 2022

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

**Tidal volume:** 27 retrieved / 7 full-text retrieved and reviewed / no studies relevant

**Ventilation rate:** 44 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):**

**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**

1. This evidence update process is only applicable to PICO's which are *not* being reviewed as ILCOR systematic and scoping reviews.

**TIDAL VOLUME**

27 studies identified, 7 full texts reviewed, none were found to be relevant (6 invasive mechanical ventilation/intubated [4 of these also had no clinical outcomes], 1 narrative review)

NO RELEVANT STUDIES

**VENTILATION RATE**

44 studies identified, 4 full texts reviewed, none were found to be relevant (2 no clinical outcomes, 2 narrative review)

NO RELEVANT STUDIES

**Reviewer Comments (including whether meet criteria for formal 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 71 citations, which were screened initially on title and abstract. 11 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 2010 CoSTR recommendations.

	<b>Approval Date</b>
<b>Evidence Update coordinator</b>	
<b>ILCOR board</b>	

**\*Once approval has been made by Evidence Update coordinator, worksheet will go to ILCOR Board for acknowledgement.**

**Reference list**

**\*\*CONFIDENTIAL DO NOT DISTRIBUTE\*\***

## 2022 Evidence Update Worksheet BLS 372 and BLS 547

**Worksheet author(s):** Peter J. Kudenchuk, MD

**Task Force:** BLS

**Date Submitted:** 12/7/2021

**Worksheet ID:** BLS 547 Lay rescuer chest compression only vs. standard CPR

**PICO / Research Question:** 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.

**Type (intervention, diagnosis, prognosis):** Intervention

**Additional Evidence Reviewer(s):** NA

**Conflicts of Interest (financial/intellectual, specific to this question):** None

**Year of last full review: 2010 / 2015 / New question:** thru November 2021

**Last ILCOR Consensus on Science and Treatment Recommendation:** 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)

**2010/2015 Search Strategy:** NA

**2019 Search Strategy:** Same terms and database as that used for 2020 Guidelines

**Database searched:** KSU search strategy (same terms and database as for 2020 Guidelines) that was provided by Dr. Olasveengen for covering the dates 1/1/2020-1/28/21. A subsequent search covering articles published in 2021 through 11/30/21 used the broad search terms “(resuscitation or CPR) and (chest compression or ventilation or mouth-to-mouth) and (2021)” within PubMed.

**Date Search Completed:** 1/1/2020- 1/28/2021; and 1/1/2021 - 11/30/2021.

**Search Results (Number of articles identified / number identified as relevant):** The original search (through 1/1/2020-1/28/2021) produced 815 articles only a few of which were relevant to the PICOST → 1 “trial

sequence analysis review” assessed survival outcome; 1 evaluated 30 day neurological outcome; 2 evaluated bystander CPR quality in manikin. A subsequent search (1/1/2021-11/30/2021) retrieved 2607 articles most of which (given the broad categories of the search) were not relevant to the PICOST, yielding → 1 meta-analysis that evaluated ROSC, survival to hospital admission, survival to hospital discharge and survival to hospital discharge with CPC 1-2; 1 observational study evaluated ROSC, survival to hospital discharge and 30 day survival; 1 observational study that evaluated 1 month survival and 1 month neurologically intact survival (CPC 1-2); and 1 randomized CPR training trial.

Thus the inclusive search spanning 1/1/2020 – 11/30/2021 produced a total of 8 relevant articles.

**Inclusion/Exclusion Criteria:** **Inclusion** - Manikin and clinical studies addressing adult resuscitation  
**Link to Article Titles and Abstracts (if available on PubMed):** See reference list below

### Summary of Evidence Update:

#### Evidence Update Process for topics not covered by ILCOR Task Forces

1. This evidence update process is only applicable to PICOs which are *not* being reviewed as ILCOR systematic and scoping reviews.
2. New information provides additional insights but not sufficient to change 2020 recommendations.

### 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
Ivan; 2020	Bystander chest compression only versus standard resuscitation in out-of-hospital cardiac arrest	BLS 372 and BLS 547	3 (addressed Hallstrom, Rea and Svensson randomized trials)	Updated systematic review and meta-analysis of randomized human trials between 1985-2019 addressing the question identified 3 such trials. Pooled results from these 3 trials found a risk ratio of 1.21 (1.01, 1.46) favoring chest	Current randomized trial evidence is insufficient to establish the superiority of one CPR method over the other.



				compression-only CPR over conventional CPR. However trial sequence analysis determined combined trial results had a risk of type 1 error of 10-30% and were therefore inconclusive. An additional 1300 patients would be needed in future randomized trials to establish conclusive results.	
Bielski; 2021	Meta-analysis of conventional CPR vs chest compression only bystander CPR in adults	BLS 372 and BLS 547	3 randomized controlled trials; 12 nonrandomized studies. One of these nonrandomized studies was erroneously included as it addressed EMS not bystander CPR and in addition did not strictly address CC-only CPR without ventilation in that treatment arm.	Survival to hospital discharge (SHD) with std CPR 10.2% vs 9.3% CCC (OR = 1.04; 95% CI: 0.93–1.16; p = 0.46). SHD with good neurological outcome by (CPC 1 or 2) std CPR 6.5% vs. 5.8% CCC (OR = 1.00; 95% CI: 0.84–1.20; p = 0.98). Prehospital return of spontaneous circulation	No significant differences in resuscitation outcome with standard CPR (std CPR) versus chest compression only CPR (CCC).

				(ROSC) std CPR 15.9% vs 14.8% CCC (OR = 1.13; 95% CI: 0.91–1.39; p = 0.26). Survival to hospital admission with ROSC std CPR 29.5% vs 28.4% CCC (OR = 1.20; 95% CI: 0.89– 1.63; p = 0.24).	
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**RCT:**

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

**Randomized non-clinical trials**

<b>Study Acronym; Author; Year Published</b>	<b>Aim of Study; Study Type; Study Size (N)</b>	<b>Patient Population</b>	<b>Study Intervention (# patients) / Study Comparator (# patients)</b>	<b>Endpoint Results (Absolute Event Rates, P value; OR or RR; &amp; 95% CI)</b>	<b>Relevant 2° Endpoint (if any); Study Limitations; Adverse Events</b>
Adequate CPR performance by bystanders with various pauses between chest	<u><b>Study Aim:</b></u> Determine whether incorporating intentional interruptions of	n= 517 laypersons trained in BLS/AED and randomized 1:1:1:1 to the	<u><b>Intervention:</b></u> 3 CPR protocols of 30 chest compressions (CC) with 2	<u><b>1° endpoint:</b></u> Primary endpoint was % of CC with adequate depth; secondary endpoints chest	Pauses (potentially for breaths) may result in higher CC with correct depth but at expense of chest compression

compressions vs continuous chest compressions; Baldi; 2020	different frequency and duration improves layperson CPR quality compared to compression-only CPR <b><u>Study Type:</u></b> Randomized manikin trial comparing 3 CPR protocols of 30 chest compressions (CC) with 2 second pause; 50 CC with 5 second pause and 100 CC with 10 second pause conducted for 8 minutes in 517 laypersons, using Laerdal REsusc Anne QCPR manikin.	various CPR protocols (n=129-130 per group)	second pause; 50 CC with 5 second pause and 100 CC with 10 second pause conducted for 8 min <b><u>Comparison:</u></b> Endpoint measures evaluated between each CPR strategy	compression fraction (CCFx%), compression rate, interruptions > 10 seconds and correct hand position. <b><u>Results:</u></b> Adequate depth 30cc:2s 96%; 50cc:5s 96%; 100cc:10s 92%; CCC 79% (p=0.006). Compared to CCC vs 30cc:2s p=0.023; CCC vs 50cc:5s p=0.003; CCC vs 100cc:10s p=0.07. Higher CCFx% in CCC group (p<0.001) and higher rate pauses >10 sec in 100cc:10s. NSD in CC rate or leaning/recoil or hand position.	fraction. However study did not take the “work of breaths” into account – which could have altered reported outcomes. Thus findings are non-definitive for interposed breathing versus continuous chest compression CPR on CPR metrics.
Flow-chart assisted CPR using standard versus continuous chest compression CPR; Rossler; 2020	<b><u>Aim:</u></b> Chest compressions more correctly delivered in flowchart-assisted resuscitation using standard CPR than chest compression-only algorithm. <b><u>Study type:</u></b> Randomized manikin trial	84 adult laypersons randomized to flow-chart assisted standard vs chest compression only CPR (n=41 per group) for 5 minute period.	<b><u>Intervention:</u></b> Standard versus chest compression only CPR. CPR quality assessed by Laerdal Skill Reporting System.	<b><u>1° endpoint:</u></b> Total number of CCs achieving correct depth 5-6 cm; secondary endpoints included hands-off-time, time to administration of CCs, total number of CCs, relative number of correct CCs (by depth), CCs > 5 cm,	The findings suggest no difference in CPR quality between the two CPR strategies apart from shorter hands-off time. Limitation of trial was manikin-based and relatively small in size to detect differences (underpowered).

				<p>average compression rate.</p> <p><b>Results:</b> Total number of “correct” (5-6 cm depth) CCs did not differ between the two groups; neither did average depth of CC, number of CCs &gt;5 cm, CC rate per minute, recoil, time to exhaustion or level of exhaustion. Total hands off time was shorter in the chest compression-only group than in standard CPR group.</p>	
<p>Comparison of long-term effects chest compression-only vs conventional CPR training on CPR skills in police officer responders; Cho; 2021</p>	<p><b>Aim:</b> Compare the quality of CPR skills immediately after and 3 months after training.</p> <p><b>Study type:</b> Randomized training trial</p>	<p>n= 119 police officers randomized to a training program including theoretical education, chest compressions practice and AED operation training (n=59); vs the addition of pocket mask ventilations practice (n=60)</p>	<p><b>Intervention:</b> Standard versus chest compression only CPR. CPR training, with subsequent skills reassessment</p>	<p><b>1° endpoint:</b> Evaluation of chest compression rate, depth, rate, recoil and chest compression position immediately post training and at 3 months.</p> <p><b>Results:</b> Good quality skills without differences between groups immediately after training. At 3 months post training overall skill performance (multiple linear</p>	<p>Immediate post training CPR skills were comparable in police trained in CCC vs conventional CPR, but favored CCC training at 3 months. Chest compression-only CPR training results in better retained CPR skills than conventional CPR training.</p>

				regression analysis) was 28.15% higher in the CC-only training module recipients.	
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### 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)
Standard vs chest compression only CPR by bystanders in non-asphyxial and asphyxial cardiac arrest; Javaudin; 2020	<b>Study Type:</b> Observational n=8541 OHCA; n=6742 non-asphyxial including n=5904 of cardiac etiology and 1799 asphyxial.	<b>Inclusion Criteria:</b> Adult, nontraumatic OHCA that were bystander witnessed with bystander CPR prior to EMS arrival	<b>1° outcome measure:</b> 30 day neurological outcome (CPC $\leq$ 2) stratified by asphyxia, non-asphyxial and cardiac causes.	No significant difference in 30 day neurological status between the two CPR methods.
Standard vs chest compression only CPR by bystanders from European Registry of Cardiac Arrest. Wnent; 2021	<b>Study Type:</b> Observational n=5884 OHCA; n=1362 standard CPR n=4044 CCC; n=478 unknown.	<b>Inclusion Criteria:</b> Adult, nontraumatic OHCA where type of CPR by bystanders could be differentiated	<b>Outcome measures:</b> ROSC, survival to hospital discharge; 30 day survival mainly in adults (1-3% were <19 yrs old). ROSC achieved in 26% CC vs 35% with Full CPR (difference 8.6%; 95% CI 5.7%, 11.5%; $p < 0.001$ ). Survival to hospital discharge 8% CC only vs 13% in standard CPR; adjusted odds ratio (age, sex, location, cause, rhythm, time on scene, witnessed and country) 1.46 (95% CI 1.17, 1.83) favored full CPR.	Adjusted survival outcome favored standard CPR
Instruction in conventional	<b>Study Type:</b>	<b>Inclusion Criteria:</b>	<b>Outcome measures:</b>	Nationwide population based study found

CPR (30:2) versus chest compression-only CPR by dispatchers in adults with bystander-witnessed out of hospital cardiac arrest. Goto; 2021	Observational n=24,947 adult bystander-witnessed OHCA; n=2169 standard CPR n=22,778 CCC with propensity matching.	Adult, bystander-witnessed OHCA who received dispatch CPR instructions, which was discretionary as to type (conventional vs chest compression only). Propensity matching was performed in 4,338 patients (2,169 patients in each treatment group)	Before propensity matching 1 month survival outcome observed in 11.3% conventional vs 10.5% CC only CPR (p=0.37) and 1 month CPC 1-2 in 7.5% conventional vs 5.8% CC only CPR (p<0.01). After propensity matching, 1 month survival in 11.3% vs 10.9% (p=0.74) and 1 month CPC 1-2 in 7.5% vs 5.7% (p<0.05) in conventional vs CC only CPR groups respectively. Adjusted OR pre-propensity matching for 1 month survival 1.09 (0.93, 1.28), p=0.28; for 1 month CPC 1-2 1.39 (1.14, 1.70) p<0.01 favoring conventional CPR. Adjusted OR post-propensity matching for 1 month survival 0.98 (0.79, 1.21) p=0.87 and 1 month CPC1-2 1.34 (1.01, 1.79) p<0.05 favoring conventional CPR.	conventional CPR with 30:2 ventilation ratio was associated with significantly improved neurologically intact survival with pre and post propensity score matching; but not in 1 month survival.
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**Reviewer Comments (including whether meet criteria for formal review):** Of the 8 articles reviewed between 1/1/2020 and 11/30/2021:

- Two manikin trials addressed CPR quality with interrupted versus continuous chest compression CPR. One found improved chest compression depth when there were interposed pauses (simulating when ventilations might be interposed) at the expense of a lower chest compression fraction. The other did not find definitive differences in CPR quality between the two approaches apart from a shorter “hands off period” with continuous compression CPR.
- One randomized trial comparing CC-only versus standard CPR training among police officers found better CPR skills performance at 3 months among those trained in CC-only.
- Reassessment of the pooled results from 3 randomized clinical trials were inconclusive of a benefit of one CPR strategy over the other.

- A large observational study observed no difference in 30 day neurological outcome between the differing CPR strategies regardless of whether the arrest was due to asphyxia, non-asphyxial or cardiac causes.
- A meta-analysis covering 3 randomized controlled trials (Hallstrom 2000, Rea 2010, Svensson 2010) and 12 nonrandomized studies (dated 2001-2021) found no significant differences in immediate, short-term or long-term outcomes between conventional CPR and chest-compression only by bystanders.
- However, 2 additional large observational studies observed significantly improved survival (1 study) and neurologically favorable survival (1 study).
- Of note, the recent search also uncovered 2 observational studies comparing a conventional versus continuous chest compression dispatch-assisted CPR approach in the pediatric population (outside the scope of this PICOST). The findings from these two studies suggested that dispatcher-assisted conventional CPR resulted in a higher neurologically intact survival compared to dispatch-assisted compression only CPR. In one of these studies outcomes between the two CPR approaches did not differ when cardiac arrest presented as a shockable rhythm as well as under other conditions, suggesting outcomes could differ depending on the circumstances surrounding the cardiac arrest.

Taken together, these findings (particularly those of the two large observational studies in adults) encourage continued tracking of this body of literature and possible consideration of a future formal review should more evidence accrue challenging the current practice of dispatch-assisted continuous chest compression CPR. For now, the interim information is insufficient to change 2020 recommendations in adults, which has been based on randomized trials, and allows for either chest compression only CPR or chest compressions with ventilation depending on the skill and willingness of providers.

	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

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Goto Y, Funada A, Maeda T, Goto Y. Dispatcher instructions for bystander cardiopulmonary resuscitation and neurologically intact survival after bystander-witnessed out-of-hospital cardiac arrests: A nationwide, population-based observational study. *Crit Care* 2021;25:408 <https://doi.org/10.1186/s13054-021-03825-w>

Cho BJ, Kin SR. Comparison of long-term effects between chest compression-only CPR training and conventional CPR training on CPR skills among police officers. *Healthcare* 2021;9:34. <https://doi.org/10.3390/healthcare9010034>

Pediatric studies (outside the scope of the current PICOST):

Goto Y, Funada A, Maeda T, Goto Y. Dispatcher-assisted conventional cardiopulmonary resuscitation and outcomes for paediatric out-of-hospital cardiac arrests. *Resuscitation* 2021 <https://doi.org/10.1016/j.resuscitation.2021.10.003>

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**\*\*CONFIDENTIAL DO NOT DISTRIBUTE\*\*****2022 Evidence Update Worksheet****Worksheet author(s):** Siobhán Masterson**Task Force:** BLS Task Force**Date Submitted:** 07/01/2022**Worksheet ID:** BLS661 Starting CPR (CAB vs ABC)**PICO / Research Question:****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)**Time:** This evidence update will examine studies published between 4 September 2019 and 10 February 2021.**Type:** Intervention**Conflicts of Interest (financial/intellectual, specific to this question):** None**Year of last full review:** 2015**Last ILCOR Consensus on Science and Treatment Recommendation (2015):**

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.

### **2015 Search Strategy:**

(((((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])))

### **Embase:**

'compression:ventilation':ab,ti OR 'chest compression fraction':ab,ti OR ('heart massage'/de OR (heart NEAR/1 massage\*):ab,ti OR (cardiac NEAR/1 massage\*):ab,ti OR compression\*:ab,ti AND ('respiration, artificial'/de OR ventilation\*:ab,ti) AND (ratio:ab,ti OR ratios:ab,ti)) NOT ('animal'/exp NOT 'human'/exp) NOT ([editorial]/lim OR [letter]/lim OR 'case report'/de) AND [embase]/lim

### **Cochrane:**

("compression:ventilation":ab,ti or "chest compression fraction":ab,ti) or (([mh "Heart Massage"] or "heart massage\*":ab,ti or "cardiac massage\*":ab,ti or "compression\*":ab,ti) and ([mh ^"Respiration, Artificial"] or ventilation\*:ab,ti) and (ratio:ab,ti or ratios:ab,ti))

### **2020 Search Strategy:**

The search strategy used in 2015 was re-run through on 4 September 2019 and yielded 491 citations after removal of duplicates (Pubmed 145 citations; Embase 230 citations and Cochrane 116 citations). After duplicates were removed, 340 abstracts were screened by two independent reviewers for applicability to the PICOST. Upon completion of their individual reviews of titles and abstracts, the reviewers concur there was no new science that would change or revise the current treatment recommendations from 2015 CoSTR.

### **2021 Search Strategy (EvUpdate)**

The search strategy used in 2020 was re-run on 10 February 2021 from September 2019 to February 2021 and yielded 302 citations: (Pubmed 51 citations; Embase 217 citations; and Cochrane 34 citations). After duplicates were removed, 285 abstracts were screened for applicability to the PICOST. No Relevant guidelines, systematic reviews, RCTs, non-randomised trials or observational studies were identified.

### **Pubmed:**

*2021 search strategy re-run 7 January 2022, date limited 10 February 2021 to 6 January 2022: 42 citations.*

(((((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]))

### **Embase:**

*2021 search strategy re-run 7 January 2022, date limited 10 February 2021 to 6 January 2022: 58 citations.*

'compression:ventilation':ab,ti OR 'chest compression fraction':ab,ti OR ('heart massage'/de OR (heart NEAR/1 massage\*):ab,ti OR (cardiac NEAR/1 massage\*):ab,ti OR compression\*:ab,ti AND ('respiration, artificial'/de OR ventilation\*:ab,ti) AND (ratio:ab,ti OR ratios:ab,ti)) NOT ('animal'/exp NOT 'human'/exp) NOT ([editorial]/lim OR [letter]/lim OR 'case report'/de) AND [embase]/lim

### **Cochrane:**

*2021 search strategy re-run 7 January 2022, date limited February 2021 to January 2022: 11 citations.*

("compression:ventilation":ab,ti or "chest compression fraction":ab,ti) or (([mh "Heart Massage"] or "heart massage\*":ab,ti or "cardiac massage\*":ab,ti or "compression\*":ab,ti) and ([mh ^"Respiration, Artificial"] or ventilation\*:ab,ti) and (ratio:ab,ti or ratios:ab,ti))

**Databases searched:** PubMed, Embase, Cochrane.

**Date Searches Completed:** 7 January 2022

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

**PubMed: 42, Embase: 58, Cochrane: 14**

**Total: 111 After duplicates removed: 84 Articles selected for full-text review: 4**

### **Inclusion/Exclusion Criteria:**

#### **Inclusion criteria:**

Randomised controlled trials (RCTs) and non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies) comparing CAB with ABC. All languages included if abstract available in English.

#### **Exclusion criteria:**

Animal studies, studies of post cardiac arrest debriefing or post cardiac arrest feedback, studies of dispatcher or telephone assisted CPR. Unpublished studies (e.g., conference abstracts, trial protocols).

**Link to Article Titles and Abstracts (if available on PubMed):** [BLS661 EvUpdate PubMed link](#)

### **Summary of Evidence Update:**

#### **Evidence Update Process for topics not covered by ILCOR Task Forces**

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

**No Relevant guidelines, systematic reviews, RCTs, non-randomised trials or observational studies were identified.**

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

No new evidence was identified for this question.

	<b>Approval Date</b>
<b>Evidence Update coordinator</b>	
<b>ILCOR board</b>	

**\*Once approval has been made by Evidence Update coordinator, worksheet will go to ILCOR Board for acknowledgement.**

**Reference list**

**\*\*CONFIDENTIAL DO NOT DISTRIBUTE\*\*****2022 Evidence Update Worksheet****Worksheet author(s):** Carolina Malta Hansen,**Task Force:** BLS**Date Submitted:** January 23rd, 2022**Worksheet ID:** BLS 740 Dispatcher recognition of cardiac arrest**PICO / Research Question:**

Among adults and children who are in cardiac arrest outside of a hospital (P), does the description of any specific symptoms to the dispatcher (I), compared with the absence of any specific description (C), change the likelihood of cardiac arrest recognition (O)?

**Outcomes:** Dispatcher recognition of cardiac arrest**Type (intervention, diagnosis, prognosis):** diagnosis**Additional Evidence Reviewer(s):** Theresa Olasveengen**Conflicts of Interest (financial/intellectual, specific to this question):**

Carolina Malta Hansen: Research grants from TrygFonden, Helsefonden, Laerdal Foundation.

**Year of last full review: 2010 / 2015 / New question: 2020****Last ILCOR Consensus on Science and Treatment Recommendation:**

We recommend that dispatch centers implement a standardized algorithm and/or standardized criteria to immediately determine if a patient is in cardiac arrest at the time of emergency call (strong recommendation, very-low-certainty evidence).

We suggest that dispatch centers monitor and track diagnostic capability. We suggest that dispatch centers look for ways to optimize sensitivity (minimize false negatives).

We recommend high-quality research that examines gaps in this area.

**2010/2015/2019/2020/2021 Search Strategy:**

Database: All Ovid Medline &lt;1946 - present&gt;

- 
- 1 emergency medical service communication systems/ (1758)
  - 2 emergency medical dispatch/ (91)
  - 3 Emergency Medical Dispatcher/ (36)
  - 4 call centers/ (61)
  - 5 hotlines/ (2659)

6 telephone/ or cell phone/ (19468)  
7 Telecommunications/ (4760)  
8 "911".tw,kf. (9248)  
9 "9-1-1".tw,kf. (583)  
10 "999".tw,kf. (13411)  
11 "9-9-9".tw,kf. (69)  
12 dispatch\*.tw,kf. (3055)  
13 despatch\*.tw,kf. (90)  
14 (call adj3 take\*).tw,kf. (163)  
15 (calls adj3 take\*).tw,kf. (81)  
16 calltaker\*.tw,kf. (1)  
17 call receiver\*.tw,kf. (4)  
18 phone\*.tw,kf. (35149)  
19 telephone\*.tw,kf. (56538)  
20 telecommunicat\*.tw,kf. (4183)  
21 "T-CPR".tw,kf. (33)  
22 operator\*.tw,kf. (56327)  
23 emergency call\*.tw,kf. (839)  
24 emergency medical call\*.tw,kf. (26)  
25 call centre\*.tw,kf. (273)  
26 call center\*.tw,kf. (573)  
27 emd.tw,kf. (2727)  
28 hotline\*.tw,kf. (1156)  
29 or/1-28 (189858)  
30 exp Heart Arrest/ (46333)  
31 Ventricular Fibrillation/ (16858)  
32 Resuscitation/ (25767)  
33 Heart Massage/ (3086)  
34 exp Cardiopulmonary Resuscitation/ (17214)  
35 cardi\* arrest\*.tw,kf. (37515)  
36 heart arrest\*.tw,kf. (2265)  
37 CPR.tw,kf. (11841)  
38 advanced cardiac life support.tw,kf. (1031)  
39 ACLS.tw,kf. (1094)  
40 basic life support.tw,kf. (1916)  
41 BLS.tw,kf. (1820)  
42 asystol\*.tw,kf. (4149)  
43 pulseless electrical activity.tw,kf. (837)  
44 (return of circulation or return of spontaneous circulation or ROSC).tw,kf. (3763)  
45 resuscitat\*.tw,kf. (62496)  
46 ventricular fibrillation\*.tw,kf. (18508)  
47 chest compression\*.tw,kf. (3615)  
48 agonal breath\*.tw,kf. (47)  
49 Electric Countershock/ (14530)  
50 Defibrillators/ (1736)

51 electric countershock.tw,kf. (397)  
 52 defibrillat\*.tw,kf. (25927)  
 53 aed.tw,kf. (6084)  
 54 exp Drowning/ (3934)  
 55 drown\*.tw,kf. (5234)  
 56 or/30-55 (172390)  
 57 29 and 56 (2929)  
 58 Communication/ (81377)  
 59 communication barriers/ (6343)  
 60 Linguistics/ (8150)  
 61 early diagnosis/ (25327)  
 62 Diagnosis, Differential/ (443460)  
 63 Delayed Diagnosis/ (5826)  
 64 exp Diagnostic Errors/ (114204)  
 65 Clinical Protocols/ (27191)  
 66 Critical Pathways/ (6464)  
 67 Risk Assessment/ (252020)  
 68 (recogni\* or identif\* or detect\* or diagnos\*).tw,kf. (6952079)  
 69 accuracy.tw,kf. (379025)  
 70 exp "Sensitivity and Specificity"/ (566344)  
 71 sensitivity.tw,kf. (768683)  
 72 specificity.tw,kf. (447265)  
 73 predictive value of test\*.tw,kf. (416)  
 74 positive predictive value.tw,kf. (40115)  
 75 negative predictive value.tw,kf. (33378)  
 76 true positive\*.tw,kf. (7781)  
 77 true negative\*.tw,kf. (3303)  
 78 false positive\*.tw,kf. (57101)  
 79 false negative\*.tw,kf. (32154)  
 80 or/58-79 (8250450)  
 81 57 and 80 (1399)  
 82 limit 81 to (comment or editorial or letter) (16)  
 83 81 not 82 (1383)  
 84 83 not (animals/ not humans/) (1361)  
 85 remove duplicates from 84 (1357)  
 86 limit 85 to ed=20190423-20191128 (59)  
 87 limit 85 to dt=20190423-20191128 (68)  
 88 limit 85 to ez=20190423-20191128 (51)  
 89 86 or 87 or 88 (121)  
 90 remove duplicates from 89 (121)

**2021 Search Strategy:** Same as above

**Database searched:** 04/01/22

**Date Search Completed:** 04/01/22

**Search Results (Number of articles identified / number identified as relevant): 231/7**

**Inclusion/Exclusion Criteria:**

Clinical studies reporting sensitivity or specificity were included, simulation studies were excluded.

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

**Summary of Evidence Update:**

**Evidence Update Process for topics not covered by ILCOR Task Forces**

1. 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:** None

**RCT:**

<b>Study Acronym; Author; Year Published</b>	<b>Aim of Study; Study Type; Study Size (N)</b>	<b>Patient Population</b>	<b>Study Intervention (# patients) / Study Comparator (# patients)</b>	<b>Endpoint Results (Absolute Event Rates, P value; OR or RR; &amp; 95% CI)</b>	<b>Relevant 2° Endpoint (if any); Study Limitations; Adverse Events</b>
Blomberg, 2021 <sup>1</sup>	<p><b><u>Study Aim:</u></b> To examine how a machine learning model trained to identify OHCA and alert dispatchers during emergency calls affected OHCA recognition and response.</p> <p><b><u>Study Type:</u></b> Double-masked, 2-group, randomized clinical trial</p>	<p><b><u>Inclusion Criteria:</u></b> All calls to emergency number 112 (equivalent to 911) in Denmark. Calls were processed by a machine learning model using speech recognition software. The machine learning model assessed ongoing calls, and calls in which the model identified</p>	<p><b><u>Intervention:</u></b> Dispatchers in the intervention group were alerted when the machine learning model identified out-of-hospital cardiac arrest, <b><u>Comparison:</u></b> Dispatchers in the control group followed normal protocols without alert.</p>	<p><b><u>1° endpoint:</u></b> The primary endpoint was the rate of dispatcher recognition of subsequently confirmed OHCA. Dispatchers in the intervention group recognized 93.1% vs 90.5% in the control group (P = .15). Machine learning alerts alone had a significantly higher sensitivity than dispatchers without alerts for confirmed OHCA (85.0% vs 77.5%; P</p>	<p><b><u>Study Limitations:</u></b> Single center study</p>



		OHCA were randomized. The trial was performed at Copenhagen Emergency Medical Services, Denmark, between September 1, 2018, and December 31, 2019		< .001) but lower specificity (97.4% vs 99.6%; P < .001) and positive predictive value (17.8% vs 55.8%; P < .001).	
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### 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>	
Hardeland, 2021 <sup>2</sup>	Retrospective cohort (n=716)	OHCA included in OHCA registry in Denmark, Sweden, Norway. Excluded EMS-witnessed, patient alive at time of call, caller cannot access patient, call interrupted, and audio file not available.	Sensitivity of recognition of OHCA (among others).	For OHCA in Copenhagen, Stockholm and Oslo, recognition of OHCA occurred in 71%, 83%, 96%, in, respectively. Abnormal breathing was addressed in 34%, 7%, 98% of cases respectively.  Despite use of same dispatch protocol sensitivity of dispatch recognition of arrest differed across 3 Scandinavian countries.
Byrsell, 2021 <sup>3</sup>	Retrospective cohort, cohort A n=851, validated OHCA calls. Cohort B consisted of a	The machine learning tool was tested on two uniform random cohorts to evaluate its	Machine learning (ML) OHCA recognition within the first minute evaluated with a 1.5 false positive rate as the primary endpoint, and	Of 851 OHCA calls, the ML recognized 36% (n=305) within 1min compared with 25% (n=213) by dispatchers. The recognition rate at any time during the call was

	random sample (n = 85,205) of priority 1–4 calls.	sensitivity and specificity: (a) validated OHCA calls, and (b) priority 1–4 calls (no OHCA).	other false positive rate settings as secondary endpoints.	86% for ML and 84% for dispatchers, with a median time to recognition of 72 versus 94s. OHCA recognized by both ML and dispatcher showed a 28s mean difference in favour of ML ( $P < 0.001$ ). ML with higher FPR settings reduced recognition times.
Gram, 2021 <sup>4</sup>	Prospective cohort (pre- vs post-intervention), n= 673	All OHCA's reported to the dispatch centre were included. Exclusion criteria: Third-party calls; calls terminated by the caller immediately after the caller had delivered the message; CPR was already in progress. Calls in which communication was impeded by for instance language barriers; OHCA occurring after EMS arrival; and calls in which other circumstances made the supervisor assess the calls "unidentifiable".	The primary outcome measure was the dispatcher's ability to recognize OHCA.	The sensitivity for recognition of OHCA was 82.3% (95% CI: 76.4–87.2%) before and 92.7% (95% CI: 88.2–95.8%) after the intervention ( $p = 0.0014$ ). Secondary outcome measures were time from contact with the caller to the dispatcher formulated essential questions related to the NO-NO-GO algorithm. The median duration of calls before recognition of OHCA was 68 and 56 s before and after the intervention ( $p = 0.097$ ). The visitation algorithm contained the two essential questions; "Is the patient conscious (awake)?" and "Is the patient breathing normally?"
Perera, 2021 <sup>5</sup>	Retrospective cohort study, N=353		Time intervals from call commencement for primary outcomes: (1) address acquisition; (2) OHCA recognition; (3)	Main findings: 50 (14%) LB calls from a cohort of 353 calls. LB calls took longer than non-LB calls (n=100) for: address acquisition

			CPR initiation; (4) telecommunicator CPR (t-CPR) compressions.	(median 29 vs 14 secs, $p<0.001$ ), OHCA recognition (103 vs 85 secs, $p=0.02$ ), and CPR initiation (206 vs 164 secs, $p=0.01$ ), but not for t-CPR compressions (292 vs 248 secs, $p=0.12$ ). Rates of OHCA recognition and 30-day-survival did not differ but smaller proportions of LB calls met the AHA standards.
Riou, 2021 <sup>6</sup>	Retrospective cohort, N=422.	Emergency calls where OHCA was recognized by the dispatcher and resuscitation was attempted by paramedics.	Impact of caller perception of patient viability on initial recognition of OHCA by the dispatcher, rates of bystander CPR and early patient survival outcomes.	Initial recognition of OHCA by the dispatcher was more frequent in cases with a declaration of death by the caller than in cases without (92%, 73/79 vs. 66%, 227/343, $p < 0.001$ ). Caller statements that the patient is dead are helpful for dispatchers to recognize OHCA early, but potentially detrimental when recruiting the caller to perform CPR. There is an opportunity to improve the rate of bystander-CPR and patient outcomes if dispatchers are attentive to caller statements about viability.
Watkins, 2021 <sup>7</sup>	Retrospective cohort, mixed methods. N=184	All suspected or confirmed OHCA patients transferred to one acute hospital from its associated regional Emergency Medical Service in England from 1/7/2013 to 30/6/2014.	To identify predictors of recognition of OHCA by call handlers.	'Unconscious' + 1 or more of symptoms 'Not breathing/Ineffective breathing/Noisy breathing' occurred in 79.8% of all OHCA's, but only 72.8% of OHCA's were correctly dispatched as such. 'Not breathing' was associated with recognition of OHCA by call handlers (OR 3.76). The presence of key indicator symptoms

				<p>'Breathing' (OR 0.29), 'Reduced or fluctuating level of consciousness' (OR 0.24), abnormal pulse/heart rate (OR 0.26) and the characteristic 'Female patient' (OR 0.40) were associated with lack of recognition of OHCA by call handlers (p-values &lt; 0.05). Small proportion of calls in which cardiac arrest indicators are described but the call is not dispatched as such. Stricter adherence to dispatch protocols may improve call handlers' OHCA recognition. The existing dispatch protocol would not be improved by the addition of further terms as this would be at the expense of dispatch specificity</p>
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**Reviewer Comments (including whether meet criteria for formal review):**

New evidence, particularly related to using new technology such as artificial intelligence or machine learning to improve recognition of cardiac arrest in emergency medical dispatch is of great interest to the resuscitation community, and the BLS task force will prioritize a full review in 2022.

	<b>Approval Date</b>
<b>Evidence Update coordinator</b>	

ILCOR board	
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**\*Once approval has been made by Evidence Update coordinator, worksheet will go to ILCOR Board for acknowledgement.**

## Reference list

1. Blomberg SN, Christensen HC, Lippert F, Ersboll AK, Torp-Petersen C, Sayre MR, Kudenchuk PJ and Folke F. Effect of Machine Learning on Dispatcher Recognition of Out-of-Hospital Cardiac Arrest During Calls to Emergency Medical Services: A Randomized Clinical Trial. *JAMA Netw Open*. 2021;4:e2032320.
2. Hardeland, Camilla; Claesson, Andreas; Blom, Marieke T; Blomberg, Stig Nikolaj Fasmer; Folke, Fredrik; Hollenberg, Jacob; Kramer-Johansen, Jo; Lippert, Freddy; Nord, Anette; Nygaard, Anne Mette; Olasveengen, Theresa Mariero; Ringh, Mattias; Svensson, Leif; Moller, Thea Palsgaard. Description of call handling in emergency medical dispatch centres in Scandinavia: recognition of out-of-hospital cardiac arrests and dispatcher-assisted CPR. *Scandinavian journal of trauma, resuscitation and emergency medicine* / 2021;29(1):88.
3. Byrsell, Fredrik; Claesson, Andreas; Ringh, Mattias; Svensson, Leif; Jonsson, Martin; Nordberg, Per; Forsberg, Sune; Hollenberg, Jacob; Nord, Anette. Machine learning can support dispatchers to better and faster recognize out-of-hospital cardiac arrest during emergency calls: A retrospective study. *Resuscitation* / 2021;162(r8q, 0332173):218-226
4. Gram, Kristel Hadberg; Praest, Mikkil; Laulund, Ole; Mikkelsen, Soren. Assessment of a quality improvement programme to improve telephone dispatchers' accuracy in identifying out-of-hospital cardiac arrest. *Resuscitation plus* / 2021;6(101774410):100096
5. Perera, Nirukshi; Birnie, Tanya; Ngo, Hanh; Ball, Stephen; Whiteside, Austin; Bray, Janet; Bailey, Paul; Finn, Judith. "I'm sorry, my English not very good": Tracking differences between Language-Barrier and Non-Language-Barrier emergency ambulance calls for Out-of-Hospital Cardiac Arrest. *Resuscitation* / 2021;169(r8q, 0332173):105-112
6. Riou M, Ball S, Morgan A, Gallant S, Perera N, Whiteside A, Bray J, Bailey P and Finn J. 'I think he's dead': A cohort study of the impact of caller declarations of death during the emergency call on bystander CPR. *Resuscitation*. 2021;160:1-6.
7. Watkins CL, Jones SP, Hurley MA, Benedetto V, Price CI, Sutton CJ, Quinn T, Bangee M, Chesworth B, Miller C, Doran D, Siriwardena AN and Gibson JME. Predictors of recognition of out of hospital cardiac arrest by emergency medical services call handlers in England: a mixed methods diagnostic accuracy study. *Scand J Trauma Resusc Emerg Med*. 2021;29:7.

**\*\*CONFIDENTIAL DO NOT DISTRIBUTE\*\*****2021 Evidence Update Worksheet****Worksheet author(s):** Janet Bray**Task Force:** BLS Task Force**Date Submitted:** Jan 7<sup>th</sup> 2022**Worksheet ID:** BLS 811 Resuscitation care for suspected opioid-associated emergencies**PICO / Research Question:**

PICOST	Description <i>(with recommended text)</i>
<b>Population</b>	Adults and children with suspected opioid-associated cardio / respiratory arrest in the pre-hospital setting
<b>Intervention</b>	Bystander naloxone administration (intramuscular or intranasal), in addition to standard CPR
<b>Comparison</b>	compared with Standard CPR only
<b>Outcomes</b>	Any clinical outcome. <i>(preset text)</i>
<b>Study Design</b>	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. <i>(preset text)</i>  <i>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 ESR after discussion with the priority team or task force.</i>
<b>Timeframe</b>	All years and all languages are included as long as there is an English abstract <i>(preset text)</i>

**Outcomes:** Short or long-term survival**Type (intervention, diagnosis, prognosis):** intervention**Additional Evidence Reviewer(s):** Theresa M. Olasveengen**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:**

Treatment Recommendation

We suggest that CPR be started without delay in any unconscious person not breathing normally and that naloxone be used by lay rescuers in suspected opioid related respiratory or circulatory arrest (weak recommendation based on expert consensus).

**2010/2015/2020/2021 Search Strategy:**

Pubmed:

((((((("Narcotics"[Mesh] OR "Narcotics" [Pharmacological Action] OR Oxycodone[TIAB] or hydrocodone[TIAB] or heroin[TIAB] or morphine[TIAB] or methadone[TIAB] or codeine[TIAB] or fentanyl[TIAB] or opiate[TIAB] or opiates[TIAB] or opioid[TIAB] or opioids[TIAB] OR Hydromorphone[TIAB] or vicodin[TIAB] or Demerol[TIAB] or oxycontin[TIAB] or Tramadol[TIAB] or Meperidine[TIAB] or opium[TIAB] or narcotic[TIAB] OR narcotics[TIAB] OR "Opioid-Related Disorders"[Mesh]) AND ("Drug Overdose"[Mesh] or "poisoning" [Subheading] or "Poisoning"[Mesh:NoExp] or "toxicity" [Subheading] or overdose[TIAB] OR overdosed[TIAB] or overdosing[TIAB] or toxicity[TIAB] or poisoning[TIAB]))) AND (("Resuscitation"[Mesh] OR "cardiopulmonary resuscitation"[TIAB] or "cardio-pulmonary resuscitation"[TIAB] or CPR[TIAB] or "chest compression"[TIAB] or "chest compressions"[TIAB] OR "basic life support"[TIAB] or BLS[TIAB] or "cardiac massage"[TIAB] or "heart massage"[TIAB] OR "Naloxone"[Mesh] OR "Narcotic Antagonists"[Mesh] or naloxone[TIAB] or naloxon[TIAB] or narkan[TIAB] or "narcotic antagonist"[TIAB] or "narcotic antagonists"[TIAB] OR "opioid antagonist"[TIAB] OR "opioid antagonists"[TIAB]))) NOT ((animals[mh] NOT humans[mh]) NOT ("letter"[pt] OR "comment"[pt] OR "editorial"[pt] or Case Reports[ptyp]))

**2021 Search Strategy:** Same as above

**Database searched:** Pubmed

**Date Search Completed:** Feb 17<sup>th</sup> 2021

**Search Results (Number of articles identified / number identified as relevant):** 387 / 0

**Inclusion/Exclusion Criteria:** Any study including cardiac or respiratory arrest patients treated with naloxone and CPR which includes a control group treated with CPR only is included. Animal studies and simulation studies are excluded. Studies looking at effects of opioid overdose education programs with and without naloxone at the population level is covered by another PICOST handled by the EIT Task Force.

**Link to Article Titles and Abstracts (if available on PubMed):** None

**Summary of Evidence Update:****Evidence Update Process for topics not covered by ILCOR Task Forces**

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 meet criteria for formal review):**

No new evidence was identified.

	<b>Approval Date</b>
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<b>Evidence Update coordinator</b>	
<b>ILCOR board</b>	

**\*Once approval has been made by Evidence Update coordinator, worksheet will go to ILCOR Board for acknowledgement**



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**2022 Evidence Update Worksheet**

**Worksheet author(s):** Christopher M Smith

**Task Force:** BLS Task Force

**Date Submitted:** 11<sup>th</sup> January 2022 (Updated searches performed 11<sup>th</sup> January 2022)

**Worksheet ID:** BLS 1527 CPR prior to call for help

**PICO / 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

**Additional Evidence Reviewer(s):**

None

**Conflicts of Interest (financial/intellectual, specific to this question):**

None

**Year of last full review:**

February 2021

**Last ILCOR Consensus on Science and Treatment Recommendation:**

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).

**Original Search Strategy:**

(Original searches conducted on 23<sup>rd</sup> October 2019.)


MEDLINE

VID

My Account

Ask A Librarian

Support & Training



ch

Journals

Books

Multimedia

My Workspace

arch 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

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Combine with:

AND

OR


EMBASE

id®

My Account

Ask A Librarian

Support & Training



ch

Journals

Books

Multimedia

My Workspace

arch 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

e

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	resuscital*	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

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

One paper

## Inclusion/Exclusion Criteria:

We included RCTs, non-randomised studies, case series with at least five cases. We considered papers in all languages provided there was an English language abstract available for review.

We excluded unpublished studies, conference abstracts, manikin or simulation studies, narrative reviews, editorials or opinions with no primary data, animal studies and experimental / lab models

We set no time limits on our searches

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

Kamikura T, Iwasaki H, Myojo Y, Sakagami S, Takei Y, Inaba H. Advantage of CPR-first over call-first actions for out-of-hospital cardiac arrests in nonelderly patients and of noncardiac aetiology. *Resuscitation* 2015;96:37-45.

<https://pubmed.ncbi.nlm.nih.gov/26193378/>

## Summary of Evidence Update:

This search across the three databases were updated on 16<sup>th</sup> February 2021, and there were no new articles identified at this point.

MEDLINE, EMBASE and Cochrane library searches re-run on 11-January 2022. MEDLINE and EMBASE searches covered 2021-current (so there will be some overlap with previous) and COCHRANE search February 2021-current.

### **Evidence Update Process for topics not covered by ILCOR Task Forces**

1. This evidence update process is only applicable to PICO's which are *not* being reviewed as ILCOR systematic and scoping reviews.

### **The latest (January 2022) searches returned:**

MEDLINE: 29 new articles  
 EMBASE: 42 new articles  
 Cochrane: 47 new articles

There were no new articles for consideration after title and abstract review.

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

This does **NOT** meet criteria for formal review at this point.

	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**

No new papers identified

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## 2022 Evidence Update Worksheet

**Worksheet author(s):** Olasveengen

**Task Force:** BLS Task Force

**Date Submitted:** 04.01.2022

**Worksheet ID:** BLS Heads up CPR

### PICO / Research Question:

**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:** 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  $\geq 5$  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.

**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 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).

### 2021 Search Strategy:

1. heart arrest.mp. or exp Heart Arrest/
2. Out-of-Hospital Cardiac Arrest.mp. or exp Out-of-Hospital Cardiac Arrest/
3. Death, Sudden, Cardiac.mp. or exp Death, Sudden, Cardiac/
4. Tachycardia, Ventricular.mp. or exp Tachycardia, Ventricular/
5. Ventricular Fibrillation.mp. or exp Ventricular Fibrillation/
6. Cardiopulmonary Resuscitation.mp. or exp Cardiopulmonary Resuscitation/
7. cardi\* arrest\*.mp.

8. resuscitat\*.mp.
9. chest compression\*.mp.
10. CPR.mp.
11. Heart Massage.mp. or exp Heart Massage/
12. or/1-11
13. head\* up.mp.
14. "head up".mp.
15. "heads up".mp.
16. "head-up".mp.
17. "heads-up".mp.
18. Torso-Up.mp.
19. "torso up".mp.
20. Anti-Trendelenburg.mp.
21. Trendelenburg.mp.
22. tilt.mp.
23. or/13-22
24. 12 and 23

**2020 Search Strategy:** Medline search as above.

**Database searched:** Medline

**Date Search Completed:** 04.01.2022

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

**Inclusion/Exclusion Criteria:** Animal studies, conference abstracts, trial protocols

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

None

#### **Summary of Evidence Update:**

##### **Evidence Update Process for topics not covered by ILCOR Task Forces**

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 meet criteria for formal review):**

No new clinical evidence was identified, but two recent systematic reviews and additional animal data.

	<b>Approval Date</b>
<b>Evidence Update coordinator</b>	
<b>ILCOR board</b>	

**\*Once approval has been made by Evidence Update coordinator, worksheet will go to ILCOR Board for acknowledgement.**

## Reference list

Pepe PE, Schepke KA, Antevy PM, Crowe RP, Millstone D, Coyle C, Prusansky C, Garay S, Ellis R, Fowler RL, et al. Confirming the clinical safety and feasibility of a bundled methodology to improve cardiopulmonary resuscitation involving a head-up/torso-up chest compression technique. *Crit Care Med*. 2019;47:449–455. doi: 10.1097/CCM.0000000000003608

## Animal studies:

Debaty G, Shin SD, Metzger A, Kim T, Ryu HH, Rees J, McKnite S, Matsuura T, Lick M, Yannopoulos D, et al. Tilting for perfusion: headup position during cardiopulmonary resuscitation improves brain flow in a porcine model of cardiac arrest. *Resuscitation*. 2015;87:38–43. doi: 10.1016/j.resuscitation.2014.11.019

Ryu HH, Moore JC, Yannopoulos D, Lick M, McKnite S, Shin SD, Kim TY, Metzger A, Rees J, Tsangaris A, et al. The effect of head up cardiopulmonary resuscitation on cerebral and systemic hemodynamics. *Resuscitation*. 2016;102:29–34. doi: 10.1016/j.resuscitation.2016.01.033

Kim T, Shin SD, Song KJ, Park YJ, Ryu HH, Debaty G, Lurie K, Hong KJ. The effect of resuscitation position on cerebral and coronary perfusion pressure during mechanical cardiopulmonary resuscitation in porcine cardiac arrest model. *Resuscitation*. 2017;113:101–107. doi: 10.1016/j.resuscitation.2017.02.008

Moore JC, Salverda B, Rojas-Salvador C, Lick M, Debaty G, Lurie KG. Controlled sequential elevation of the head and thorax combined with active compression decompression cardiopulmonary resuscitation and an impedance threshold device improves neurological survival in a porcine model of cardiac arrest. *Resuscitation*. 2021;158:220–227. doi: 10.1016/j.resuscitation.2020.09.030

Rojas-Salvador C, Moore JC, Salverda B, Lick M, Debaty G, Lurie KG. Effect of controlled sequential elevation timing of the head and thorax during cardiopulmonary resuscitation on cerebral perfusion pressures in a porcine model of cardiac arrest. *Resuscitation*. 2020;149:162–169. doi: 10.1016/j.resuscitation.2019.12.011

Park YJ, Hong KJ, Shin SD, Kim TY, Ro YS, Song KJ, Ryu HH. Worsened survival in the head-up tilt position cardiopulmonary resuscitation in a porcine cardiac arrest model. *Clin Exp Emerg Med*. 2019;6:250–256. doi: 10.15441/ceem.18.060

Moore JC, Duval S, Lick C, Holley J, Schepke KA, Salverda B, Rojas-Salvador C, Jacobs M, Nystrom P, Quinn R, Adams PJ, Debaty GP, Hutchison M, Mason C, Martinez E, Mason S, Clift A, Antevy P, Coyle C, Grizzard E, Garay S, Lurie KG, Pepe PE. Faster time to automated elevation of the head and thorax during cardiopulmonary resuscitation increases the probability of return of spontaneous circulation. *Resuscitation*. 2021 Nov 15;170:63–69. doi: 10.1016/j.resuscitation.2021.11.008

**\*\*CONFIDENTIAL DO NOT DISTRIBUTE\*\*****2022 Evidence Update Worksheet****Worksheet author(s):** Giuseppe Ristagno**Task Force:** BLS Task Force**Date Submitted:** January 11<sup>th</sup>, 2022**Worksheet ID:** BLS paddle size and placement for defibrillation

**PICO / Research Question:** ALS-E-030A 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.

**Type (intervention, diagnosis, prognosis):** The use of any specific pad size/orientation and position

**Additional Evidence Reviewer(s):** Theresa Olasveengen**Conflicts of Interest (financial/intellectual, specific to this question):** None**Year of last full review:** 2020 (Scoping review) **New question:** N.A.

**Last ILCOR Consensus on Science and Treatment Recommendation:** These treatment recommendations (below) are unchanged from 2010. 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 greater than 8 cm.

**2010/2015 Search Strategy:** (("Heart Arrest"[Mesh] OR "Cardiopulmonary Resuscitation"[Mesh] OR "Electric Countershock"[Mesh])) AND (("pad\*" OR "impedance"[All Fields] OR "transthoracic"[All Fields] OR "transthoracic impedance"[All Fields] OR "transthoracic resistance"[All Fields])).

**2019 Search Strategy:**

- 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\*).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.  
 ((orientation? or position\* or placement or placed or placing or situated or shape? or size? or rectangl\* or square or  
 55 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]

## Database searched: Pubmed

**Date Search Completed:** January 11<sup>th</sup>, 2022

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

- Previous search update – Feb 15<sup>th</sup> 2021: 187 articles identified / 4 reviewed / 0 relevant
- Since last search: 29 articles identified / 0 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.

**Link to Article Titles and Abstracts (if available on PubMed):** N.A.

**Summary of Evidence Update:** No new relevant articles were found. Update systematic review for 2022 is not needed.

**Evidence Update Process for topics not covered by ILCOR Task Forces**

1. 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

Organisation (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations
ILCOR; Olasveengen; 2020	Systematic review	Paddle Size and Placement for Defibrillation (ALS-E-030A: ScopRev)	0 relevant from 2010	There are no studies in patients with VF/pulseless VT directly comparing the effects of various positions of paddle/pad placement on defibrillation success and ROSC. Most studies evaluate cardioversion (eg, AF) or secondary end points (eg, TTI). No data on pads size related to survival outcome are available.	Unchanged from 2010

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
	<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: N.A.

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

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

	<b>Approval Date</b>
<b>Evidence Update coordinator</b>	
<b>ILCOR board</b>	

**\*Once approval has been made by Evidence Update coordinator, worksheet will go to ILCOR Board for acknowledgement.**

**Reference list**

**\*\*CONFIDENTIAL DO NOT DISTRIBUTE\*\*****2022 Evidence Update Worksheet****Worksheet author(s):** Sung Phil Chung**Task Force:** BLS Task Force**Date Submitted:** 2022 Jan**Worksheet ID:** Video-based dispatch system

**PICO / Research Question:** 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**Type (intervention, diagnosis, prognosis):** Intervention**Additional Evidence Reviewer(s):** Theresa Olasveengen**Conflicts of Interest (financial/intellectual, specific to this question):** None**Year of last full review:** 2010 / 2015 / **New question:** 2021**Last ILCOR Consensus on Science and Treatment Recommendation: 2021**

We suggest that the usefulness of video-based dispatch systems be assessed in clinical trials or research initiatives (weak recommendation, very low-certainty evidence).

**2021 Search Strategy:**

**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)))

**2022 Search Strategy:** same as above

**Database searched:** PubMed, Embase, Cochrane Library

**Date Search Completed:** 2021 Jan 1 to 2021 Dec 18

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

PubMed: 623 articles identified / Embase: 417 articles identified / Cochrane: 260 articles identified / 6 selected for full-text review / 2 articles identified as relevant

### **Inclusion/Exclusion Criteria:**

The dispatcher defined as an individual tasked with receiving the call (including delivery of treatment instructions) and allocation of ambulances to emergency calls. Dispatcher assisted CPR is defined as a form of CPR provided by bystanders which in accordance with instructions by a dispatcher with communication system between dispatcher center and cardiac arrest scene.

The studies without clinical outcome such as manikin simulation study were excluded. Studies with irrelevant population, intervention, outcome, study design, and lack of information were also excluded.

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

1. Lee HS, You K, Jeon JP, Kim C, Kim S. The effect of video-instructed versus audio-instructed dispatcher-assisted cardiopulmonary resuscitation on patient outcomes following out of hospital cardiac arrest in Seoul. *Sci Rep.* 2021 Jul 30;11(1):15555.

We aimed to investigate whether video-instructed dispatcher-assisted (DA)-cardiopulmonary resuscitation (CPR) improved neurologic recovery and survival to discharge compared to audio-instructed DA-CPR in adult out-of-hospital cardiac arrest (OHCA) patients in a metropolitan city with sufficient experience and facilities. A retrospective cohort study was conducted for adult bystander-witnessed OHCA patients administered DA-CPR due to presumed cardiac etiology between January 1, 2018 and October 31, 2019 in Seoul, Korea. The primary and secondary outcomes were the differences in favorable neurologic outcome and survival to discharge rates in adult OHCA patients in the two instruction groups. Binary logistic regression analysis was performed to identify the outcome predictors after DA-CPR. A total of 2109 adult OHCA patients with DA-CPR were enrolled. Numbers of elderly patients in audio instruction and video instruction were 1260 (73.2%) and 214 (55.3%), respectively. Elderly patients and those outside the home or medical facility were more likely to receive video instruction. Favorable neurologic outcome was observed more in patients who received video-instructed DA-CPR (n = 75, 19.4%) than in patients who received audio-instructed DA-CPR (n = 117, 6.8%). The survival to discharge rate was also higher in video-instructed DA-CPR (n = 105, 27.1%) than in audio-instructed DA-CPR (n = 211, 12.3%). **Video-instructed DA-CPR was significantly associated with neurologic recovery (aOR = 2.11, 95% CI 1.48-3.01) and survival to discharge (aOR = 1.81, 95% CI 1.33-2.46)** compared to audio-instructed DA-CPR in adult OHCA patients after adjusting for age, gender, underlying diseases and CPR

location. Video-instructed DA-CPR was associated with favorable outcomes in adult patients with OHCA in a metropolitan city equipped with sufficient experience and facilities.

2. Linderroth 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.

**Aim:** To investigate whether live video streaming from the bystander's smartphone to a medical dispatcher can improve the quality of bystander cardiopulmonary resuscitation (CPR) in out-of-hospital cardiac arrest (OHCA).

**Methods:** After CPR was initiated, live video was added to the communication by the medical dispatcher using smartphone technology. From the video recordings, we subjectively evaluated changes in CPR quality after the medical dispatcher had used live video to dispatcher-assisted CPR (DA-CPR). CPR quality was registered for each bystander and compared with CPR quality after video-instructed DA-CPR. Data were analysed using logistic regression adjusted for bystander's relation to the patient and whether the arrest was witnessed.

**Results:** CPR was provided with live video streaming in 52 OHCA calls, with 90 bystanders who performed chest compressions. Hand position was incorrect for 38 bystanders (42.2%) and improved for 23 bystanders (60.5%) after video-instructed DA-CPR. The compression rate was incorrect for 36 bystanders (40.0%) and improved for 27 bystanders (75.0%). Compression depth was incorrect for 57 bystanders (63.3%) and improved for 33 bystanders (57.9%). **The adjusted odds ratios for improved CPR after video-instructed DA-CPR were; hand position 5.8 (95% CI: 2.8-12.1), compression rate 7.7 (95% CI: 3.4-17.3), and compression depth 7.1 (95% CI: 3.9-12.9).** Hands-off time was reduced for 34 (37.8%) bystanders.

**Conclusions:** Live video streaming from the scene of a cardiac arrest to medical dispatchers is feasible. It allowed an opportunity for dispatchers to coach those providing CPR which was associated with a subjectively evaluated improvement in CPR performance.

### Summary of Evidence Update:

#### Evidence Update Process for topics not covered by ILCOR Task Forces

1. 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:** not reported

**RCT:** not reported

#### Nonrandomized Trials, Observational Studies

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)
Lee 2021 Korea	Retrospective cohort study N=2,109 (2018-2019)	Adult bystander- witnessed OHCA patients with DA- CPR due to	<b>Outcomes:</b> CPC 1,2 at discharge and survival <b>Results:</b> Video-instructed DA-CPR was significantly associated with	This study shows significant improvement of neurologic

		presumed cardiac etiology	neurologic recovery (aOR = 2.11, 95% CI 1.48-3.01) and survival to discharge (aOR = 1.81, 95% CI 1.33-2.46) than audio-based DA in multivariable logistic regression model.	outcome after adjustment. But, studies from other countries were needed to generalize.
Linderoth 2021 Denmark	Retrospective observational study N=52 OHCA (90 CPR)	OHCA with dispatcher-assisted CPR, Before vs after video-instruction	<b>Outcomes:</b> CPR quality <b>Results:</b> The adjusted odds ratios for improved CPR after video-instruction were; hand position 5.8 (95% CI: 2.8-12.1), compression rate 7.7 (95% CI: 3.4-17.3), and compression depth 7.1 (95% CI: 3.9-12.9).	Not survival outcomes reported.

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

In 2021 CoSTR summary, ILCOR suggest that the usefulness of video-based dispatch systems be assessed in clinical trials or research initiatives (weak recommendation, very low-certainty evidence). At that time, only 1 clinical study was available (Lee SY 2020). Now, 2 additional clinical studies (Lee HS 2021, Linderoth 2021) are found. Linderoth et al reported CPR quality as an outcome.

Both studies (Lee SY, Lee HS) were from Korea, but the inclusion period is not overlapped. So, meta-analysis was possible using 2 studies for ROSC, survival, and neurologic outcome. Pooled ORs with 95% CI were follows: 2.32 (1.87-2.88), 2.33 (1.87-2.91), and 2.77 (2.14-3.59), respectively.

We would better wait additional studies from other countries with maintaining previous recommendation (research initiatives).

	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. Lee HS, You K, Jeon JP, Kim C, Kim S. The effect of video-instructed versus audio-instructed dispatcher-assisted cardiopulmonary resuscitation on patient outcomes following out of hospital cardiac arrest in Seoul. Sci Rep. 2021 Jul 30;11(1):15555.



2. Linderøth 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.

Topic/PICO	Year last updated	Existing TR	RCTs since last review	Observational studies since last review	Key findings	Sufficient data to warrant SysRev?
Video-based dispatch system	2021	The usefulness of video-based dispatch systems be assessed in clinical trials or research initiatives (weak recommendation, very low-certainty evidence).	0	2	Video-based dispatch assisted CPR was significantly associated with CPR quality, survival to discharge and neurological recovery than audio-based dispatch.	No

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## 2022 Evidence Update Worksheet

**Worksheet author(s):** Mathias J. Holmberg

**Task Force:** ALS

**Date Submitted:** December 6, 2021

**Worksheet ID:** Vasopressors provided IV or IO during CPR

### **PICO / Research Question:**

Population: Adults (>18 years) with cardiac arrest in any setting (out-of-hospital or in-hospital)

Intervention: Vasopressor or a combination of vasopressors provided IV or IO during CPR

Comparators: No vasopressor, a different vasopressor, or a different combination of vasopressors provided IV or IO during CPR

Outcomes: Short-term survival (return of spontaneous circulation and survival to hospital admission), mid-term survival (survival to hospital discharge, 28 days, 30 days, or 1 month), mid-term favorable neurological outcomes (Cerebral Performance Category score of 1-2 or modified Rankin Scale 0-3 at hospital discharge, 28 days, 30 days, or 1 month) and long-term favorable and poor (modified Rankin Score 4-5) neurological outcomes (after 1 month)

**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:** 2019

### **Last ILCOR Consensus on Science and Treatment Recommendation:**

#### Treatment Recommendation in Adult Patients:

We recommend administration of epinephrine during cardiopulmonary resuscitation (strong recommendation, low to moderate certainty of evidence)

For non-shockable rhythms (PEA/asystole), we recommend administration of epinephrine as soon as feasible during cardiopulmonary resuscitation (strong recommendation, very low certainty of evidence)

For shockable rhythms (VF/VT), we suggest administration of epinephrine after initial defibrillation attempts are unsuccessful during cardiopulmonary resuscitation (weak recommendation, very low certainty of evidence)

We suggest against the administration of vasopressin in place of epinephrine during cardiopulmonary resuscitation (weak recommendation, very low certainty of evidence)

We suggest against the addition of vasopressin to epinephrine during cardiopulmonary resuscitation (weak recommendation, low certainty of evidence)

### **2010/2015/2020 Search Strategy:**

Resuscitation 2019, Jun; 139: 106-121

Vasopressors during adult cardiac arrest: a systematic review and meta-analysis

Holmberg MJ, Issa MS, Moskowitz A, Morley P, Welsford M, Neumar RW, Paiva EF, Coker A, Hansen CK, Andersen LW, Donnino MW, Berg KM, for the ALS Task Force at the ILCOR

### **2021 Search Strategy:**

("Heart Arrest"[Mesh] OR heart arrest[tiab] OR cardiac arrest[tiab] OR sudden cardiac death[tiab] OR cardiovascular arrest[tiab] OR cardiopulmonary arrest[tiab] OR cardiopulmonary failure[tiab] OR "Resuscitation"[Mesh] OR resuscitation[tiab] OR "Cardiopulmonary Resuscitation"[Mesh] OR cardiopulmonary resuscitation[tiab] OR cpr[tiab] OR code blue[tiab] OR code 99[tiab] OR basic life support[tiab] OR bls[tiab] OR "Advanced Cardiac Life Support"[Mesh] OR advanced cardiac life support[tiab] OR acls[tiab] OR pulseless electrical activity[tiab] OR "Ventricular Fibrillation"[Mesh] OR ventricular fibrillation[tiab] OR asystole[tiab] OR pulseless ventricular tachycardia[tiab]) AND ("Vasoconstrictor Agents"[Mesh] OR "Vasoconstrictor Agents" [Pharmacological Action] OR vasoconstrictor agent[tiab] OR vasoconstrictor agents[tiab] OR "Epinephrine"[Mesh] OR epinephrine[tiab] OR adrenalin[tiab] OR "Vasopressins"[Mesh] OR vasopressins[tiab] OR vasopressin[tiab] OR noradrenalin[tiab] OR norepinephrine[tiab] OR adrenaline acid tartrate[tiab] OR epinephrine hydrogen tartrate[tiab] OR adrenaline acid tartrate[tiab] OR epinephrine bitartrate[tiab] OR epinephrine hydrochloride[tiab] OR adrenaline hydrochloride[tiab]) AND (Clinical Trial[ptyp] OR Comparative Study[ptyp] OR Controlled Clinical Trial[ptyp] OR Guideline[ptyp] OR Meta-Analysis[ptyp] OR Multicenter Study[ptyp] OR Observational Study[ptyp] OR Practice Guideline[ptyp] OR Pragmatic Clinical Trial[ptyp] OR Randomized Controlled Trial[ptyp] OR systematic[sb])

**Database searched:** PubMed

**Date Search Completed:** Nov. 23, 2018 – Dec. 2, 2021

**Search Results:** 193 records screened; 12 studies were identified as relevant

**Inclusion/Exclusion Criteria:** RCTs, non-randomized trials, and observational studies

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

Jouffroy, The American Journal of Emergency Medicine, 2019

<https://pubmed.ncbi.nlm.nih.gov/29857945/>

Fothergill, Resuscitation, 2019

<https://pubmed.ncbi.nlm.nih.gov/30708076/>

Lupton, Resuscitation, 2019

<https://pubmed.ncbi.nlm.nih.gov/30902690/>

Sigal, Resuscitation, 2019

<https://pubmed.ncbi.nlm.nih.gov/30991079/>

Lundin, Resuscitation, 2019

<https://pubmed.ncbi.nlm.nih.gov/31125581/>

Aoki, Scientific Reports, 2019

<https://pubmed.ncbi.nlm.nih.gov/31289342/>

Yamamoto, Scandinavian Journal of Trauma, Resuscitation, and Emergency Medicine, 2019

<https://pubmed.ncbi.nlm.nih.gov/31420058/>

Grunau, Annals of Emergency Medicine, 2019

<https://pubmed.ncbi.nlm.nih.gov/31248676/>

Perkins, Intensive Care Medicine, 2020

<https://pubmed.ncbi.nlm.nih.gov/31912202/>

Tenney, Journal of Cardiology, 2020

<https://pubmed.ncbi.nlm.nih.gov/32107069/>

Haywood, Resuscitation, 2021

<https://pubmed.ncbi.nlm.nih.gov/33524488/>

Evans, BMJ, 2021

<https://pubmed.ncbi.nlm.nih.gov/34759038/>

### Summary of Evidence Update:

#### RCTs

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
Perkins; 2021	<u>Study Aim:</u>	<u>Inclusion Criteria:</u>	<u>Intervention:</u> Epinephrine	<u>1° endpoint:</u>	The effect of epinephrine on

	<p>Time to epinephrine vs placebo; 2014-2017; N = 8014</p> <p><b><u>Study Type:</u></b> Substudy of PARAMEDIC2</p>	<p>OHCA, age <math>\geq 16</math> years, ALS provided by trial-trained paramedics</p>	<p><b><u>Comparison:</u></b> Placebo</p>	<p>No difference in survival at 30 days between groups over time: OR for interaction, 0.98; 95%CI, 0.94 to 1.03</p> <p><b><u>2° endpoints:</u></b> ROSC increased for epinephrine vs placebo over time: OR for interaction, 1.03; 95%CI, 1.01 to 1.05</p> <p>No difference in Modified Rankin Scale 0-3 at 30 days between groups over time: OR for interaction, 0.98; 95%CI, 0.93 to 1.03</p>	<p>ROSC increased relative to placebo over time</p> <p><b><u>Study Limitations:</u></b> Few events for long term outcomes</p>
<p>Haywood; 2021</p>	<p><b><u>Study Aim:</u></b> Long term outcomes of adrenaline vs placebo in OHCA; 2014-2017; N = 8014</p> <p><b><u>Study Type:</u></b> Substudy of PARAMEDIC2</p>	<p><b><u>Inclusion Criteria:</u></b> OHCA, age <math>\geq 16</math> years, ALS provided by trial-trained paramedics</p>	<p><b><u>Intervention:</u></b> Epinephrine</p> <p><b><u>Comparison:</u></b> Placebo</p>	<p><b><u>1° endpoint:</u></b> Reported in original trial</p> <p><b><u>2° endpoints:</u></b> Survival at 6 months: 117 (2.9%) vs 85 (2.1%); OR, 1.43; 95%CI, 1.05 to 1.96</p> <p>Survival at 12 months: 107 (2.7%) vs 80 (2.0%); OR, 1.38; 95%CI, 1.00 to 1.92</p>	<p>Epinephrine improved survival through 12-month follow-up but there was no improvement in neurological outcomes</p> <p><b><u>Study Limitations:</u></b> Loss to follow-up</p>

				<p>Modified Rankin Scale 0-3 at 6 months: 78 (2.0%) vs 58 (1.5%); OR, 1.35; 95%CI, 0.93 to 1.97</p> <p>No difference in cognitive function and quality of life at 3 and 6 months between groups</p>	
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### 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)
Jouffrey; 2019	<b>Study Type:</b> Observational; 2007-2013; N = 1532	<b>Inclusion Criteria:</b> OHCA, age > 18 years, non-shockable initial rhythm, epinephrine administration	<b>Exposure:</b> Cumulative dose of epinephrine in those achieving ROSC to those not achieving ROSC  <b>1° endpoint:</b> ROSC: 4 mg (SD, 3 mg) vs 10 mg (SD, 4 mg); p = 0.04	The cumulative dose of epinephrine during OHCA was associated with failure to obtain ROSC
Fothergill; 2019	<b>Study Type:</b> Observational; 2012-2013; N = 3151	<b>Inclusion Criteria:</b> OHCA, age ≥ 18 years, at least one dose of epinephrine	<b>Exposure:</b> Repeated doses of epinephrine (≥ 3 doses vs 1 dose)  <b>1° endpoint:</b> Survival to hospital discharge: OR, 0.15; 95%CI, 0.09 to 0.26  <b>2° endpoints:</b> Survival to 1 year: OR, 0.18; 95%CI, 0.10 to 0.33	Repeated doses of epinephrine were associated with worse outcomes

Lupton; 2019	<b><u>Study Type:</u></b> Substudy of the PART trial; 2015-2017; N = 2404	<b><u>Inclusion Criteria:</u></b> OHCA, age $\geq 18$ years	<b><u>Exposure:</u></b> Time of epinephrine administration ( $< 10$ min vs $\geq 10$ min)  <b><u>1° endpoint:</u></b> ROSC: OR, 1.36; 95%CI, 1.05 to 1.77	Early administration of epinephrine was associated with improved survival
Sigal; 2019	<b><u>Study Type:</u></b> Observational; Not reported; N = 1826	<b><u>Inclusion Criteria:</u></b> OHCA, initial shockable rhythm, receiving epinephrine, more than 10 min of CPR	<b><u>Exposure:</u></b> Administration of epinephrine during CPR for survivors compared to non-survivors  <b><u>1° endpoint:</u></b> Timing, 5 min (SD, 10.1 min) vs 7 min (SD, 14.7 min); $p < 0.02$  Dosing, 2.0 doses (SD, 1.7) vs 3.0 doses (SD, 2.4); $p < 0.01$	Early epinephrine administration was associated with improved survival to hospital discharge but not with favorable neurological outcome
Lundin; 2019	<b><u>Study Type:</u></b> Observational; 2015-2017; N = 6033	<b><u>Inclusion Criteria:</u></b> IHCA, age $\geq 18$ years, index events	<b><u>Exposure:</u></b> Epinephrine vs no epinephrine during CPR  <b><u>1° endpoint:</u></b> ROSC: 72% vs 98% for shockable rhythms and 50% vs 65% for non-shockable rhythms; $p < 0.01$  <b><u>2° endpoints:</u></b> Survival at 30 days: 30% vs 85% for shockable rhythms and 12% vs 48% for non-shockable rhythms; $p < 0.01$  CPC 1-2 at 30 days: 22% vs 80% for shockable rhythms and 8% vs 41% for non-shockable rhythms; $p < 0.01$	Epinephrine during CPR was associated with worse outcomes  The association was reversed for non-shockable rhythms when stratified by CPR duration

Aoki, 2019	<b><u>Study Type:</u></b> Observational; 2012-2015; N = 5204	<b><u>Inclusion Criteria:</u></b> Traumatic OHCA	<b><u>Exposure:</u></b> Prehospital epinephrine administration vs no prehospital epinephrine administration  <b><u>1° endpoint:</u></b> Survival at 1 month: 11 (1.5%) vs 41 (0.9%); OR, 1.50; 95%CI, 0.76 to 2.95; OR after PS matching, 2.36; 95%CI, 0.61 to 9.22  <b><u>2° endpoints:</u></b> ROSC: 74 (9.8%) vs 40 (0.9%); OR, 3.78; 95%CI, 2.10 to 6.81; OR after PS matching, 6.87; 95%CI, 3.33 to 14.2	Prehospital epinephrine administration was not associated with survival at 1 month
Yamamoto; 2019	<b><u>Study Type:</u></b> Observational; 2012-2013; N = 356 (propensity matched)	<b><u>Inclusion Criteria:</u></b> Traumatic OHCA, age $\geq 15$ years,	<b><u>Exposure:</u></b> Epinephrine vs no epinephrine during in- hospital CPR  <b><u>1° endpoint:</u></b> Survival at 7 days: 1 (1%) vs 9 (5%); OR, 0.11; 95%CI, 0.01 to 0.85  <b><u>2° endpoints:</u></b> ROSC: 32 (18%) vs 16 (9%); OR, 2.21; 95%CI, 1.16 to 4.19	Epinephrine during in- hospital CPR was associated with decreased 7-day survival
Grunau; 2019	<b><u>Study Type:</u></b> Substudy of the ROC CCC trial; 2011-2015; N = 15909	<b><u>Inclusion Criteria:</u></b> OHCA, age $\geq 18$ years, CPR by EMS, at least two doses of epinephrine	<b><u>Exposure:</u></b> Epinephrine dosing interval ( $< 3$ min vs $\geq 5$ min intervals)  <b><u>1° endpoint:</u></b> Survival to hospital discharge with a MRS 0- 3: OR, 0.26; 95%CI, 0.19 to 0.35  <b><u>2° endpoints:</u></b>	Shorter epinephrine dosing intervals were associated with improved outcomes



			<p>Survival to hospital admission: OR, 0.20; 95%CI, 0.18 to 0.23</p> <p>Survival to hospital discharge: OR, 0.23; 95%CI, 0.18 to 0.30</p>	
Tenney; 2020	<p><b><u>Study Type:</u></b> Observational; 2016; N = 349</p>	<p><b><u>Inclusion Criteria:</u></b> IHCA, age &gt; 18 years, initial non-shockable rhythm</p>	<p><b><u>Exposure:</u></b> Time of epinephrine administration (&lt; 5 min vs &gt; 5 min)</p> <p><b><u>1° endpoint:</u></b> ROSC: 118 (49%) vs 38 (35%); OR, 1.63; 95%CI, 1.01 to 2.64</p> <p>Survival to hospital discharge: 10 (4.2%) vs 2 (1.8%); effect estimates not reported</p>	<p>Early epinephrine administration was associated with improved ROSC but not with survival to hospital discharge</p>
Evans; 2021	<p><b><u>Study Type:</u></b> Observational; 2000-2018; N = 18022 (propensity matched)</p>	<p><b><u>Inclusion Criteria:</u></b> IHCA, age ≥ 18 years, index events, initial shockable rhythm</p>	<p><b><u>Exposure:</u></b> Epinephrine vs no epinephrine prior to first defibrillation</p> <p><b><u>1° endpoint:</u></b> Survival to hospital discharge: 25% vs 30%; OR, 0.81; 95%CI, 0.74 to 0.88</p> <p><b><u>2° endpoints:</u></b> CPC 1-2: 19% vs 21%; OR, 0.85; 95%CI, 0.76 to 0.92</p> <p>ROSC: 64% vs 69%; OR, 0.76; 95%CI, 0.70 to 0.83</p>	<p>Epinephrine prior to defibrillation was associated with worse outcomes</p>

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

This update includes 2 secondary analyses of the PARAMEDIC2 trial and 10 observational studies. There is insufficient new data to pursue a Scoping Review or Systematic Review and unlikely to change the current treatment recommendation.

	<b>Approval Date</b>
<b>Evidence Update coordinator</b>	
<b>ILCOR board</b>	

**\*Once approval has been made by Evidence Update coordinator, worksheet will go to ILCOR Board for acknowledgement.**

## Reference list

Jouffroy, R et al. Epinephrine administration in non-shockable out-of-hospital cardiac arrest. The American Journal of Emergency Medicine, 2019. Mar; 37(3): 387-390

Fothergill, RT et al. Repeated adrenaline doses and survival from an out-of-hospital cardiac arrest. Resuscitation, 2019. May; 138: 316-321

Lupton, RJ et al. Effect of initial airway strategi on time to epinephrine administration in patients with out-of-hospital cardiac arrest. Resuscitation, 2019. Jun; 139: 314-320

Sigal, A et al. Impact of adrenaline dose and timing on out-of-hospital cardiac arrest survival and neurological outcomes. Resuscitation, 2019. Jun; 139: 182-188

Lundin, A et al. Adrenaline, ROSC, and survival in patients resuscitated from in-hospital cardiac arrest. Resuscitation, 2019. Jul; 140: 64-71

Aoki, M et al. Association of prehospital epinephrine administration with survival among patients with traumatic cardiac arrest caused by traffic collisions. Scientific Reports, 2019. Jul; 9(1): 9922

Yamamoto, R et al. Epinephrine during resuscitation of traumatic cardiac arrest and increased mortality: a post hoc analysis of prospective observational study. Scandinavian Journal of Trauma, Resuscitation, and Emergency Medicine, 2019. Aug; 27(1): 74

Grunau, B et al. The association of the average epinephrine dosing interval and survival with favorable neurologic status at hospital discharge in out-of-hospital cardiac arrest. Annals of Emergency Medicine, 2019. Dec; 74(6): 797-806

Perkins, GD et al. The influence of time to adrenaline administration in the PARAMEDIC2 randomized controlled trial. Intensive Care Medicine, 2020. Mar; 46(3): 426-436

Tenney, JW et al. Retrospective evaluation of resuscitation medication utilization in hospitalized adult patients with cardiac arrest. Journal of Cardiology, 2020. Jul; 76(1): 9-13

Haywood, KL et al. Long term outcomes of participants in the PARAMEDIC2 randomized trial of adrenaline in out-of-hospital cardiac arrest. Resuscitation, 2021. Mar; 160: 84-93

Evans, E et al. Epinephrine before defibrillation in patients with shockable in-hospital cardiac arrest: propensity matched analysis. *BMJ*, 2021. Nov; 375: e066534

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## 2022 Evidence Update Worksheet

**Worksheet author(s):** Asger Granfeldt, Mathias J. Holmberg, Bernd W. Böttiger, Wolfgang A. Wetsch

**Task Force:** ALS

**Date Submitted:** Dec, 2021

**Worksheet ID:** Cardiac Arrest due to PE

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

**Population:** *Among adults who are in cardiac arrest due to PE or suspected PE in any setting*

**Intervention:** *Does any specific alteration in treatment algorithm (eg, fibrinolytics, or any other intervention)*

**Comparators:** *Standard advanced life support care*

**Outcomes:** Survival with favorable neurological/functional outcome at discharge, 30 days, 60 days, 180 days AND/OR 1 year. Survival at discharge, 30 days, 60 days, 180 days AND/OR 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) are eligible for inclusion. Unpublished studies (e.g., conference abstracts, trial protocols) are 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 dates below.*

### Additional Evidence Reviewer(s):

**Conflicts of Interest (financial/intellectual, specific to this question):** AG, WAW, MJH non to declare. BWB is treasurer of the European Resuscitation Council (ERC), Chairman of the German Resuscitation Council (GRC), Member of the Advanced Life Support (ALS) Task Force of the International Liaison Committee on Resuscitation (ILCOR), Member of the Executive Committee of the German Interdisciplinary Association for Intensive Care and Emergency Medicine (DIVI), Founder of the “Deutsche Stiftung Wiederbelebung”, Federal Medical Advisor of the German Red Cross, Co-Editor of “Resuscitation”, Editor of the Journal “Notfall + Rettungsmedizin”, Co-Editor of the Brazilian Journal of Anesthesiology. He received fees for lectures from the following companies: Forum für medizinische Fortbildung (FomF), Baxalta Deutschland GmbH, ZOLL Medical Deutschland GmbH, C.R. Bard GmbH, GS Elektromedizinische Geräte G. Stemple GmbH, Novartis Pharma GmbH, Philips GmbH Market DACH, Bioscience Valuation BSV GmbH.

Wolfgang A. Wetsch: None to declare.

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

## Last ILCOR Consensus on Science and Treatment Recommendation:

We suggest administering fibrinolytic drugs for cardiac arrest when PE is the suspected cause of cardiac arrest (weak recommendation, very low certainty of evidence).

We suggest the use of fibrinolytic drugs or surgical embolectomy or percutaneous mechanical thrombectomy for cardiac arrest when PE is the known cause of cardiac arrest (weak recommendation, very low certainty of evidence).

The role of extracorporeal life support (eCPR) techniques has been addressed in the 2019 ILCOR CoSTR {Soar 2019 145}{Karami, 2021 #14}{ Soar 2019 e82}

We suggest that extracorporeal CPR may be considered as a rescue therapy for selected patients with cardiac arrest when conventional CPR is failing in settings in which it can be implemented (weak recommendation, very low certainty of evidence).

## 2010/2015 Search Strategy:

### 2019 Search Strategy:

**PubMed:** ( Search Completed: September 14, 2019 ) (ROSC[TIAB] OR "return of spontaneous circulation"[TIAB] OR "Heart Arrest"[Mesh] OR "heart arrest"[TIAB] OR "heart arrests"[TIAB] OR "cardiac arrest"[TIAB] OR "cardiac arrests"[TIAB] OR "cardiovascular arrest"[TIAB] OR asystole\*[TIAB] OR "pulseless electrical activity"[TIAB] OR "cardiopulmonary arrest"[TIAB] OR "cardiopulmonary arrests"[TIAB] OR "cardio-pulmonary arrest"[TIAB] OR "cardio-pulmonary arrests"[TIAB] OR "resuscitation"[Mesh] OR resuscitation[TIAB] OR "Advanced Cardiac Life Support"[TIAB] OR "advanced life support"[TIAB]) AND ("pulmonary thromboembolism"[TIAB] OR "pulmonary embolism"[TIAB] OR "lung embolism"[TIAB] OR pulmonary embolism[MeSH] OR embolectomy[MeSH] OR embolectomy[TIAB] OR Thrombolytic therapy[MeSH] OR Thrombectomy[MeSH] OR Thrombectomy[TIAB] OR Thrombolytic\*[TIAB] OR Thrombolysis[TIAB] OR Fibrinolytic Agents [Mesh] OR Fibrinolytic\*[TIAB] OR Fibrinolysis[MeSH] OR Fibrinolysis[TIAB] OR Streptokinase[TIAB] or urokinase[TIAB] or alteplase[TIAB] or reteplase[TIAB] or tenecteplase[TIAB] or anistreplase[TIAB] or rt-PA[TIAB]) NOT ("letter"[Publication Type] OR "comment"[Publication Type] OR "editorial"[Publication Type] or Case Reports[Publication Type] OR News[Publication Type]) NOT (animals[mesh] NOT humans[mesh])

**Embase:** ( Search Completed: September 14, 2019 ) (ROSC:ti,ab OR "return of spontaneous circulation":ti,ab OR "heart arrest"/exp OR "heart arrest":ti,ab OR "heart arrests":ti,ab OR "cardiac arrest":ti,ab OR "cardiac arrests":ti,ab OR "cardiovascular arrest":ti,ab OR asystole\*:ti,ab OR "pulseless electrical activity":ti,ab OR "cardiopulmonary arrest"/exp OR "cardiopulmonary arrest":ti,ab OR "cardiopulmonary arrests":ti,ab OR "cardio-pulmonary arrest":ti,ab OR "cardio-pulmonary arrests":ti,ab OR "resuscitation"/exp OR resuscitation:ti,ab OR "Advanced Cardiac Life Support":ti,ab OR "advanced life support":ti,ab) AND ("pulmonary thromboembolism":ti,ab OR "pulmonary embolism":ti,ab OR "lung embolism":ti,ab OR "lung embolism"/exp OR "embolectomy"/exp OR embolectomy:ti,ab OR "fibrinolytic therapy"/exp OR "thrombectomy"/exp OR Thrombectomy:ti,ab OR Thrombolytic\*:ti,ab OR Thrombolysis:ti,ab OR "fibrinolytic agent"/exp OR Fibrinolytic\*:ti,ab OR "fibrinolysis"/exp OR Fibrinolysis:ti,ab OR "plasminogen activator"/exp OR Streptokinase:ti,ab OR urokinase:ti,ab OR alteplase:ti,ab OR reteplase:ti,ab OR tenecteplase:ti,ab OR anistreplase:ti,ab OR rt+PA:ti,ab) NOT ("animal"/exp NOT "human"/exp) NOT ("editorial"/lim OR "letter"/lim OR "case report"/de) AND [embase]/lim

## 2021 search strategy

### Pubmed

(ROSC[TIAB] OR "return of spontaneous circulation"[TIAB] OR "Heart Arrest"[Mesh] OR "heart arrest" [TIAB] OR "heart arrests"[TIAB] OR "cardiac arrest" [TIAB] or "cardiac arrests" [TIAB] OR "cardiovascular arrest"[TIAB] or asystole\*[TIAB] OR "pulseless electrical activity" [TIAB] or "cardiopulmonary arrest" [TIAB] or "cardio-pulmonary arrest" [TIAB] OR "cardiopulmonary arrests" [TIAB] or "resuscitation"[Mesh] OR resuscitation[TIAB] OR "Advanced Cardiac Life Support" [TIAB] OR "advanced life support" [TIAB]) AND ("pulmonary thromboembolism" [TIAB] OR "pulmonary embolism" [TIAB] OR "lung embolism" [TIAB] or pulmonary embolism[Mesh] OR embolectomy[Mesh] OR embolectomy[TIAB] OR Thrombolytic therapy[Mesh] OR Thrombectomy[Mesh] OR Thrombectomy[TIAB] OR Trombolytic\*[TIAB] OR Thrombolysis[TIAB] OR Fibrinolytic Agents[Mesh] OR Fibrinolytic\*[TIAB] OR Fibrinolysis[Mesh] OR Fibrinolysis[TIAB] OR Streptokinase[TIAB] OR urokinase[TIAB] OR alteplase[TIAB] OR reteplase[TIAB] OR tenecteplase[TIAB] OR anistreplase[TIAB] OR rt-PA[TIAB]) NOT ("letter"[Publication Type] OR "comment" [Publication Type] OR "editorial" [Publication Type] or Case Reports[Publication Type] OR News[Publication Type]) NOT (animals[Mesh] NOT humans[mesh])

### Embase

(ROSC:ti,ab OR 'return of spontaneous circulation':ti,ab OR 'Heart Arrest'/exp OR 'heart arrest':ti,ab OR 'heart arrests':ti,ab OR 'cardiac arrest':ti,ab or 'cardiac arrests':ti,ab OR 'cardiovascular arrest':ti,ab OR asystole\*:ti,ab OR

'pulseless electrical activity':ti,ab or 'cardiopulmonary arrest':ti,ab OR 'cardio-pulmonary arrest':ti,ab OR 'cardiopulmonary arrests':ti,ab or 'resuscitation'/exp OR resuscitation:ti,ab OR 'Advanced Cardiac Life Support':ti,ab OR 'advanced life support':ti,ab) AND ('pulmonary thromboembolism':ti,ab OR 'pulmonary embolism':ti,ab OR 'lung embolism':ti,ab or 'pulmonary embolism'/exp OR 'embolectomy'/exp OR embolectomy:ti,ab OR 'Thrombolytic therapy'/exp OR 'Thrombectomy'/exp OR Thrombectomy:ti,ab OR Trombolytic\*:ti,ab OR Thrombolysis:ti,ab OR 'Fibrinolytic Agents'/exp OR Fibrinolytic\*:ti,ab OR 'Fibrinolysis'/exp OR Fibrinolysis:ti,ab OR Streptokinase:ti,ab OR urokinase:ti,ab OR alteplase:ti,ab OR reteplase:ti,ab OR tenecteplase:ti,ab OR anistreplase:ti,ab OR rt-PA:ti,ab) NOT ('animal'/exp OR 'animal') NOT ('case report'/exp OR 'review'/exp)

**Database searched:** 11/29/2021

**Date Search Completed:** 11/29/2021

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

### **Inclusion criteria**

PE as suspected or confirmed cause of cardiac arrest

Ongoing cardiopulmonary resuscitation (CPR)

Only considering studies with at least 10 patients

### **Exclusion Criteria:**

ROSC before intervention

Other probable or confirmed causes of cardiac arrest

Outcome of patients with CA due to PE could not be differentiated from CA from other possible causes (i.e. no subgroup analysis)

Not true cardiac arrest models (e.g. exsanguination, great vessel occlusion, carotid artery occlusion)

Cooling (therapeutic hypothermia) pre or during arrest

Cardiopulmonary bypass or ECMO as addressed in ECPR SR

Other probable/confirmed cause of cardiac arrest

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

De Paz, 2021 <https://pubmed.ncbi.nlm.nih.gov/33654439/>

Henriksson, 2021 <https://pubmed.ncbi.nlm.nih.gov/34766067/>

Javaudin, 2019 <https://pubmed.ncbi.nlm.nih.gov/31381884/>

Keller, 2020 <https://pubmed.ncbi.nlm.nih.gov/31102407/>

### **Summary of Evidence Update:**

#### **Evidence Update Process for topics not covered by ILCOR Task Forces**

1. 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
	<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)
De Paz, 2021	<u>Study Type:</u> Observational 2013-2017 16 patients	<u>Inclusion Criteria:</u> Confirmed or highly suspected PE as the primary cause of the CA and who had received CPR with or without emergency thrombolysis (subgroup)	<u>Exposure:</u> Thrombolysis  <u>1° endpoint:</u> 30 day survival Thrombolysis 5/8 (63%) vs no thrombolysis 5/7 (71%) p=1.0	No difference In survival or survival with a good neurological outcomes  Unadjusted results, high risk of bias
	<u>Study Type:</u> Observational	<u>Inclusion Criteria:</u>	<u>Exposure:</u> Thrombolysis	Thrombolysis is often not administered but

<b>Henriksson, 2021</b>	2007-2020 64 patients	In-hospital cardiac arrest and pulmonary embolism	<b><u>1° endpoint:</u></b> Survival to hospital discharge Thrombolysis 7/16 (44%) No thrombolysis 4/48 (%8.3) p<0.01	thrombolysis may increase survival to hospital discharge  Unadjusted results, high risk of bias
<b>Javaudin, 2019</b>	<b><u>Study Type:</u></b> Observational 2013-2018 246 patients	<b><u>Inclusion Criteria:</u></b> Out-of-hospital cardiac arrest and pulmonary embolism	<b><u>Exposure:</u></b> Thrombolysis  <b><u>1° endpoint:</u></b> 30 day survival Thrombolysis 9/58 (16%) No thrombolysis 12/188 (6%) p<0.06	Absolute higher survival in patients treated with thrombolysis, but not significant  Unadjusted results, high risk of bias
<b>Keller, 2020</b>	<b><u>Study Type:</u></b> Observational 2005-2015 60519 patients	<b><u>Inclusion Criteria:</u></b> <u>Pulmonary embolism and patients who necessitated CPR (subgroup)</u>	<b><u>Exposure:</u></b> Thrombolysis and Embolectomy  <b><u>1° endpoint:</u></b> All-cause in-hospital death  Trombolysis vs no thrombolysis OR .92 (95% CI 0.87-0.97), p = 0.002 Embolectomy vs no embolectomy OR 0.82 (95%CI 0.60–1.11) p = 0.2	Lower survival in patients treated with thrombolysis  Adjusted results, high risk of bias

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

This update includes 4 observational studies with a limited number of patients. There is insufficient new data to pursue a Scoping Review or Systematic Review for the current PICO as very unlikely to change current treatment recommendation. There is a need for an evidence update that includes extracorporeal cardiopulmonary resuscitation for the treatment of pulmonary embolus.



	<b>Approval Date</b>
<b>Evidence Update coordinator</b>	
<b>ILCOR board</b>	

**\*Once approval has been made by Evidence Update coordinator, worksheet will go to ILCOR Board for acknowledgement.**

### **Reference list**

1. de Paz D, Diez J, Ariza F, Scarpetta DF, Quintero JA, Carvajal SM. Emergency Thrombolysis During Cardiac Arrest Due to Pulmonary Thromboembolism: Our Experience Over 6 Years. Open Access Emerg Med. 2021;13:67-73.
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**\*\*CONFIDENTIAL DO NOT DISTRIBUTE\*\*****2022 Evidence Update Worksheet****Worksheet author(s):** Amelia Reis, Thomaz Bittencourt Couto, Antonio Nunes**Task Force:** PLS**Date Submitted:** July/2021**Worksheet ID:** PLS 388 Sodium bicarbonate administration for children in cardiac arrest

<b>PICOST</b>	<b>Description (with recommended text)</b>
<b>Population</b>	<i>Infants, children and adolescents in any setting (out and in-hospital) in cardiac arrest.</i>
<b>Intervention</b>	<i>sodium bicarbonate administration or buffering agents</i>
<b>Comparison</b>	<i>no sodium bicarbonate administration or no buffering agents</i>
<b>Outcomes</b>	<i>ROSC, survival and brain function at discharge and or 30 days and between 6 and 12 months after arrest</i>
<b>Study Design</b>	<i>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. Evidence Updates only Systematic Reviews and guideline publications and large case series n&gt;20 are eligible for inclusion.</i>
<b>Type</b>	<i>interventions</i>
<b>Timeframe</b>	<i>AFTER 2009 and all languages are included as long as there is an English abstract</i>

**Additional Evidence Reviewer(s):****Conflicts of Interest (financial/intellectual, specific to this question):** None**Year of last full review:**

- **2010: worksheet Peds-028**
- **2020: PLS 388: EvUp.**

**Last ILCOR Consensus on Science and Treatment Recommendation:***Treatment recommendations 2010**Routine administration of sodium bicarbonate is not recommended in the management of paediatric cardiac arrest. (Class III, LOE B).***Search Strategy:****Date Search Completed:** 2009 to June 2021

**Database searched:** Pubmed

*((cardiac arrest[MeSH Terms]) OR (arrest, cardiopulmonary[MeSH Terms])) AND (cardiopulmonary resuscitation[MeSH Terms]) OR (buffers[MeSH Terms])  
Limited to children*

Studies from 2010 guidelines	Studies from 2020 guidelines (ERC-EvUp)	Studies after guidelines 2020
Meert 2009 Vukmir 2006 Lokesh 2004	Wu 2009 RaymondT 2013. Lopez-Herce 2014 Del Castillo 2014 Raymond 2015 Matamoros 2015 Mok. 2016 Nehme 2018 Wolfe 2019	<b>Chang 2020 (SR)</b> that include the following articles: Mos 2006# Wu 2009 Haque 2011 Lopez-Herce2014 Raymond 2015 Mok 2016 Sutton 2018#
	<b>Others</b> Herman 2009 Haque 2011	

# not included in EvUp from guidelines 2020

## Relevant Guidelines and 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
ILCOR; Caen AR, Kleinman ME, et al. 2010	Guideline ILCOR Pediatric CoSTR	PLS 52 Sodium bicarbonate during cardiac arrest. Peds-028.	3	There are no randomised controlled studies in infants and children examining the use of sodium bicarbonate as part of the management of paediatric cardiac arrest. One LOE 2 multicentre retrospective in-hospital paediatric study(Meert 2009) found that sodium bicarbonate administered during cardiac arrest was associated with decreased survival, even after controlling for age, gender, and first documented cardiac rhythm. Two LOE 5 randomised controlled studies have examined the value of sodium bicarbonate in the management of arrest in other populations: one adult out-of-hospital	Routine administration of sodium bicarbonate is not recommended in the management of paediatric cardiac.

				cardiac arrest study (Vukmir 2006) and one study in neonates with respiratory arrest in the delivery room.(Lokesh 2004) Both failed to show an improvement in overall survival.	
AHA, Kleinman ME 2010	Guideline AHA		3		Routine administration of sodium bicarbonate is not recommended in cardiac arrest (Class III, LOE B). Sodium bicarbonate may be administered for treatment of some toxidromes or special resuscitation situations such as hyperkalemic cardiac arrest.
ILCOR; Maconochie IK, 2020	Guideline ILCOR Pediatric CoSTR	Sodium Bicarbonate Administration for Children in Cardiac Arrest. PLS 388: EvUp.	9	Sodium Bicarbonate Administration for Children in Cardiac Arrest (PLS 388: EvUp) The most recent PLS Task Force review of the EvUp was performed and found insufficient evidence to consider a SysRev of this topic, so the recommendations of 2010 remain in effect. To review the EvUp, see Appendix C Supplement Appendix C-29. <a href="https://doi.org/10.1016/j.resuscitation.2020.09.013">https://doi.org/10.1016/j.resuscitation.2020.09.013</a>	The treatment recommendation was unchanged from 2010: Routine administration of sodium bicarbonate is not recommended in the management of pediatric cardiac arrest.
ERC Patrick Van de Voorde 2021	Guideline ERC 2020		9	one narrative review and nine observational trials describing the association between the administration of sodium bicarbonate (or THAM) and outcomes in paediatric CA did not provide evidence to change previous recommendation	bicarbonate should not be given routinely in paediatric CA.

AHA, Topjian AA 2020	Guideline AHA 2020		8	review identified 8 observational studies of sodium bicarbonate administration during cardiac arrest. Bicarbonate administration was associated with worse survival outcomes for both IHCA and OHCA. There are special circumstances in which bicarbonate is used, such as the treatment of hyperkalemia and sodium channel blocker toxicity, including from tricyclic antidepressants.	Routine administration of sodium bicarbonate is not recommended in pediatric cardiac arrest in the absence of hyperkalemia or sodium channel blocker (eg. tricyclic antidepressant) toxicity
<i>Chang CY, Wu PH, Hsiao CT, Chang CP, Chen YC, Wu KH Resuscitation. 2021 May;162:188-197.</i>	SR	<i>Sodium bicarbonate (SB) administration during in-hospital pediatric cardiac arrest: A systematic review and meta-analysis.</i>	7	The findings are on the next table See below	This meta-analysis of non-randomized studies supported current PLS guideline that routine administration of SB is not recommended in pediatric cardiac arrest except in special resuscitation situations.

## Recent systematic review:

Adapted from Chang, Resuscitation 2021 (systematic review and meta-analysis)

Author	Data collection	Patient number	Age	Outcome
Mos 2006	1997 to 2002 retrospective	91 (SB: 46 )	Mean: 4y 1d to 17.7 y	Survival to <b>hospital discharge</b> OR 0.68 (95%CI:0.26-1.77)
Wu 2009	2000 to 2006 Retrospective Prospective	252 (SB: 168)	Mean: 3.8y	Survival to <b>hospital discharge</b> OR 0.63(95%CI0.33-1.18)
Haque 2011	2001to 2006 Retrospective	106 (SB: 47)	Mean:2.1y 1m-14y	Survival to <b>hospital discharge</b> OR 0.09(95%CI0.01-0.76)
Lopez-Herce	2007 to 2009 Prospective	494 (SB: 278)	Mean: 3.7y 1m-18 y	Survival to <b>hospital discharge</b> OR0.30(95%CI0.20-0.43)

Raymond 2015	2000 to 2010 Retrospective	3719 (SB: 2536)	SB group Median: 0.83y No SB group Median: 0.42 y	Survival to <b>hospital discharge</b> OR 0.60(95%CI 0.51-0.70) <b>24-h survival:</b> OR 0.72(95% CI 0.62-0.84) Survival with <b>good neurologic outcome</b> at discharge: OR 0.59(95% CI 0.48-0.73)
Mok 2016	2009 to 2014 Retrospective	51 (SB:23)	Survivors median: 0.6y (IQR 0.3-5.5) No- Survivors median 2.9y (IQR 1.0-8.7)	Survival to <b>hospital discharge</b> OR 0.03(95% CI 0.01-0.17)
Sutton 2018	2013 to 2016 Prospective	164 (SB: 93)	< 1 y: 98 ≥ 1 y:66	Survival to <b>hospital discharge</b> OR 0.46 (95%CI0.25-0.87)

**Key study:** (sentinel papers that are appropriate to answer this PICO. Please insert full references)

Raymond TT, Stromberg D, Stigall W, Burton G, Zaritsky A; American Heart Association's Get With The Guidelines-Resuscitation Investigators. Sodium bicarbonate use during in-hospital pediatric pulseless cardiac arrest - a report from the American Heart Association Get With The Guidelines<sup>®</sup>-Resuscitation. Resuscitation. 2015 Apr;89:106-13. doi: 10.1016/j.resuscitation.2015.01.007. Epub 2015 Jan 20. PMID: 25613362; PMCID: PMC6155484

3719 pediatric CPR events (<18y), GWTG-R database, 2000-2010

68% received SB (from 2000-2005: 71,1%, from 2006-2010: 66,2%; p=0.002)

Adjusting for confounding factors, SB was associated with decreased survival to hospital discharge (aOR 0.80; 95%CI: 0.65-0.97).

In group of patients with metabolic/electrolyte abnormalities, hyperK and toxidromes (n=674), SB was not associated with decreased survival.

Author Study design	Findings	Outcome	Observations
Raymond 2015  Retrospective GWTG-R database Data collection: 2000 to 2010 <18 y N= 3719	SB used: 2000-2010: 68%  2000-2005: 71% 2006-2010: 66% p=0.002	Survival to <b>hospital discharge</b> OR 0.60(95%CI0.51-0.70)  <b>24-h survival:</b> OR 0.72(95% CI 0.62-0.84)  Survival with <b>good neurologic outcome</b> at discharge: OR 0.59(95% CI 0.48-0.73)  Adjusting: survival to <b>hospital discharge</b> (aOR 0.80; 95%CI: 0.65-0.97) No difference in <b>neurologic outcome</b>	N=674 with metabolic/electrolyte disturbances, hyperK, toxicologic abnormalities  Survival to <b>hospital discharge</b> aOR 1.52 (95%CI:84-2.77)  Survival with <b>good neurologic outcome</b> at discharge: aOR 0.61(95% CI 0.09-4.16)

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

The rationale for using sodium bicarbonate during CPR is to minimize the metabolic acidosis that develops in the absence of adequate tissue oxygenation, cardiac arrest being the most critical example of this situation.

(Vukmir 2006) However, as with other therapeutic attempts, there is a lack of evidence of the benefit of using bicarbonate in pediatric CPR and there is still doubt as to whether its use is safe or even harmful. (Aschner 2008)

The 2005 guideline (Circulation 2005;112:167–87) established that the routine administration of sodium bicarbonate has not been shown to improve outcome of resuscitation and could be considered for prolonged cardiac arrest or for some toxidromes after effective ventilation and chest compressions. Also in this guideline it was hypothesized that: excessive sodium bicarbonate may impair tissue oxygen delivery; cause hypokalemia, hypocalcemia, hypernatremia, hyperosmolality; decrease the VF threshold; and impair cardiac function.

2010 guidelines recommended that routine administration of sodium bicarbonate is not recommended in the management of pediatric cardiac arrest.

An EvUp was performed in 2019 by the ERC including 9 articles published after 2009, all of which are observational retrospectives. This review concluded that the 2010 guidance should be maintained in 2020, ie a recommendation against routine use of SB during pediatric CPR.

Although the use of SB in pediatric cardiac arrest has declined (Lomba 2019), in practice SB is still frequently used (38-56,7%) in CPR after chest compressions, “some epinephrines” and intubation. (Sutton 2018, Nehme 2018). Therefore, Ilcor peds task-force has decided that this 2021 EvUp would be needed.

After 2019 EvUp ( <https://doi.org/10.1016/j.resuscitation.2020.09.013> ) a systematic review and meta-analysis (Chang 2021) was published by a group from Taiwan. This study included 7 observational studies (2 prospective) published from 2006 to 2018 were included, with a total of 4877 pediatric in-hospital CA. The Research was made on Pubmed, Embase and Cochrane. Studies that had two treatment arms (treated with SB or not) were selected. Risk of bias was assessed using NOS and certainty of evidence using GRADE.

This meta-analysis showed SB during CPR was associated with significantly decreased rate to **hospital discharge** (OR=0.40, IC:0.25-0.63, p=0.0003). There were Insufficient studies to neurologic outcomes analysis. The certainty of evidence was very low to low.

Subgroup analyses were done based on data collection period (“before 2010” and “after 2010”) and survival rates were lower in patients who received SB in both groups. Subgroup analyses weren’t done in special circumstances (hyperK, acidosis, overdose) because a lack of studies in pediatric resuscitation. This study supports the current guideline and summarizes the results from other studies

#### Summary of Evidence Update:

##### Evidence Update Process for topics not covered by ILCOR Task Forces

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

	<b>Approval Date</b>
<b>Evidence Update coordinator</b>	

<b>ILCOR board</b>	
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**\*Once approval has been made by Evidence Update coordinator, worksheet will go to ILCOR Board for acknowledgement.**

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## **2020 Treatment Recommendations : Sodium bicarbonate administration for children in cardiac arrest (PLS New: EvUps)**

### ***2020 ILCOR guidelines***

#### **Treatment Recommendations**

Routine administration of sodium bicarbonate is not recommended in the management of pediatric cardiac arrest.

#### **Current data supports this recommendation**

#### **Knowledge gaps**

*No randomized study, only observational.*

*There is insufficient data about the use of bicarbonate in special circumstances, such as hypercalemia, metabolic acidosis previous and intoxication drug.*

*An important confounder must be considered when analyzing the association between administration of sodium bicarbonate and longer CPR duration, as this drug is given more frequent in prolonged arrest.*

*There are lack of information about sodium bicarbonate administration: solution concentration, dose, timing, vias*

*The role of other buffering is not known in pediatric cardiac arrest*

*Possible confounders (as in any intervention evaluation) must be considered: conditions before arrest (acidosis, hypotension, sepsis, metabolic disturbances, chronic diseases, etc), during CPR (rhythm, medications, timing, ECPR, etc) pos-arrest (temperature, oxygenation, vasopressor, glucose control, etc)*

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**2022 Evidence Update Worksheet**

**Worksheet author(s):** Monica Kleinman, Steve Schexnayder

**Task Force:** PLS

**Date Submitted:** December 5, 2021

**Worksheet ID:** PLS 414 Chest Compression Only CPR vs. Conventional CPR

**PICO / Research Question:**

**P:** Infants, children and adolescents in any setting (IH or OH) with cardiac arrest

**I:** Chest compression-only CPR

**C:** Conventional CPR (with rescue breathing)

**Outcomes:** ROSC, survival and brain function at discharge and or 30 days and between 6 and 12 months after arrest

**Type:** intervention

**Additional Evidence Reviewer(s):** none

**Conflicts of Interest (financial/intellectual, specific to this question):** none

**Year of last full review:** 2015

**Last ILCOR Consensus on Science and Treatment Recommendation:**

We recommend that rescuers provide rescue breaths and chest compressions for pediatric IHCA and OHCA. If rescuers cannot provide rescue breaths, they should at least perform chest compressions (strong recommendation, low-quality evidence).

**Outcome =** 30-day neurologically intact survival

**No evidence for** 1-year neurologically intact survival, ICU LOS, survival to discharge

**2010/2015 Search Strategy:**

**2019 Search Strategy:**

**2021 Search Strategy:**

("Cardiopulmonary Resuscitation"[Mesh] OR "Out-of-Hospital Cardiac Arrest"[Mesh] OR "Cardiopulmonary Resuscitation"[tiab] OR "CPR"[tiab]) AND ("compression-only"[tiab] OR "compression only"[tiab] OR (compression\*[tiab] AND interrupt\*[tiab]))

**Database searched:** Pubmed

**Date Search Completed:** 12/22/21

**Search Results (Number of articles identified / number identified as relevant):** 12/1

**Inclusion/Exclusion Criteria:**

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

<https://www.ncbi.nlm.nih.gov/sites/myncbi/1bwgSveDmlmYst/collections/61435827/public/>

**Summary of Evidence Update:****Evidence Update Process for topics not covered by ILCOR Task Forces**

1. 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:** **NONE**

**RCT:** **NONE**

**Nonrandomized Trials, Observational Studies**

<b>Study Acronym; Author; Year Published</b>	<b>Study Type/Design; Study Size (N)</b>	<b>Patient Population</b>	<b>Primary Endpoint and Results (include P value; OR or RR; &amp; 95% CI)</b>	<b>Summary/Conclusion Comment(s)</b>
Naim, 2021	<u>Study Type:</u> Retrospective Registry Review (CARES Registry)	<u>Inclusion Criteria:</u> Out of hospital non-traumatic pediatric cardiac arrests (age $\leq 18$ )	Adj. ORs comparing Rescue breathing CPR (RB- CPR and no CPR) (95% CI) Infants 1.65 (1.19-2.3, $p=0.003$ ) Children 2.73 (2.00-3.72, $p<0.001$ ) Adolescents 2.12 (1.44-3.11, $p<0.001$ )  Comparing Compression Only (CO) and no CPR (95% CI) Infants 1.16 (0.083-1.62, $p=0.394$ ) Children 1.94 (1.41-2.68, $p<0.001$ ) Adolescents 1.71 (1.23-2.37, $p<0.001$ )	In age-stratified analysis, RB-CPR was associated with better neurologically favorable survival versus no CPR in all age groups. CO-CPR was associated with better neurologically favorable survival compared with no CPR in children and adolescents, but not in infants.

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

The one study published since the last CoSTR publication study supports our current recommendation that best practice remains includes providing both rescue breathing in combination with chest compressions in pediatric cardiac arrest.

Despite the study reaffirming evidence from over a decade ago (Kitamura 2010 1347) that compression only CPR is infants is no better than no CPR, the task force continues to recommend the provision of compression only CPR for infants in cardiac arrest when rescuers are unwilling or unable to provide rescue breathing.

	<b>Approval Date</b>
<b>Evidence Update coordinator</b>	
<b>ILCOR board</b>	

**\*Once approval has been made by Evidence Update coordinator, worksheet will go to ILCOR Board for acknowledgement.**

#### **Reference list:**

Naim MY, Griffis HM, Berg RA, Bradley RN, Burke RV, Markenson DM, McNally BF, Nadkarni VN, Song L, Vellano K, Vetter V, Rossano JW. Compression-Only Versus Rescue-Breathing Cardiopulmonary Resuscitation After Pediatric Out-of-Hospital Cardiac Arrest. J Am Coll Cardiol 2021;78:1042-1052, <https://doi.org/10.1016/j.jacc.2021.06.042>.

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**\*\*CONFIDENTIAL DO NOT DISTRIBUTE\*\*****2022 Evidence Update Worksheet****Worksheet author(s):** Patrick Van de Voorde – Steve Schexnayder – David Kloeck**Task Force:** PLS**Date Submitted:** 16/09/2021**Worksheet ID:** PLS 709- Sequence of Chest Compression and Ventilation

<b>Population</b>	Children (0-18y, excluding those in transition after birth) who are in cardiac arrest in any setting, but not traumatic cardiac arrest
<b>Intervention</b>	the use of a circulation – airway – breathing approach to initial management
<b>Comparison</b>	the use of an airway – breathing – circulation approach to initial management
<b>Outcomes</b>	Any clinical outcome
<b>Study Design</b>	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. Only pediatric studies and mixed studies in which a pediatric subgroup can be identified will be considered. Studies that have been accepted for publication in a peer-reviewed journal will be included when identified if the full text of the final accepted article can be obtained from the lead author. Case reports will also be considered if the number of cases included is more than 10. Unpublished studies (e.g., conference abstracts, trial protocols), and non-human studies are excluded.
<b>Timeframe</b>	<b>EVIDENCE UPDATE:</b> any publication after 01/01/2014, provided there is an English abstract

**Type (intervention, diagnosis, prognosis):** intervention**Conflicts of Interest (financial/intellectual, specific to this question):** none**Year of last full review:** 2015 Peds 709**Last ILCOR Consensus on Science and Treatment Recommendation:** 2015

The confidence in effect estimates is so low that the panel decided a recommendation was too speculative.

**2015 Search Strategy:** Pubmed – Embase – Cochrane (search completed February 2014)**2021 Search Strategy:**

1> CAB[Title/Abstract] OR circulation-airway-breathing[Title/Abstract] OR C-A-B[Title/Abstract] OR "Compression airway breathing"[Title/Abstract] OR compressions-first[Title/Abstract] OR "compression\* first"[Title/Abstract] OR ABC[Title/Abstract] OR airway-breathing-circulation[Title/Abstract] OR "airway

breathing circulation"[Title/Abstract] OR A-B-C[Title/Abstract] OR "first ventilation\*"[Title/Abstract] OR ventilations-first[Title/Abstract] OR "ventilation\* first"[Title/Abstract]; filtered for 2014-2021: n=16134

2> #1 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]); n=50

3> #2 AND (infan\*[tw] OR child\*[tw] OR adolescen\*[tw] OR pediatric\*[tw] OR paediatric\*[tw] OR pube\*[tw] OR juvenil\*[tw] OR school\*[tw] OR newborn\*[tiab] OR new-born\*[tiab] OR neo-nat\*[tiab] OR neonat\*[tiab] OR premature\*[tiab] OR postmature\*[tiab] OR pre-mature\*[tiab] OR post-mature\*[tiab] OR preterm\*[tiab] OR pre-term\*[tiab] OR baby[tiab] OR babies[tiab] OR toddler\*[tiab] OR youngster\*[tiab] OR preschool\*[tiab] OR kindergart\*[tiab] OR kid[tiab] OR kids[tiab] OR playgroup\*[tiab] OR play-group\*[tiab] OR playschool\*[tiab] OR prepube\*[tiab] OR preadolescenc\*[tiab] OR junior high\*[tiab] OR highschool\*[tiab] OR senior high[tiab] OR young people\*[tiab] OR minors[tiab] NOT (animals[mh] NOT (humans[mh] AND animals[mh]))); n=8

NO RELEVANT ARTICLES FOUND looking at title/abstract

**Database searched: Pubmed**

**Date Search Completed: 21/08/2021**

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

*No publications could be found since the last EvUp for what concerns children. Adult evidence is highly indirect and we did not consider it specifically relevant to our current search.*

*There might be additional data to be evaluated by comparing results from registry data from different regions, looking at observational studies describing outcome from e.g. dispatcher assisted CPR but such data would be highly indirect and prone to bias.*

	<b>Approval Date</b>
<b>Evidence Update coordinator</b>	
<b>ILCOR board</b>	

**\*Once approval has been made by Evidence Update coordinator, worksheet will go to ILCOR Board for acknowledgement.**

**Reference list: None**



**\*\*CONFIDENTIAL DO NOT DISTRIBUTE\*\*****2022 Evidence Update Worksheet****Worksheet author(s):** Thomaz Bittencourt Couto, Amelia Reis, Antonio Nunes**Council:** IAHF**Date Submitted:** 11/18/2021**Worksheet ID:** Drugs for Pediatric Bradycardia**PICO / Research Question:** Drugs for Pediatric Bradycardia**Population:** Infants, children and adolescents in any setting (IH or OH) in Bradycardia associated with hemodynamic compromise.**Intervention:** Any drug (Epinephrine / Atropine)**Comparison:** Comparator drug (Epinephrine/ Atropine) or no medication/placebo**Outcomes:** ROSC, survival and brain function at discharge and or 30 days and between 6 and 12 months after arrest**Type (intervention, diagnosis, prognosis):** Intervention**Additional Evidence Reviewer(s):****Conflicts of Interest (financial/intellectual, specific to this question):** None**Year of last full review:** 2010 / 2015 / **New question:** 2019**Last ILCOR Consensus on Science and Treatment Recommendation:** 2020**2019 Search Strategy:****Date Search Completed:** 1 DEC 2019 , Search was updated from 1 Dec 2019 to 1 Nov 2021, using the same strategy from 2019.**Database searched:** Medline, Embase

Used terms

- Bradycard\*-Bradyarrhythmia atropine; either as individual term (ti,ab,kw) or related MESH Term; combined using Boolean 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 To exclude animal studies: NOT (animals[mh]NOT humans[mh])

- o To exclude NOT "Letter" [Publication Type] OR "Editorial" [Publication Type] OR "Comment" [Publication Type]

- For Embase we prefiltered to avoid Medline duplicates by using [embase]/ limNOT ([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)

**Search Results(Number of articles identified / number identified as relevant): 57 / 3**

**Inclusion/Exclusion Criteria:**

**In:** as defined by PICOST

**Ex:** studies primarily concerning congenital cardiomyopathy, ketamine analgesedation, specific intoxications; animal studies; letters, editorials or comments; unpublished studies(e.g., conference abstracts, trial protocols), no English abstract; Newborn at Delivery

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

### 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
ILCOR; Kleinman ME, 2010	ILCOR Pediatric CoSTR	PLS 52 (atropine vs epinephrine)	16	<p>Evidence from 1 LOE 3 study of in-hospital pediatric cardiac arrest observed an improved odds of survival to discharge for those patients who received atropine based on multivariate analysis, whereas the use of epinephrine was associated with decreased odds of survival. Another large LOE 3 study demonstrated no association between atropine administration and survival.</p> <p>In 1 LOE 5 adult case series, 6 of 8 patients in cardiac arrest who did not respond to epinephrine did respond to atropine with a change to a perfusing rhythm; 3 survived to hospital discharge. An LOE 5 retrospective adult review observed that a small number of asystolic patients who failed to respond to epinephrine did respond to atropine, but none survived to hospital discharge.</p> <p>Four LOE 5 adult studies showed a benefit of atropine in vagally mediated bradycardia. One small LOE 4 pediatric case series showed that</p>	Epinephrine may be used for infants and children with bradycardia and poor perfusion that is unresponsive to ventilation and oxygenation. It is reasonable to administer atropine for bradycardia caused by increased vagal tone or cholinergic drug toxicity. There is insufficient evidence to support or refute the routine use of atropine for pediatric cardiac arrest.

				<p>atropine is more effective than epinephrine in increasing heart rate and blood pressure in children with post–cardiac surgical hypotension and bradycardia (Bezold-Jarisch reflex mediated bradycardia).</p> <p>Four LOE 5 adult, and 4 LOE 5 animal studies showed no benefit from atropine used to treat bradycardia or cardiac arrest. One LOE 5 animal study did show a benefit of atropine when used with epinephrine in cardiac arrest.</p>	
ILCOR; Maconochie IK, 2020	ILCOR Pediatric CoSTR	Drugs for the Treatment of Bradycardia: Atropine Versus No Atropine and Atropine Versus Epinephrine	0	None	<p>This treatment recommendation (below) is unchanged from 2010.</p> <p>Epinephrine may be administered to infants and children with bradycardia and poor perfusion that is unresponsive to ventilation and oxygenation. It is reasonable to administer atropine for bradycardia caused by increased vagal tone or anti-cholinergic drug toxicity. There is insufficient evidence to support or refute the routine use of atropine for pediatric cardiac arrest.</p>

**RCT: None**

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

<b><u>Study</u></b> <b>Acronym;</b> <b>Author;</b> <b>Year Published</b>	<b>Study Type/Design;</b> <b>Study Size (N)</b>	<b>Patient Population</b>	<b>Primary Endpoint and Results (include P value; OR or RR; &amp; 95% CI)</b>	<b>Summary/Conclusion Comment(s)</b>
Khera 2019	<b><u>Study Type:</u></b> Observational, retrospective, registry	<b><u>Inclusion Criteria:</u></b> Pediatric patients >30 days and <18 years of age who received CPR at hospitals participating in Get With The Guidelines-Resuscitation during 2000 to 2016 were included	<b><u>1° endpoint:</u></b> Rates of survival to discharge were 70.0% (1351 of 1930) for bradycardia with pulse, 30.1% (262 of 869) for bradycardia progressing to pulselessness, and 37.5% (1046 of 2793) for initial pulseless cardiac arrest (P for difference across groups <0.001)	<p>Among hospitalized children in whom CPR is initiated, half have bradycardia with poor perfusion at the initiation of chest compressions, and nearly one-third of these progress to pulseless in-hospital cardiac arrest despite CPR. Survival was significantly lower for children who progress to pulselessness despite CPR compared with those who were initially pulseless. These findings suggest that pediatric patients who lose their pulse despite resuscitation attempts are at particularly high risk and require a renewed focus on postresuscitation care.</p> <p><b>Comments:</b> Epinephrine use was not the objective for this study.</p> <p>Epinephrine was used in two-thirds of bradycardia events that did not progress to pulselessness and nearly 90% of arrests with initial or subsequent pulselessness. The bradycardia group had a shorter time to the first epinephrine dose than both the groups with bradycardia and subsequent pulselessness and with initial pulseless arrests</p>

Holmberg 2020	<b><u>Study Type:</u></b> Observational, retrospective, Time-dependent propensity score matching	<b><u>Inclusion Criteria:</u></b> pediatric patients ( $\leq 18$ years) who received in-hospital cardiopulmonary resuscitation for bradycardia with poor perfusion (non-pulseless event) between January 2000 and December 2018	<b>1° endpoint:</b> A total of 3528 patients who received epinephrine were matched to 3528 patients at risk of receiving epinephrine based on the propensity score. Epinephrine was associated with decreased survival to hospital discharge (RR, 0.79 [95% CI, 0.74-0.85]; $p < 0.001$ )	In children receiving cardiopulmonary resuscitation for bradycardia with poor perfusion, epinephrine was associated with worse outcomes, although the study does not eliminate the potential for confounding.  <b>Comments:</b> Findings suggest a possible negative effect of epinephrine in pediatric bradycardia.
Morgan, 2020	<b><u>Study Type:</u></b> Observational, retrospective, registry	<b><u>Inclusion Criteria:</u></b> Collaborative Pediatric Critical Care Research Network. Patients: Children ( $< 19$ yr old) who received greater than or equal to 1 minute of cardiopulmonary resuscitation with invasive arterial blood pressure monitoring in place.	Of 164 patients, 96 (59%) had bradycardia and poor perfusion as the initial cardiopulmonary resuscitation rhythm. Compared to those with initial pulseless rhythms, these children were younger (0.4 vs 1.4 yr; $p = 0.005$ ) and more likely to have a respiratory etiology of arrest ( $p < 0.001$ ). Children with bradycardia and poor perfusion were more likely to survive to hospital discharge (adjusted odds ratio, 2.31; 95% CI, 1.10-4.83; $p = 0.025$ )	Most children receiving cardiopulmonary resuscitation in ICUs had an initial rhythm of bradycardia and poor perfusion. They were more likely to survive to hospital discharge and survive with favorable neurologic outcomes than patients with pulseless arrests, although there were no differences in immediate event outcomes or intra-arrest hemodynamics. Patients who progressed to pulselessness after cardiopulmonary resuscitation initiation had lower intra-arrest hemodynamics and worse event outcomes than those who were never pulseless.  <b>Comments:</b> Epinephrine use was not the objective for this study. There were no differences in epinephrine use between

				bradycardia and other rhythms
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### Reviewer Comments (including whether meet criteria for formal review):

Both Khera 2019 and Holmberg 2020 studied mainly the same population, with Holmberg adding 2 years of the pediatric Get With The Guidelines-Resuscitation. There is an association between epinephrine use and worse prognosis found in Khera study, which is further analyzed in Holmberg study with a Time-dependent propensity score matching. Similar findings were not described in Morgan 2020, with a different population (Collaborative Pediatric Critical Care Research Network), with no differences between epinephrine use between compared population (study not designed for this outcome).

Findings from Holmberg suggest a possible negative effect of epinephrine in pediatric bradycardia. However, this is only one study, with complex analysis and many potential confounders. Discussion within the Pediatric taskforce reached the conclusion the current evidence is not enough to change current recommendation, and thus should not prompt a review.

### Summary of Evidence Update:

Evidence Update Process for topics not covered by ILCOR Task Forces

1. This evidence update process is only applicable to PICO's which are *not* being reviewed as ILCOR systematic and scoping reviews.

	<b>Approval Date</b>
<b>Evidence Update coordinator</b>	
<b>ILCOR board</b>	

**\*Once approval has been made by Evidence Update coordinator, worksheet will go to ILCOR Board for acknowledgement.**

### Reference list

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## Discussion:

1. Khera R, Tang Y, Girotra S, Nadkarni VM, Link MS, Raymond TT, et al. Pulselessness After Initiation of Cardiopulmonary Resuscitation for Bradycardia in Hospitalized Children. *Circulation.* 2019 Jul 30;140(5):370–8.

Background: Cardiopulmonary resuscitation (CPR) is initiated in hospitalized children with bradycardia and poor perfusion. However, their rate of progression to pulseless cardiac arrest despite CPR and the differences in survival compared with initially pulseless arrest are unknown. We examined the prevalence and predictors of survival of children who progress from bradycardia to pulseless in-hospital cardiac arrest despite CPR.



**Methods:** Pediatric patients >30 days and <18 years of age who received CPR at hospitals participating in Get With The Guidelines-Resuscitation during 2000 to 2016 were included. Each CPR event was classified as bradycardia with pulse, bradycardia with subsequent pulselessness, and initial pulseless cardiac arrest. We assessed risk-adjusted rates of survival to hospital discharge using multilevel Poisson regression models.

**Results:** Overall, 5592 pediatric patients were treated with CPR, of whom 2799 (50.1%) received CPR for bradycardia with poor perfusion and 2793 (49.9%) for initial pulseless cardiac arrest. Among those with bradycardia, 869 (31.0%, or 15.5% of cohort) became pulseless after a median of 3 minutes of CPR (interquartile range, 1-9 minutes). Rates of survival to discharge were 70.0% (1351 of 1930) for bradycardia with pulse, 30.1% (262 of 869) for bradycardia progressing to pulselessness, and 37.5% (1046 of 2793) for initial pulseless cardiac arrest (P for difference across groups <0.001). Children who became pulseless despite CPR for bradycardia had a 19% lower likelihood (risk ratio, 0.81 [95% CI, 0.70, 0.93]; P=0.004) of surviving to hospital discharge than those who were initially pulseless. Among children who progressed to pulselessness despite CPR for bradycardia, a longer interval between CPR and pulselessness was a predictor of lower survival (reference, <2 minutes; for 2-5 minutes, risk ratio, 0.54 [95% CI, 0.41-0.70]; for >5 minutes, risk ratio, 0.41 [95% CI, 0.32-0.53]).

**Conclusions:** Among hospitalized children in whom CPR is initiated, half have bradycardia with poor perfusion at the initiation of chest compressions, and nearly one-third of these progress to pulseless in-hospital cardiac arrest despite CPR. Survival was significantly lower for children who progress to pulselessness despite CPR compared with those who were initially pulseless. These findings suggest that pediatric patients who lose their pulse despite resuscitation attempts are at particularly high risk and require a renewed focus on postresuscitation care.

2. Holmberg MJ, Ross CE, Yankama T, Roberts JS, Andersen LW, American Heart Association's Get With The Guidelines®-Resuscitation Investigators. Epinephrine in children receiving cardiopulmonary resuscitation for bradycardia with poor perfusion. *Resuscitation*. 2020 Apr;149:180–90.

**Aim:** To determine whether the use of epinephrine in pediatric patients receiving cardiopulmonary resuscitation for bradycardia and poor perfusion was associated with improved clinical outcomes.

**Methods:** Using the Get With The Guidelines-Resuscitation registry, we included pediatric patients (≤18 years) who received in-hospital cardiopulmonary resuscitation for bradycardia with poor perfusion (non-pulseless event) between January 2000 and December 2018. Time-dependent propensity score matching was used to match patients receiving epinephrine within the first 10 min of resuscitation to patients at risk of receiving epinephrine within the same minute.

**Results:** In the full cohort, 55% of patients were male and 39% were neonates. A higher number of patients receiving epinephrine required vasopressors and mechanical ventilation prior to the event compared to those not receiving epinephrine. A total of 3528 patients who received epinephrine were matched to 3528 patients at risk of receiving epinephrine based on the propensity score. Epinephrine was associated with decreased survival to hospital discharge (RR, 0.79 [95% CI, 0.74-0.85]; p < 0.001), return of spontaneous circulation (RR, 0.94 [95% CI, 0.91-0.96]; p < 0.001), 24-h survival (RR, 0.85 [95% CI, 0.81-0.90]; p < 0.001), and favorable

neurological outcome (RR, 0.76 [95% CI, 0.68-0.84];  $p < 0.001$ ). Epinephrine was also associated with an increased risk of progression to pulselessness (RR, 1.17 [95% CI, 1.06-1.28];  $p < 0.001$ ).

**Conclusion:** In children receiving cardiopulmonary resuscitation for bradycardia with poor perfusion, epinephrine was associated with worse outcomes, although the study does not eliminate the potential for confounding.

3. Morgan RW, Reeder RW, Meert KL, Telford R, Yates AR, Berger JT, et al. Survival and Hemodynamics During Pediatric Cardiopulmonary Resuscitation for Bradycardia and Poor Perfusion Versus Pulseless Cardiac Arrest. *Critical Care Medicine*. 2020 Jun;48(6):881–9.

**Objectives:** The objective of this study was to compare survival outcomes and intra-arrest arterial blood pressures between children receiving cardiopulmonary resuscitation for bradycardia and poor perfusion and those with pulseless cardiac arrests.

**Design:** Prospective, multicenter observational study.

**Setting:** PICUs and cardiac ICUs of the Collaborative Pediatric Critical Care Research Network.

**Patients:** Children (< 19 yr old) who received greater than or equal to 1 minute of cardiopulmonary resuscitation with invasive arterial blood pressure monitoring in place.

**Interventions:** None.

**Measurements and main results:** Of 164 patients, 96 (59%) had bradycardia and poor perfusion as the initial cardiopulmonary resuscitation rhythm. Compared to those with initial pulseless rhythms, these children were younger (0.4 vs 1.4 yr;  $p = 0.005$ ) and more likely to have a respiratory etiology of arrest ( $p < 0.001$ ). Children with bradycardia and poor perfusion were more likely to survive to hospital discharge (adjusted odds ratio, 2.31; 95% CI, 1.10-4.83;  $p = 0.025$ ) and survive with favorable neurologic outcome (adjusted odds ratio, 2.21; 95% CI, 1.04-4.67;  $p = 0.036$ ). There were no differences in diastolic or systolic blood pressures or event survival (return of spontaneous circulation or return of circulation via extracorporeal cardiopulmonary resuscitation). Among patients with bradycardia and poor perfusion, 49 of 96 (51%) had subsequent pulselessness during the cardiopulmonary resuscitation event. During cardiopulmonary resuscitation, these patients had lower diastolic blood pressure (point estimate, -6.68 mm Hg [-10.92 to -2.44 mm Hg];  $p = 0.003$ ) and systolic blood pressure (point estimate, -12.36 mm Hg [-23.52 to -1.21 mm Hg];  $p = 0.032$ ) and lower rates of return of spontaneous circulation (26/49 vs 42/47;  $p < 0.001$ ) than those who were never pulseless.

**Conclusions:** Most children receiving cardiopulmonary resuscitation in ICUs had an initial rhythm of bradycardia and poor perfusion. They were more likely to survive to hospital discharge and survive with favorable neurologic outcomes than patients with pulseless arrests, although there were no differences in immediate event outcomes or intra-arrest hemodynamics. Patients who progressed to pulselessness after cardiopulmonary resuscitation initiation had lower intra-arrest hemodynamics and worse event outcomes than those who were never pulseless.

## **2020 Treatment Recommendations : Drugs for the Treatment of Bradycardia: Atropine Versus No Atropine and Atropine Versus Epinephrine (PLS New: EvUps)**

The PLS Task Force reviewed this topic in 2010. Two EvUps were performed to determine if any studies were published after 2010 about atropine compared with epinephrine (see Supplement Appendix C-16) and atropine compared with no atropine (see Supplement Appendix C-17) for the treatment of bradycardia in infants or children. The EvUps identified no studies published after 2010. After completion of the reviews, however, the task force identified 1 nonrandomized (in-hospital registry) study about epinephrine for children receiving CPR for bradycardia and poor perfusion.<sup>58</sup> The PLS Task Force agreed that there remains insufficient evidence for consideration of a SysRev; as a result, the 2010 treatment recommendation remains in effect.

### **Population, Intervention, Comparator, Outcome, Study Design, and Time Frame**

- Population: Infants and children with bradycardia for any reason
- Intervention: Use of atropine at a specific dose
- Comparator: Not using atropine, using another drug, or using it [atropine] at a different dose
- Outcome: All
- Study design: RCTs and nonrandomized studies (non-RCTs, interrupted time series, controlled before-and-after studies, cohort studies) eligible for inclusion
- Time frame: All years and languages were included if there was an English abstract. The literature search was conducted in November 2019.

### **Treatment Recommendations**

This treatment recommendation (below) is unchanged from 2010.

Epinephrine may be administered to infants and children with bradycardia and poor perfusion that is unresponsive to ventilation and oxygenation. It is reasonable to administer atropine for bradycardia caused by increased vagal tone or anti-cholinergic drug toxicity.

There is insufficient evidence to support or refute the routine use of atropine for pediatric cardiac arrest.

## **2010 : Atropine versus adrenaline for bradycardia Peds-052A**

### **Consensus on science**

Evidence from one LOE 3 study of in-hospital paediatric cardiac arrest<sup>537</sup> observed an improved odds of survival to discharge for those patients who received atropine based on multivariate analysis, whereas the use of adrenaline was associated with decreased odds of survival. Another large LOE 3 study<sup>538</sup> demonstrated no

association between atropine administration and survival. In one LOE 5 adult case series,<sup>539</sup> six of eight patients in cardiac arrest who did not respond to adrenaline did respond to atropine with a change to a perfusing rhythm; three survived to hospital discharge. An LOE 5 retrospective adult review<sup>540</sup> observed that a small number of asystolic patients who failed to respond to adrenaline did respond to atropine, but none survived to hospital discharge.

Four LOE 5 adult studies<sup>541–544</sup> showed a benefit of atropine in vagally mediated bradycardia. One small LOE 4 paediatric case series<sup>545</sup> showed that atropine is more effective than adrenaline in increasing heart rate and blood pressure in children with post-cardiac surgical hypotension and bradycardia (Bezold–Jarisch reflex mediated bradycardia).

Four LOE 5 adult<sup>542,546–548</sup> and four LOE 5 animal<sup>549–552</sup> studies showed no benefit from atropine used to treat bradycardia or cardiac arrest. One LOE 5 animal study<sup>553</sup> did show a benefit of atropine when used with adrenaline in cardiac arrest.

### Treatment recommendations

Adrenaline may be used for infants and children with bradycardia and poor perfusion that is unresponsive to ventilation and oxygenation. It is reasonable to administer atropine for bradycardia caused by increased vagal tone or cholinergic drug toxicity. There is insufficient evidence to support or refute the routine use of atropine for paediatric cardiac arrest.

### Knowledge gaps

What is the optimal dose of adrenaline for paediatric bradycardia?

Is there a role for titrated doses? Does the use of adrenaline versus atropine improve outcome from paediatric bradycardia?

Are there circumstances under which atropine administration improves outcome from paediatric cardiac arrest?

**\*\*CONFIDENTIAL DO NOT DISTRIBUTE\*\*****2022 Evidence Update Worksheet****Worksheet author(s):** Gabrielle Nuthall, Vinay Nadkarni, Anne-Marie Guerguerian**Task Force:** Pediatric Advanced Life Support**Date Submitted:** November 20, 2021**Worksheet ID:** Target Temperature Management**PICO Short Title:** ECPR for pediatric cardiac arrest**Type:** Intervention**Outcomes:** Survival and Neurologic Outcomes (see below).

<b>Population</b>	Children (age < 18 years) with cardiac arrest in any setting (out of hospital or in-hospital)
<b>Intervention</b>	Extracorporeal CPR, including extracorporeal membrane oxygenation therapy or cardiopulmonary bypass during cardiac arrest and/or within 20 min or return of circulation.
<b>Comparison</b>	Manual or mechanical CPR
<b>Outcomes</b>	Clinical outcomes, including short-term survival and neurological outcomes (e.g., hospital discharge, 30 days, and 1 month) and long-term survival and neurological outcomes (e.g., 3 months, 6 months and 1 year).
<b>Study Design</b>	Randomized controlled trials (RCTs) and non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies, registry-based studies) are eligible for inclusion. Unpublished studies (e.g., conference abstracts, trial protocols) are excluded. Systematic Reviews and guideline publications and large case series n>20 are eligible for inclusion. Studies evaluating other populations where cardiac arrest and ECPR were studied were excluded if there were not at least 20 ECPR events.
<b>Timeframe</b>	January 2018 to August 30, 2021 and all languages are included as long as there is an English abstract.

**Conflicts of Interest (financial/intellectual, specific to this question):** The evidence reviewers hold faculty positions in institution that use ECPR in select populations.

**Year of last full review: 2019: Systematic review published in 2018 and COSTR 2019/2020.**

**Last ILCOR Consensus on Science and Treatment Recommendation:**

## **2020 Pediatric COSTR**

### **Extracorporeal Cardiopulmonary Resuscitation (ECPR) for Cardiac Arrest – Pediatrics**

“A SysRev regarding extracorporeal CPR for adults and pediatrics was performed in 2018 (Holmberg 2018) and an ILCOR Pediatric CoSTR was published as part of the 2019 International CoSTR Summary. (Soar 2019, Soar 2019 95) The summary of the consensus on science can be found in the 2019 CoSTR. The following section was included in the 2020 Pediatric CoSTR:

### **PICOST 2018-2019**

Population: Adults (age  $\geq 18$  years) and children (age  $< 18$  years) with cardiac arrest in any setting (out of hospital or in-hospital).

Intervention: Extracorporeal CPR, including extracorporeal membrane oxygenator therapy or cardiopulmonary bypass during cardiac arrest.

Comparator: Manual or mechanical CPR.

Outcome: 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 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 and case series were excluded.

### **2020 Treatment Recommendations**

We suggest that CPR with extracorporeal membrane oxygenation (ECPR) may be considered as an intervention for selected infants and children (e.g., cardiac populations) with IHCA refractory to conventional CPR in settings where resuscitation systems allow ECPR to be well-performed and implemented (weak recommendation, very-low-quality evidence).

There is insufficient evidence in pediatric OHCA to formulate a recommendation for the use of ECPR.

### **2021 BLS Scoping Review**

**Extra Corporeal Membrane Oxygenator (ECMO) in Drowning (BLS #856): TF Scoping Review – Created August 2020 and Last Updated April 2021.**

### **PICOST**

Population: In adults and children who are submerged in water

Intervention: extracorporeal membrane oxygenation (ECMO)

Comparators: no ECMO

Outcomes: Any clinical outcome (e.g. survival, survival with a favourable neurological outcome, hospitalisation), CPR quality, physiological end-points.

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. Manikin studies will only be included if no human studies are available.

Timeframe: From 2000 onwards. All languages were included as long as there was an English abstract; unpublished studies (e.g., conference abstracts, trial protocols), narrative reviews, animal studies were excluded. Literature search updated to October 2019.

**No Treatment Recommendation as this was an initial Scoping Review.**

## Search Strategy:

### Extracorporeal CPR for in-hospital Cardiac Arrest (2019 CoSTR)

Database: Ovid Medline: (general search: needs peds filter)

- 1 Extracorporeal Circulation/ (13566)
- 2 Cardiopulmonary Bypass/ (24689)
- 3 Extracorporeal Membrane Oxygenation/ (8724)
- 4 Heart Bypass, Left/ (190)
- 5 extracorporeal circulation\*.tw,kf. (8027)
- 6 extra-corporeal circulation\*.tw,kf. (306)
- 7 extracorporeal blood flow\*.tw,kf. (109)
- 8 extra-corporeal blood flow\*.tw,kf. (2)
- 9 extracorporeal bypass\*.tw,kf. (223)
- 10 extra-corporeal bypass\*.tw,kf. (4)
- 11 extracorporeal perfusion\*.tw,kf. (570)
- 12 extra-corporeal perfusion\*.tw,kf. (10)
- 13 (artificial adj2 circulation\*).tw,kf. (913)
- 14 (cardiac adj2 bypass\*).tw,kf. (1065)
- 15 (heart adj1 bypass\*).tw,kf. (922)
- 16 extracorporeal cardiopulmonary resuscitation\*.tw,kf. (255)
- 17 extracorporeal CPR.tw,kf. (36)
- 18 ECPR.tw,kf. (193)
- 19 E-CPR.tw,kf. (60)
- 20 cardiopulmonary bypass\*.tw,kf. (32118)
- 21 CPB.tw,kf. (10564)
- 22 atriopulmonary shunt\*.tw,kf. (3)
- 23 cardiopulmonary shunt\*.tw,kf. (4)
- 24 heart-lung bypass\*.tw,kf. (97)
- 25 (extracorporeal adj3 oxygenation\*).tw,kf. (8715)
- 26 (extra-corporeal adj3 oxygenation\*).tw,kf. (283)
- 27 ECMO.tw,kf. (6144)
- 28 extrapulmonary oxygenation\*.tw,kf. (13)

- 29 extra-pulmonary oxygenation\*.tw,kf. (1)
- 30 extracorporeal life support\*.tw,kf. (1675)
- 31 extra-corporeal life support\*.tw,kf. (53)
- 32 ECLS.tw,kf. (1072)
- 33 left ventric\* bypass\*.tw,kf. (198)
- 34 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 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 (69449)
- 35 exp Heart Arrest/ (45606)
- 36 Ventricular Fibrillation/ (18038)
- 37 Tachycardia, Ventricular/ (14734)
- 38 heart arrest\*.tw,kf. (2225)
- 39 cardiac arrest\*.tw,kf. (31130)
- 40 circulat\* arrest\*.tw,kf. (5872)
- 41 heart standstill\*.tw,kf. (8)
- 42 cardiopulmonary arrest\*.tw,kf. (2302)
- 43 cardiovascular arrest\*.tw,kf. (66)
- 44 asystol\*.mp. (4182)
- 45 ventric\* fibrillation\*.tw,kf. (19248)
- 46 ventric\* tachy\*.tw,kf. (27344)
- 47 ventricular tachyarrhythmia\*.tw,kf. (4326)
- 48 pulseless electrical activity.mp. (762)
- 49 35 or 36 or 37 or 38 or 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48 (107855)
- 50 34 and 49 (6244)
- 51 exp Animals/ not Humans/ (4809559)
- 52 50 not 51 (5077)
- 53 limit 52 to (case reports or comment or editorial or letter) (1472)
- 54 52 not 53 (3605)

## Weekly Pubmed automated searches

### Search: (cardiac arrest) AND ECMO

("heart arrest"[MeSH Terms] OR ("heart"[All Fields] AND "arrest"[All Fields]) OR "heart arrest"[All Fields] OR ("cardiac"[All Fields] AND "arrest"[All Fields]) OR "cardiac arrest"[All Fields]) AND ("extracorporeal membrane oxygenation"[MeSH Terms] OR ("extracorporeal"[All Fields] AND "membrane"[All Fields] AND "oxygenation"[All Fields]) OR "extracorporeal membrane oxygenation"[All Fields] OR "ecmo"[All Fields])

### Translations

cardiac arrest: "heart arrest"[MeSH Terms] OR ("heart"[All Fields] AND "arrest"[All Fields]) OR "heart arrest"[All Fields] OR ("cardiac"[All Fields] AND "arrest"[All Fields]) OR "cardiac arrest"[All Fields]



ECMO: "extracorporeal membrane oxygenation"[MeSH Terms] OR ("extracorporeal"[All Fields] AND "membrane"[All Fields] AND "oxygenation"[All Fields]) OR "extracorporeal membrane oxygenation"[All Fields] OR "ecmo"[All Fields]

### **Search: ECMO and resuscitation OR ECPR**

((("extracorporeal membrane oxygenation"[MeSH Terms] OR ("extracorporeal"[All Fields] AND "membrane"[All Fields] AND "oxygenation"[All Fields]) OR "extracorporeal membrane oxygenation"[All Fields] OR "ecmo"[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])) OR "ECPR"[All Fields])

### **Translations**

ECMO: "extracorporeal membrane oxygenation"[MeSH Terms] OR ("extracorporeal"[All Fields] AND "membrane"[All Fields] AND "oxygenation"[All Fields]) OR "extracorporeal membrane oxygenation"[All Fields] OR "ecmo"[All Fields]

resuscitation: "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 "resuscitator's"[All Fields] OR "resuscitators"[All Fields]

### **Database searched: Medline Pubmed**

**Date Search Completed: 2021-August-30**

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

**Adult and Children total numbers: 1382/14**

### **Inclusion/Exclusion Criteria:**

We excluded studies in adults only, animals, mannequins, unpublished studies (e.g., conference abstracts, trial protocols). We considered studies that included diverse populations with pediatric cardiac arrests and when they reported ECPR; these needed to include at least a sample of 20 participants exposed to ECPR and the study had to report the outcomes of this sub-group.

### **Link to Article Titles and Abstracts (if available on PubMed): Included articles**

<https://www.ncbi.nlm.nih.gov/sites/myncbi/1DlCa9WA5Z/collections/61346234/public/>

### **Background:**

Since the systematic review by Holmberg et al was published in 2018 that summarized the evidence used in the 2019 and 2020 CoSTR (Duff or Maconichie) for the use of

extracorporeal cardiopulmonary resuscitation (ECPR) in cardiac arrest, several studies were published with samples of children who underwent extracorporeal membrane oxygenation (ECMO) in the context of cardiac arrest and resuscitation. Systematic reviews on the topic were published and the ILCOR BLS Task Force completed a scoping review on the use of ECMO in the context of drowning.[[ILCOR hyperlink to website](#)] Another important statement relevant for the field of resuscitation in children with cardiac disease was published by Marino et al in 2018; this statement explains why in some physiologic conditions or cardiac diseases, conventional CPR may not provide the most optimal means of providing oxygenated perfusion to the cerebral and systemic circulation. It is worth also mentioning that in an effort to enhance the systematic reporting of extracorporeal cardiopulmonary resuscitation (ECPR), the Extracorporeal Life Support Organization (ELSO) and Utstein guidelines harmonized their nomenclature and clarified the definition for ECPR (Conrad, 2018) in 2018. ECPR is defined when ECMO flow is started during conventional CPR, delivered with manual or mechanical compressions, or within 20 min of return spontaneous of circulation. Given this background, we undertook an evidence update for the PICOST on pediatric ECPR by searching the published literature since January 2018 up to the end of August 2021.

### Summary of Evidence Update:

### Evidence Update Process:

### 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 recommendati ons
ILCOR sponsored Holmberg et al 2018 <sup>1</sup> Extracorporeal cardiopulmonary resuscitation for cardiac arrest: A systematic review.	Systematic review	In adult or pediatric IHCA or OHCA, is ECPR vs conventional CPR	3 studies were available for pediatric IHCA. No studies were identified for pediatric OHCA. No randomized trials were included.	Pediatric studies were in favor of ECPR. The risk of bias for individual studies was overall assessed to be critical, with confounding being the primary source of bias. The overall	2019 & 2020 COSTR “We suggest that CPR with extracorporeal membrane oxygenation (ECPR) may be considered as an intervention for selected infants and children (e.g., cardiac populations)

				quality of evidence was assessed to be very low.	with IHCA refractory to conventional CPR in settings where resuscitation systems allow ECPR to be well-performed and implemented (weak recommendation, very-low-quality evidence). There is insufficient evidence in pediatric OHCA to formulate a recommendation for the use of ECPR."
Farhat A, et al. Outcomes of Pediatric Extracorporeal Cardiopulmonary Resuscitation: A Systematic Review and Meta-Analysis. <sup>2</sup>	Systematic review of observational studies	Outcomes following ECPR in pediatrics. Survival to ICU discharge and Neurologic outcome as reported by studies.	28 studies (27 retrospective)	Increase in reported use of ECPR. Cardiac patients represent the majority of studied population. Survival rate of 46% (CI 95% = 43–48%; $p < 0.01$ ). Survival with favorable neurologic outcome was	No treatment recommendation.

				30% (CI 95% = 27–33%; $p < 0.01$ ).	
Esangbedo I.D, et al. Pediatric Extracorporeal Cardiopulmonary Resuscitation: A Systematic Review. <sup>3</sup>	Narrative review of observational studies.	Report on the utilization, clinical and technical practices, and clinical outcomes.	96 studies, majority of retrospective studies.	Majority of studies report ECPR in pediatric cardiac population. Variability between studies in reported selection criteria, surgical approaches, quality of CPR, logistics, use of temperature management, and team training.	No treatment recommendations.

**RCT:** The main RCTs were published before the PICOST timeframe but as there are several secondary analyses included in the Evidence Update, we include the information to enhance clarity.

<b>Study Acronym; Author; Year Published</b>	<b>Aim of Study; Study Type;</b>	<b>Patient Population Study Size (N)</b>	<b>Study Intervention (# patients) / Study Comparator (# patients)</b>	<b>Endpoint Results (Absolute Event Rates, P value; OR or RR; &amp; 95% CI)</b>	<b>Relevant 2° Endpoint (if any); Study Limitations ; Adverse Events</b>
THAPCA OHCA <sup>4</sup>	Multicenter RCT to compare the effect of 120 hours of targeted temperature	Children who remained comatose following out of hospital cardiac arrests > 2 days and <	Intervention: 155 assigned to 33 °C Comparison: 140 assigned to 36.8 °C.	Survival at 12 months, hypothermia 20% vs normothermia 12% RR 1.54 95%	Change in the VABS-II score from baseline to 12 months also did not

	management initiated within 6 hours of randomization: 33 vs 36.8 °C.	18 years of age. N 295 randomized and 260 who could be evaluated with a VABS-II $\geq$ 70 baseline.		CI, 0.86 to 2.76; P = 0.14).	differ significantly (P = 0.13). The overall proportion of patients with 12-month VABS-II scores that did not decrease by more than 15 points (1 SD) of their baseline measurements was similar in the hypothermia group and the normothermia group (14% and 13%).
THAPCA IHCA <sup>5</sup>	Multicenter RCT to compare the effect of 120 hours of targeted temperature management initiated within 6 hours of randomization: 33 vs 36.8 °C.	Children who remained comatose following in-hospital cardiac arrests > 2 days and < 18 years of age. N 329 patients were randomized and 257 could be evaluated	Intervention: 166 assigned to 33 °C. Comparison: 163 assigned to 36.8 °C. ECMO was used after cardiac arrest and before randomization in 87 (52%) in hypothermia	Survival at 12 months did not differ as 36% [48 of 133 patients] and 39% [48 of 124 patients], RR, 0.92; 95% CI, 0.67 to 1.27; P = 0.63). Primary outcome in ECMO strata used after cardiac arrest and prior to	Survival at 12 months unchanged with 49% compared to 46%, RR 1.07 95 CI 0.85-1.34, p=0.56. Primary outcome in ECMO strata used after

		with a baseline VABS-II $\geq 70$ .	and 95 (58%) in normothermia groups respectively.	randomization: 20/77 (26%) compared to 27/82 (33%) $p=0.34$ . Among strata where ECMO was not used, 28/56 (50%) and 21/42 (50%), $p=0.92$ .	cardiac arrest and prior to randomization: 20/77 (26%) compared to 27/82 (33%) $p=0.34$ . Among strata where ECMO was not used, 28/56 (50%) and 21/42 (50%), $p=0.92$ .
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#### Nonrandomized Trials, Observational Studies

Study Acronym; Author; Year Published	Study Type/Design; Study Size (N); continent.	Patient Population; inclusion criteria and sample characteristics when available about ECPR duration and co-exposures.	Primary Endpoint and Results (include P value; OR or RR; & 95% CI)	Summary/Conclusion Comment(s)
Anton Martin, 2019 <sup>6</sup>	Single center, retrospective case series from 2000-2013; (N 73); North America.	IHCA; cardiac ICU patients with > 30 min ECPR; < 18 years of age. 33 (45.2%) central; 40 (55.8%) peripheral; 35 (48%) post	Survival to hospital discharge: 32 (43%).	Neurologic outcomes on hospital discharge by PCPC: PCP 1-2 75 % PCP 3-4 25%.

		cardiac surgery. ECPR duration: median 56 min (IQR 45-81). 28 (39%) were exposed to hypothermia,		
Bembea, 2019 <sup>7</sup>	Retrospective analysis of a merge sample of ECPR cases combining ELSO and AHA GWTG registries, with prospective data collection; 2000-2014; (N 593). North America.	IHCA; < 18 years of age; had to have data available to merge for each index case; 44 (55%) central cannulation; 61 (76%) post cardiac surgery.	Survival to hospital discharge 41%.	Neurologic outcomes on hospital discharge available in 48% of survivors. Among these, 93% had favorable PCPC 1-2.
Beshish, 2018 <sup>8</sup>	Single center; retrospective case series; 2005-2015; (N 80); North America.	IHCA; < 18 years of age; pediatric cardiac ICU; cannulation during compressions; 44 (55%) central cannulation; 61(76%) post surgery	Survival to hospital discharge 38 (47.5%)	Out of 38 survivors, 19 (50%) had a change of Functional Status Scale (FSS) score greater than or equal to 3, that is consistent with new morbidity, and 26 (68%) had favorable functional outcomes with a change in FSS score of less than 5. Half of surviving patients (19/38) had new morbidity, while 68% (26/38) had favorable outcomes
Bruneti, 2018 <sup>9</sup>	Retrospective multicenter	IHCA; < 18 years of age;	Survival to hospital discharge 50% in	

	cohort quality registry; 2014-2016; ECPR vs ECMO; 23 hospitals.	pediatric cardiac ICU; cannulation during compressions; E-CPR was initiated in N 100 (24%) of surgical IHCA and 36 (16%) of medical. Median duration E-CPR events 38 min and 49 min in surgical and medical cardiac arrests.	surgical hospitalizations and 17% in medical hospitalizations.	
Chen 2018 <sup>10</sup>	International registry based retrospective case series from Asian countries and hospitals reporting to ELSO 1999-2016.	< 18 years; N 351; cannulations during cardiac arrest.	Survival to hospital discharge 163 (51%)	Neurologic complications: 16 brain dead; 54 infarction & hemorrhage.
de la Llana 2020 <sup>11</sup>	Single center; retrospective case series with three periods; 2008-2019; Australia	IHCA; refractory to CPR; N 70; cannulation during compressions; 72% cardiac population.	Survival to hospital discharge 44%.	Among survivors: PCPC 1-3 86.4%; PCPC 4-5 13.6%
De Mul 2019 <sup>12</sup>	Multicenter retrospective case series;	IHCA; < 16 years; cannulation during	Survival to hospital discharge 14 (25%)	Among survivors: PCPC 1-2 64%; PCPC 3-4 35%.



	2008-2016; Switzerland	compressions; N 55; 40 (72.7%) central cannulation; 45 (82%) cardiac.		
Hamzah 2021 <sup>13</sup>	Retrospective analysis of an administrative national inpatient sample datasets; 2000–2017, participating hospitals in 47 US states and the District of Columbia.	Cardiac arrests as primary or secondary diagnoses; ECPR: ECMO initiation and CPR procedure on the same day.	20,654 pediatric cases with in-hospital cardiac arrest; 8226 (39.82%) patients survived. Survival is the same with ECPR and no ECMO with mortality ECPR and those with CPR without ECMO (59.7% vs. 60.2%, OR= 0.98; 95%CI: 0.88–1.08; p < 0.681).	ECPR longer median LOS (14 days vs. 4 days; p < 0.001) and a much higher median cost of hospitalization (\$327,515 vs. \$66,681, p < 0.001). ECPR more likely to have congenital heart diseases (51.0% vs. 20.8%, aOR = 3.96; 95% CI: 3.57–4.38; p < 0.001), cardiomyopathy (14.3% vs. 4.5%, aOR = 3.54; 95% CI: 3.04–4.13; p < 0.001), and stroke (21.0% vs. 4.5%, aOR = 5.67; 95% CI: 4.95–6.50; p < 0.001).
Khorsandi 2018 <sup>14</sup>	Single center, retrospective case series; 2011-2016; Scotland UK.	< 16 years; ECMO applied to cardiac surgery patients; (N 66, ECPR 22) compared to ECMO and ECMO post CPB.	Survival to hospital discharge 41%.	
Meert, Guerguerian, 2019 <sup>15</sup>	Case series; secondary analysis of multicenter	>2 days < 18 years; IHCA; comatose; and exposed to	Sixty-one (41.5%) survived to 12 months, 32 (22.1%) survived to 12	On regression, open-chest cardiac massage was independently

	RCT (THAPCA); 2009-2015; USA, Canada, UK.	ECPR; N 147; 51% post cardiac surgery;	months with VABS-II, decreased by less than or equal to 15 points from baseline, and 39 (30.5%) survived to 12 months with VABS-II greater than or equal to 70.	associated with greater 12-month survival with VABS-II, decreased by less than or equal to 15 points and greater 12-month survival with VABS-II greater than or equal to 70.
Meert, Slomine, 2019 <sup>16</sup>	Cohort study; secondary analysis of multicenter RCT (THAPCA); 2009-2015; USA, Canada, UK.	>2 days < 18 years; IHCA; comatose; 12 month survivors with pre-arrest VABS-II $\geq$ 70; N 127 with N 57 ECPR; N 14 ECMO later; N 56 no ECMO.	Cognitive and neurologic score distributions were similar between ECPR, later ECMO and no ECMO groups. Completed assessments: 55 (96.5%) ECPR survivors, cognitive testing for 44 (77.2%) and neurologic examination for 47 (82.5%). At 12 months, 39 (70.9%) ECPR survivors had VABS-II scores greater or equal to 70. On cognitive testing, 24 (54.6%) had scores $>$ 70 and on neurologic examination, 28 (59.5%) had no/minimal to mild impairment.	
Melvan 2020 <sup>17</sup>	Single center, retrospective case series; 2002-2017; USA.	< 18 years; IHCA, OHCA, cannulation during compressions;	Survival to hospital discharge: 79 (43%); 15% in non-cardiac etiology	Adjusted mortality with mechanical complications (OR 6.27, 95% CI: 1.24-35.58, P=0.026),

		N 184; IHCA 181; central cannulation 107 (58%); 124 (89% following cardiac surgery); 157 (85%) cardiac pathology;		neurologic complications (OR 8.43, 95% CI: 1.31-54.18, P=0.025), and renal replacement therapy (OR 5.49, 95% CI: 1.40-21.58, P =0.015). Neurologic injury: in cardiac patients (26/157, 17%) and in noncardiac patients (15/27, 56%)
Morell 2020 <sup>18</sup>	International ELSO registry of ECMO; 2007-2018;	>28 days < 18 years; diagnosis of pulmonary hypertension; N 605 with 106 ECPR;	Survival to hospital discharge 29/106 (27.3%).	
Shakoor 2019 <sup>19</sup>	Single center, retrospective case series; 2010-2017.	< 21 years; IHCA; cannulation during compressions; ECPR N 71	Survival to hospital discharge 54%.	Survival to decannulation 70%.
Torres-Andres, 2018 <sup>20</sup>	Single center, retrospective case series; 2007-2015.	Witnessed IHCA or OHCA; N 56; central cannulation 19 (32.8%); 24 (42%) post cardiac surgery; 12 (21%) non-cardiac.	Survival to hospital discharge: 65.5%	Survival long term 61% (median 38 months after exposure). Among survivors, 6 (16.7%) were discharge on anti-epileptic drugs. Brain imaging, PedsQL and Macmaster Family Assessment Device administered.

### Knowledge Gaps:

(1) Reporting of studies using ECPR is heterogeneous and not standardized; this domain of CPR would benefit from an update in the Utstein IHCA reporting standards.

(2) The knowledge gaps remain numerous when it comes to comparing ECPR (which involves a first period of conventional CPR) to conventional CPR alone.

The published literature does not include sufficient pediatric out of hospital cardiac arrests to provide guidance.

The published literature reports a limited number of non-cardiac children with IHCA exposed to ECPR.

There remains unanswered questions about the following: the selection of patients, the timing of the transition from conventional measures to extracorporeal measures, the optimal cannulation approaches, the efficacy of conventional CPR or of open chest CPR during surgical instrumentation, the pharmacological co-interventions and transfusion therapies, and the optimal early ECMO post cardiac arrest care (E-PCAC) including target temperature, oxygenation and decarboxylation, systemic and cerebral perfusion pressures.

## **2021 Treatment Recommendations are unchanged from previous**

We suggest that CPR with extracorporeal membrane oxygenation (ECPR) may be considered as an intervention for selected infants and children (e.g., cardiac populations) with IHCA refractory to conventional CPR in settings where resuscitation systems allow ECPR to be well-performed and implemented (weak recommendation, very-low-quality evidence).

There is insufficient evidence in pediatric OHCA to formulate a recommendation for the use of ECPR.

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

	<b>Approval Date</b>
<b>Evidence Update coordinator</b>	
<b>ILCOR board</b>	

**\*Once approval has been made by Evidence Update coordinator, worksheet will go to ILCOR Board for acknowledgement.**

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## 2022 Evidence Update Worksheet

**Worksheet author(s):** Janice Tijssen, Thomaz Couto, Antonio Rodriguez-Nunez

**Task Force:** ILCOR PLS

**Date Submitted:** 2 December 2021

**Worksheet ID:** IV/IO

### PICO / Research Question:

- Population: Pediatric patients in any setting (in-hospital or out-of-hospital) with cardiac arrest
- Intervention: Placement of an intraosseous (IO) cannula and drug administration through this IO during cardiac arrest
- Comparator: Placement of an intravenous (IV) cannula and drug administration through this IV during cardiac arrest
- Outcome: Return of spontaneous circulation, survival to hospital discharge, and survival to hospital discharge with a favorable neurological outcome
- Study design: Randomized trials, non-RCTs, and observational studies (cohort studies and case-control studies) comparing IO with IV administration of drugs included; randomized trials assessing the effect of specific drugs (eg, epinephrine, amiodarone/lidocaine) in subgroups related to IO versus IV administration also included
- Time frame: All years and languages were included if there was an English abstract; unpublished studies (eg, conference abstracts, trial protocols) were excluded. September 13 2019-October 25, 2021.

**Additional Evidence Reviewer(s):** None.

**Conflicts of Interest (financial/intellectual, specific to this question):** No.

**Year of last full review:** 2020

**Last ILCOR Consensus on Science and Treatment Recommendation:** Intraosseous cannulation is an acceptable route of vascular access in infants and children with cardiac arrest. It should be considered early in the care of critically ill children whenever venous access is not readily available.

### 2010/2015 Search Strategy:

All Ovid Medline <1946 - present>

1 exp Heart Arrest/ (45608)

2 Ventricular Fibrillation/ (16747)

3 Resuscitation/ (25588)

4 Heart Massage/ (3068)

5 exp Cardiopulmonary Resuscitation/ (16927)

6 cardi\* arrest\*.tw,kf. (36886)

7 heart arrest\*.tw,kf. (2227)

- 8 OHCA.tw,kf. (2201)
- 9 IHCA.tw,kf. (288)
- 10 CPR.tw,kf. (11630)
- 11 advanced cardiac life support.tw,kf. (1018)
- 12 ACLS.tw,kf. (1080)
- 13 basic life support.tw,kf. (1880)
- 14 BLS.tw,kf. (1775)
- 15 asystol\*.tw,kf. (4118)
- 16 pulseless electrical activity.tw,kf. (820)
- 17 pulseless ventricular tachycardia.tw,kf. (318)
- 18 (return of circulation or return of spontaneous circulation or ROSC).tw,kf. (3669)
- 19 resuscitat\*.tw,kf. (61684)
- 20 ventricular fibrillation\*.tw,kf. (18360)
- 21 chest compression\*.tw,kf. (3561)
- 22 or/1-21 (141248)
- 23 Infusions, Intraosseous/ (702)
- 24 Intraosseous.tw,kf. (5865)
- 25 Intra-osseous.tw,kf. (623)
- 26 or/23-25 (6533)
- 27 Infusions, Intravenous/ (53864)
- 28 Intravenous.tw,kf. (276952)
- 29 Intra-venous.tw,kf. (538)
- 30 Umbilical Veins/ (12517)
- 31 (umbilical vein or umbilical veins or umbilical venous).tw,kf. (24157)
- 32 (venous adj3 catheter\*).tw,kf. (16311)

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- 33 (vascular adj3 catheter\*).tw,kf. (2106)
- 34 catheterization/ or catheterization, central venous/ or catheterization, peripheral/ (71132)
- 35 catheters/ or catheters, indwelling/ or exp vascular access devices/ (26842)
- 36 central venous.tw,kf. (24246)
- 37 vascular access.tw,kf. (9286)
- 38 or/27-37 (439774)
- 39 (IO adj15 IV).tw,kf. (145)
- 40 (26 and 38) or 39 (747)
- 41 22 and 40 (337)
- 42 41 not (animals/ not humans/) (278)
- 43 limit 42 to (case reports or comment or editorial or letter) (49)
- 44 42 not 43 (229)
- 45 remove duplicates from 44 (228)

**2021 Search Strategy:** same as above but Sept 13, 2019 to October 25, 2021.

**Database searched:** Pubmed

**Date Search Completed:** October 25, 2021

**Search Results (Number of articles identified / number identified as relevant):** 19/3

**Inclusion/Exclusion Criteria:** newborn, animal, ILCOR systematic review

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

<https://pubmed.ncbi.nlm.nih.gov/34389454/>



**Introduction:** In pediatric out-of-hospital cardiac arrest (OHCA) the effect of intraosseous (IO) or intravenous (IV) access on outcomes is unclear.

**Methods:** We analyzed prospectively collected data of non-traumatic OHCA in the Resuscitation Outcomes Consortium registry from 2011 to 2015. We included EMS-treated patients  $\leq 17$  years of age, classified patients based on vascular access routes, and calculated success rates of IO and IV attempts. After excluding patients with obvious non-cardiac etiologies and those with unsuccessful vascular access or multiple routes, we fit a logistic regression model to evaluate the association of IO vascular access (reference IV access) with the primary outcome of survival, using multiple imputation to address missing data. We analyzed a subgroup of patients at least 2 years of age.

**Results:** There were 1549 non-traumatic OHCA: 895 (57.8%) patients had an IO line attempted with 822 (91.8%) successful; 488 (31.5%) had an IV line attempted with 345 (70.7%) successful (difference 21%, 95% CI 17 to 26%). Of the 761 patients included in our logistic regression, 601 received IO (30 [5.2%] survived) and 160 received IV (40 [25%] survived) vascular access. Intraosseous access was associated with a decreased probability of survival (adjusted OR 0.46; 95% CI 0.21-0.98). Patients at least 2 years of age showed a similar association (adjusted OR 0.36; CI 0.15-0.86).

**Conclusions:** Intraosseous access was associated with decreased survival among pediatric non-traumatic OHCA. These results are exploratory and support the need for further study to evaluate the effect of intravascular access method on outcomes.

<https://pubmed.ncbi.nlm.nih.gov/33433156/>

**Objectives:** Despite the evolving recommendations that favor the use of intraosseous access in pediatric resuscitation, the impact of vascular access type on survival in young children has not been demonstrated. The aim of this study was to assess the impact of the intravascular injection route on the return on spontaneous circulation, survival to hospital admission (0 day), and 30 days or survival to hospital discharge, by comparing survival rates in young children having intraosseous and peripheral IV access. The second aim was to compare the rates of favorable neurologic outcome after 30 days or survival to hospital discharge.

**Design:** This was a multicenter retrospective comparative study between July 2011 and October 2018.

**Setting:** Based on the French cardiac arrest registry data.

**Patients:** All prepubescent (males < 12 yr old, females < 10 yr old) victims of an out-of-hospital cardiac arrest.

**Interventions:** Patients with adrenaline administration by intraosseous versus peripheral venous technique were compared, using propensity score matching.

**Measurements and main results:** The analysis included 603 prepubescent patients, 351 (58%) in the intraosseous group and 252 (42%) in the peripheral IV group. Intraosseous group patients were younger, lighter, with more medical cause for arrest. The intraosseous group had lower survival rates at 30 days or hospital discharge ( $n = 6$ ; 1.7%) than the peripheral IV group ( $n = 12$ ; 4.8%) ( $p = 0.030$ ). After matching, 101 pairs of patients were created. No difference was observed on return of spontaneous circulation or 0-day survival rates (odds ratio = 1.000 [95% CI, 0.518-1.930]; odds ratio = 0.946 [95% CI, 0.492-1.817], respectively) and on 30 days or hospital discharge survival ( $n = 3$  in both groups) (odds ratio = 1.000 [95% CI, 0.197-5.076]). Meaningful statistical evaluation of neurologic status among survivors was precluded by inadequate numbers.

**Conclusions:** The type of injection route (intraosseous or peripheral venous access) does not appear to have an impact on survival of out-of-hospital cardiac arrest in a prepubescent population, but limitations of propensity matching limit a definitive conclusion.

### Summary of Evidence Update:

#### Evidence Update Process for topics not covered by ILCOR Task Forces

1. 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:** n/a

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:** 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
	<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)

<b>Besserer, 2021</b> <b>Canadian</b> <b>Resuscitation</b> <b>Outcomes</b> <b>Consortium</b> <b>(ROC)</b>	<u><b>Study Type:</b></u>  Retrospective cohort (n=761)	<u><b>Inclusion Criteria:</b></u> OHCA 0-17 y (excluded no access, both IO and IV, access before EMS arrival or after ROSC, obvious non-cardiac etiology)	<u><b>1° endpoint:</b></u> Survival to hospital d/c aOR 0.46 (0.21-0.98) – with multiple imputation for missing aOR 0.83 (0.32-2.12)- whole cohort Subgroups: 1- aOR 0.36 (0.15-0.86) for >2 year with multiple imputation (MI) aOR 0.65 (0.23-1.79) for >2 year whole cohort 2- aOR 0.38 (0.17-0.87)- excluding failure of any access (with MI) aOR 0.74 (0.27-2.03) (without MI) 3- aOR 1.3 (0.45-3.76)- only those who had epinephrine (with MI) aOR 1.82 (0.54-6.09)- (without MI)	IO vascular access was associated with decreased survival among pediatric non-traumatic OHCA.  Unmeasured confounders: arrest characteristics, EMS crew experience. Very few children under 2 y.  No data about neurological recovery. Use of both IO and IV routes excluded.  These results are exploratory and support the need for further study.
<b>Recher, 2021</b> <b>(ReAC)</b>	<u><b>Study Type:</b></u>  Retrospective cohort (n=603)	<u><b>Inclusion Criteria:</b></u> OHCA 0-10y (female) and 0-12y (male) And who received epinephrine (excluded trauma or unknown etiology, DNR, resuscitation >1h, ROSC prior to EMS arrival, IV and IO)	<u><b>1° endpoint:</b></u> <i>Only presenting results of propensity score matching</i> Survival to hospital d/c aOR 1.0 (0.518, 1.93)  D30 or HD aOR 1.0 (0.197, 5.076)  D30 or HD CPC 1-2- n/a	In prepubescent OHCA, there was no significant association between the type of vascular access for adrenaline administration and the rate of ROSC and HD survival post OHCA after adjustment. Score matching excluded 2/3 of children (only 101 pairs analyzed).  The injection route (IO or PIV) does not appear to have an impact on survival. Children with IO were younger and may have been sicker.  No data about neurological recovery.

				<p>Use of both IO and IV routes excluded.</p> <p>The time to administration of the first dose of adrenaline appears to be too long, regardless of the route.</p> <p>The question whether guidelines are followed in pediatric OHCA population requires further study.</p>
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#### **Reviewer Comments (including whether meet criteria for formal review):**

In the 2 years since the last SR, the available data are very limited to ascertain the role of IO vs IV vascular access in the outcome of children in cardiac arrest. Only two registries have reported on this topic and both have several biases, confounders and limitations. In both studies the cases where both IO and IV accesses were obtained and used were excluded; these cases could be informative as it is common to first obtain an IO and as soon as possible an IV line.

One study included few children younger than 2 years, a subgroup where IV access is particularly challenging and IO access could make an impact on outcome. Data about certain arrest characteristics (e.g. some time data) and EMS personnel experience are lacking. Many children with non-cardiac causes of arrest, who potentially would benefit from a quick and high flow vascular access were excluded.

The other study performed a propensity score matching that excluded 2/3 of cases. The survival rate in this study was very low and therefore neurological recovery comparison was not possible. In addition, the fact that time to administration of adrenaline was too long suggested to authors that guidelines were not adequately followed and this might be a significant confounder.

In summary, one study found worse outcomes with IO access while the other found no difference. Both studies had significant limitations. There are insufficient new publications to trigger a systematic review and no change to the Recommendation will be made.

	<b>Approval Date</b>
<b>Evidence Update coordinator</b>	

ILCOR board	
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**\*Once approval has been made by Evidence Update coordinator, worksheet will go to ILCOR Board for acknowledgement.**

## Reference list

1. Besserer F, Kawano T, Dirk J, Meckler G, Tijssen JA, DeCaen A, Scheuermeyer F, Beno S, Christenson J, Grunau B; Canadian Resuscitation Outcomes Consortium. The association of intraosseous vascular access and survival among pediatric patients with out-of-hospital cardiac arrest. *Resuscitation*. 2021 Oct;167:49-57. doi: 10.1016/j.resuscitation.2021.08.005.
2. Recher M, Baert V, Escutnaire J, Le Bastard Q, Javaudin F, Hubert H, Leteurtre S. Intraosseous or Peripheral IV Access in Pediatric Cardiac Arrest? Results From the French National Cardiac Arrest Registry. *Pediatr Crit Care Med*. 2021 Mar 1;22(3):286-296. doi: 10.1097/PCC.0000000000002659.
3. Granfeldt A, Avis SR, Lind PC, Holmberg MJ, Kleinman M, Maconochie I, Hsu CH, Fernanda de Almeida M, Wang TL, Neumar RW, Andersen LW. Intravenous vs. intraosseous administration of drugs during cardiac arrest: A systematic review. *Resuscitation*. 2020 Apr;149:150-157. doi: 10.1016/j.resuscitation.2020.02.025.

## **Intraosseous Versus Intravenous Route of Drug Administration (PLS, NLS, and ALS: SysRev)**

### Rationale for Review

This topic was last reviewed in 2010. A SysRev was requested to identify evidence comparing effects of intraosseous with intravenous drug administration during pediatric cardiac arrest. The PLS Task Force joined with the ALS and NLS Task Forces in requesting the SysRev.

Refer to the ALS and NLS publications in this supplement for details of the evidence summary.

### Population, Intervention, Comparator, Outcome, Study Design, and Time Frame

- Population: Pediatric patients in any setting (in-hospital or out-of-hospital) with cardiac arrest
- Intervention: Placement of an intraosseous (IO) cannula and drug administration through this IO during cardiac arrest
- Comparator: Placement of an intravenous (IV) cannula and drug administration through this IV during cardiac arrest
- Outcome: Return of spontaneous circulation, survival to hospital discharge, and survival to hospital discharge with a favorable neurological outcome

- Study design: Randomized trials, non-RCTs, and observational studies (cohort studies and casecontrol studies) comparing IO with IV administration of drugs included; randomized trials assessing the effect of specific drugs (eg, epinephrine, amiodarone/lidocaine) in subgroups related to IO versus IV administration also included
- Time frame: All years and languages were included if there was an English abstract; unpublished studies (eg, conference abstracts, trial protocols) were excluded. The literature search was updated to September 2019.

### Consensus on Science

The SysRev identified no papers involving infants and children in cardiac arrest. To review the adult evidence identified by the SysRev, see the ALS publication in this supplement (ALS 2046: SysRev). To review the neonatal evidence identified by the SysRev, see the intraosseous versus umbilical vein for emergency access discussion in the NLS publication of this supplement (NLS 616: SysRev).

The PLS Task Force agreed that, in the absence of new evidence, the previous (2010) treatment recommendation should remain in effect.

### Treatment Recommendations

This treatment recommendation (below) is unchanged from 2010.

Intraosseous cannulation is an acceptable route of vascular access in infants and children with cardiac arrest. It should be considered early in the care of critically ill children whenever venous access is not readily available.

### **2010: Intraosseous accessPeds-035**

#### Consensus on science

There are no studies comparing IO with IV access in children with cardiac arrest. In one LOE 5 study of children in shock<sup>230</sup> IO access was frequently more successful and achieved more rapidly than IV access. Eight LOE 4 case series<sup>231–238</sup> showed that providers with many levels of training could rapidly establish IO access with minimal complications for children with cardiac arrest.

#### Treatment recommendations

IO cannulation is an acceptable route of vascular access in infants and children with cardiac arrest. It should be considered early in the care of critically ill children whenever venous access is not readily attainable.

#### Knowledge gaps

Does the use of IO compared with IV vascular access improve outcome of paediatric cardiac arrest? Does the use of newer IO devices (e.g., bone injection guns and drills) compared with conventional IO needles affect outcome in paediatric cardiac arrest?

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## 2020 Evidence Update Worksheet

**Worksheet author(s):** Patrick Van de Voorde – Monica Kleinman – David Kloeck

**Task Force:** PLS Task Force

**Date Submitted:** 16/09/2021

**Worksheet ID:** Transcutaneous Pacing

<b>Population</b>	Children (0-18y of age) in any setting with symptomatic bradycardia, not in cardiac arrest
<b>Intervention</b>	emergency transcutaneous pacing
<b>Comparison</b>	Any other treatment
<b>Outcomes</b>	Any clinical outcome
<b>Study Design</b>	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. Only pediatric studies and mixed studies in which a pediatric subgroup can be identified will be considered. Studies that have been accepted for publication in a peer-reviewed journal will be included when identified if the full text of the final accepted article can be obtained from the lead author. Case reports will also be considered if the number of cases included is more than 10. Unpublished studies (e.g., conference abstracts, trial protocols), and non-human studies are excluded.
<b>Timeframe</b>	<b>EVIDENCE UPDATE:</b> Publications after 01/01/2019 are included as long as there is an English abstract

**Type (intervention, diagnosis, prognosis):** intervention

**Conflicts of Interest (financial/intellectual, specific to this question):** none

**Year of last full review:** 2010 / 2015 / **New question:** 2020 EvUp (AHA)

**Last ILCOR Consensus on Science and Treatment Recommendation:** 2020

2010 AHA recommendation: Emergency transcutaneous pacing may be lifesaving if the bradycardia is due to complete heart block or sinus node dysfunction unresponsive to ventilation, oxygenation, chest compressions, and medications, especially if it is associated with congenital or acquired heart disease (Class IIb, LOE C)

### 2019 Search Strategy: Pubmed

1. Bradycardia [MeSH]: 25,870
  2. AND cardiac pacing [MeSH]: 2648
  3. Filtered by publication date, infant or child or adolescent, and humans not animals: 65
- Eventually included 2 observational studies

1. Pirasath S and Arulnithy K. Yellow oleander poisoning in eastern province: an analysis of admission and outcome. *Indian J Med Sci.* 2013;67:178-83.
  2. Nazif TM, Vazquez J, Honig LS and Dizon JM. Anti-N-methyl-D-aspartate receptor encephalitis: an emerging cause of centrally mediated sinus node dysfunction. *Europace.* 2012;14:1188-94.
- COMMENT: Included studies do not have a comparator group and have extremely small number of patients (1 and 3, respectively) who had refractory bradycardia requiring pacing. Both studies are primarily in adult patients, with unknown paced patient's age in 1st study and the 2nd study's paced patients were not <18 years

## 2021 Search Strategy:

1. Pacing [tiab] OR cardiac pacing, artificial [mesh] 46256
  2. child (building block) - human not animals
  3. bradycardia [mesh] OR bradycardia [tiab] 27621
- #1+#2+#3 n=441  
2019-2021 n=25  
selection based on abstract **0 relevant**

alternative search strategy was the original 2019 search (corrected for mesh term 'cardiac pacing, artificial'; not filtered for age nor human): 2019-2021 **0 relevant**; 1 adult case series **Bektas 2016 2090** found via practice guideline but outside time period

finally, we did find one case report of a single case (Jones 2019 e162) and if further exploring 'similar articles' from that case report 2019-2021 we had 46 hits leading to 11 abstracts; **0 relevant**

**Database searched: Pubmed**

**Date Search Completed: 21/08/2021**

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

*No publications could be found since the last EvUp for what concerns children. Adult evidence is highly indirect and we did not consider it specifically relevant to our current search*

	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



## **2020 Statement**

### **2020 Statement : Emergency Transcutaneous Pacing for Bradycardia (PLS New: EvUp)**

This topic was last addressed by the Pediatric Task Force in 2000,(Ref) when an international consensus on science and international guidelines were published. As a result, the PLS Task Force requested an EvUp to determine if there was relevant evidence to suggest the need to consider a SysRev. After review of the EvUp (see Supplement Appendix C-18), the task force agreed that there is insufficient evidence to suggest the need for a Sys-Rev. As a result, the 2000 treatment recommendation remains in effect.(Ref)

Population, Intervention, Comparator, Outcome, Study Design, and Time Frame

- There was no previous PICOST for this question. See Supplement Appendix C-18 for details of the search strategy.

### **Treatment Recommendations**

This treatment recommendation (below) is unchanged from 2000.(Ref)

In selected cases of bradycardia caused by complete heart block or abnormal function of the sinus node, emergency transthoracic pacing may be lifesaving. Pacing is not helpful in children with bradycardia secondary to a postarrest hypoxic/ischemic myocardial insult or respiratory failure. Pacing was not shown to be effective in the treatment of asystole in children.

Ref : The American Heart Association in collaboration with the International Liaison Committee on Resuscitation. Guidelines 2000 for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Part 10: pediatric advanced life support. The American Heart Association in collaboration with the International Liaison Committee on Resuscitation. Circulation.2000;102(suppl):I291–I342

**2021 :**

Consensus on Science

Treatment Recommendations

In selected cases of bradycardia caused by complete heart block or abnormal function of the sinus node, emergency transthoracic pacing may be lifesaving. Pacing is not helpful in children with bradycardia secondary to a postarrest hypoxic/ischemic myocardial insult or respiratory failure. Pacing was not shown to be effective in the treatment of asystole in children.

Values, Preferences, and Task Force Insights

Knowledge Gaps

**\*\*CONFIDENTIAL DO NOT DISTRIBUTE\*\*****2022 Evidence Update Worksheet**

**Worksheet author(s):** B. R. Scholefield, AM. Guerguerian, J. Tijssen, C Stewart, A. Topjian

**Collaborators:** Craig Stewart MBBS – Affiliation PICU, Birmingham Children's Hospital, Birmingham UK  
Alexis Topjian MD – Affiliation PICU Children's Hospital of Philadelphia, USA.

**Task Force:** Pediatric Life Support

**Date Submitted:** 13<sup>th</sup> July 2021

**Worksheet ID:** PLS-Target Temperature Management

**PICO / Research Question:**

- **Population:** (P) Pediatric patients (>24 hours to < 18 years of age) who achieve return of sustained circulation (ROSC) after out-of-hospital or in-hospital cardiac arrest,
- **Intervention:** (I) Targeted temperature management (TTM) with a target temperature of 32-36C,
- **Comparison:** (C) No TTM or TTM at an alternative target temperature range, (O)
- **Outcome:**
  - Primary Outcome: Good neurobehavioral survival (GBS) long-term
  - Secondary Outcomes: GBS short-term and intermediate-term; Neurobehavioral score changes from pre-arrest, intermediate-term and long-term; Survival short-term, intermediate-term, and long-term; Health-related quality of life (HRQoL) score intermediate-term, and long-term; HRQoL score change from pre-arrest intermediate-term and long-term.

Note: Long-term defined as 1-3 years, intermediate term defined as 3-6 months, short-term defined as 28-30 days (or hospital discharge).

- **Study Designs:** Randomized controlled trials (RCT), quasi-randomized controlled trials (qRCT), and non-randomized cohort studies were eligible to be included. **Excluded** animal studies, unpublished studies (e.g., conference abstracts), case series.

**Type (intervention, diagnosis, prognosis):** Intervention

**Conflicts of Interest (financial/intellectual, specific to this question):**

B Scholefield received national NIHR funding for post cardiac arrest research and was a Principle Investigator in the THAPCA-IH trial in the UK. A Topjian was principal investigators for the THAPCA-OH and IH trials.

**Year of last full review:** Full systematic review search in Dec 2018

**Last ILCOR Consensus on Science and Treatment Recommendation:**

The PLS task force provided the following treatment recommendations in 2020 (1) following the ILCOR commissioned systematic review by Buick *et al* (2) which included the two main randomized control trials (RCTs) using similar protocols in the pediatric OHCA and IHCA. (3, 4)

We suggest that for infants and children who remain comatose following ROSC from OHCA and IHCA, targeted temperature management be used to maintain a central temperature of 37.5 °C or less (weak recommendation, moderate-certainty evidence).

On the basis of 2 randomized trials and 8 retrospective observational cohort studies that provided comparative data on favorable neurological outcome, survival, and in-hospital adverse events, there is inconclusive evidence to support or refute the use of therapeutic hypothermia (32 °C to 34 °C) compared with therapeutic normothermia (36 °C to 37.5 °C) (or an alternative temperature) for children who achieve ROSC but remain comatose after OHCA or IHCA.

In the original CoSTR (5) the PLS task force reported a preference for the use of induced hypothermia 32°C to 34°C as opposed to active control of temperature at normothermia 36°C to 37.5°C for OHCA. There were insufficient data on patients with IHCA to make a preference in that population. The task force also noted that fever is potentially harmful and should be avoided

### **2018 Search Strategy: Rerun search including dates since previous search Dec 2018.**

Database: Ovid MEDLINE(R) <1946 to June Week 2 2021>

Search Strategy:

- 
- 1 exp Heart Arrest/ (50277)
  - 2 Ventricular Fibrillation/ (17270)
  - 3 Resuscitation/ (26922)
  - 4 exp Cardiopulmonary Resuscitation/ (19208)
  - 5 cardiac arrest\*.tw,kf. (32346)
  - 6 cardiovascular arrest\*.tw,kf. (60)
  - 7 heart arrest\*.tw,kf. (2219)
  - 8 cardiopulmonary arrest\*.tw,kf. (2218)
  - 9 cardio-pulmonary arrest\*.tw,kf. (46)
  - 10 cardiopulmonary resuscitation.tw,kf. (14114)
  - 11 cardio-pulmonary resuscitation.tw,kf. (345)
  - 12 CPR.tw,kf. (11496)
  - 13 advanced cardiac life support.tw,kf. (959)
  - 14 ACLS.tw,kf. (1019)
  - 15 asystole.tw,kf. (3405)
  - 16 pulseless electrical activity.tw,kf. (772)
  - 17 postresuscitation.tw,kf. (1039)
  - 18 (return of circulation or return of spontaneous circulation or ROSC).tw,kf. (3652)
  - 19 post resuscitation.tw,kf. (1046)
  - 20 or/1-19 (110804)
  - 21 exp Hypothermia, Induced/ (20926)
  - 22 therapeutic hypothermia.tw,kf. (3326)
  - 23 Hypothermia therapy.tw,kf. (256)
  - 24 targeted temperature.tw,kf. (721)
  - 25 target temperature.tw,kf. (814)
  - 26 therapeutic mild hypothermia.tw,kf. (33)

- 27 therapeutic moderate hypothermia.tw,kf. (20)
- 28 Hypothermia for neuroprotection.tw,kf. (105)
- 29 induced hypothermia.tw,kf. (2362)
- 30 induced mild hypothermia.tw,kf. (60)
- 31 induced moderate hypothermia.tw,kf. (19)
- 32 artificial hibernation.tw,kf. (524)
- 33 artificial hypothermia.tw,kf. (120)
- 34 extracorporeal hypothermia.tw,kf. (5)
- 35 target body temperature.tw,kf. (17)
- 36 resuscitative hypothermia.tw,kf. (21)
- 37 (cool or cooling or chill or chilling).tw,kf. (39499)
- 38 or/21-37 (59528)
- 39 20 and 38 (4658)
- 40 (Infan\* or newborn\* or new-born\* or perinat\* or neonat\* or baby or baby\* or babies or toddler\* or minors or minors\* or boy or boys or boyfriend or boyhood or girl\* or kid or kids or child or child\* or children\* or schoolchild\* or schoolchild).mp. or school child.tw. or school child\*.tw. or adolescen\*.mp. or juvenil\*.mp. or youth\*.mp. or teen\*.mp. or under\*age\*.mp. or pubescen\*.mp. or exp Pediatrics/ or pediatric\*.mp. or paediatric\*.mp. or peadiatric\*.mp. or school.tw. or school\*.tw. or prematur\*.mp. or preterm\*.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] (4445417)
- 41 39 and 40 (704)
- 42 41 not (animals/ not humans/) (644)
- 43 limit 42 to (comment or editorial or letter) (51)
- 44 42 not 43 (593)
- 45 remove duplicates from 44 (593)
- 46 limit 45 to ed=20181213-20210619 (77)

**Database searched:** OVID MEDLINE

**Date Search Completed:** 7<sup>th</sup> Sept 2021

**Search Results (Number of articles identified / number identified as relevant):** 8

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

<https://pubmed.ncbi.nlm.nih.gov/31175965/>  
<https://pubmed.ncbi.nlm.nih.gov/30572071/>  
<https://pubmed.ncbi.nlm.nih.gov/30422861/>  
<https://pubmed.ncbi.nlm.nih.gov/30075198/>  
<https://pubmed.ncbi.nlm.nih.gov/29228147/>  
<https://pubmed.ncbi.nlm.nih.gov/30291883/>  
<https://pubmed.ncbi.nlm.nih.gov/34534164/>  
<https://pubmed.ncbi.nlm.nih.gov/30557540/>

## Summary of Evidence Update:

### Evidence Update Process for topics not covered by ILCOR Task Forces

1. 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

Organisation (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations
ILCOR Buick 2018	Systematic Review	Identical to this EvUp (see above)	N=12 2 RCTs 1 substudy of RCT 8 observational 1 pilot study	Twelve studies involving 2060 patients were included. Two randomized controlled trials provided the evidence that TTM at 32–34 C compared with a target at 36–37.5 C did not statistically improve long-term good neurobehavioural survival (risk ratio: 1.15; 95% CI: 0.69–1.93), long-term survival (RR: 1.14; 95% CI: 0.93–1.39), or short-term survival (risk ratio: 1.14; 95% CI: 0.96–1.36). TTM at 32–34 C did not show statistically increased risks of infection, recurrent cardiac arrest, serious bleeding, or arrhythmias. A novel analysis suggests that another small RCT might provide enough evidence to show benefit for TTM in out-of-hospital cardiac arrest.	There is currently inconclusive evidence to either support or refute the use of TTM at 32–34 C for comatose children who achieve return of sustained circulation after cardiac arrest. Future trials should focus on children with out-of-hospital 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 RCTs identified	<b><u>Study Aim:</u></b>	<b><u>Inclusion Criteria:</u></b>	<b><u>Intervention:</u></b>	<b><u>1° endpoint:</u></b>	<b><u>Study Limitations:</u></b>
	<b><u>Study Type:</u></b>		<b><u>Comparison:</u></b>		

### Nonrandomized Trials, Observational Studies

<b>Study Acronym; Author; Year Published</b>	<b>Study Type/Design; Study Size (N)</b>	<b>Patient Population</b>	<b>Primary Endpoint and Results (include P value; OR or RR; &amp; 95% CI)</b>	<b>Summary/Conclusion Comment(s)</b>
Cornell, T 2018	Secondary analysis of subgroup of THAPCA-OH study. N=282	OHCA with AKI	Rate of AKI in TH group (39.9%) versus NT group (43.0%) p=0.629	Selective secondary analysis of RCT data. No additional info on survival or neurodevelopment outcome
Meert, K. L 2019	Secondary analysis of subgroup of THAPCA-IH study. N=147	IHCA and ECPR	Rate of hospital survival TH group 26/72 versus NT group 35/72 p=0.194. Rate of good neurodevelopmental outcome TH groups 11/72 versus NT group 21/73 p=0.05	Selective secondary analysis of RCT data. HT reached p=0.05 threshold for good neurodevelopmental outcome.
Meert, K. L. 2019 .	Secondary analysis of subgroup of THAPCA-IH study. N=56	IHCA and Open chest cardiopulmonary resuscitation	Rate of hospital survival TH group 17/25 versus NT group 16/312 p=0.278. Rate of good neurodevelopmental outcome TH groups 10/24 versus NT group 12/30 p=1.0.	Selective secondary analysis of RCT data. No difference in TH and HT group.
Moler, F. W. 2019	Secondary analysis of subgroup of THAPCA-IH study. Early group n=91. Late group n=180	OHCA: Time to goal target temperature and outcomes	Early time to target: Rate of hospital survival TH group 10/49 versus NT group 18/42 p=0.025. Rate of good neurodevelopmental outcome & survival TH groups 5/46 versus NT group 5/39 p=1.0.  Late time to target: Rate of hospital survival TH group 47/99 versus NT group 18/42 p=0.002. Rate of good neurodevelopmental outcome & survival TH groups 22/89 versus NT group 10/79 p=0.077	No difference in outcome in relation too early or late onset of temperature management.
Scholefield, B. R 2018	Secondary analysis of pooled THAPCA-OH and IH study. N=627	OHCA and IHCA	Rate of hospital survival TH group 138/317 versus NT group 113/297 p=0.15 Rate of good neurodevelopmental outcome TH groups 75/271 versus NT group 63/246 p=0.61	Secondary analysis of RCT data. No difference in HT and NT group.
Topjian, A. 2018	Secondary analysis of subgroup of THAPCA-OH study.	OHCA: Rate of hypotension post ROSC	Kaplein Meier presentation in graph of Hypotension + HT, Hypotension + NT, No hypotension + HT, No hypotension + NT.	Secondary analysis of RCT data. No difference in HT and NT group from

	No hypotension N=214, Hypotension N=78		Log rank test of equality over strata p< 0.001	appearance of Kaplan Meier curves.
Topjian, A. 2019	Secondary analysis of subgroup of THAPCA-IH study. Non-ECMO group: Hypotension N=42, No hypotension N=100	IHCA: Rate of hypotension post ROSC	In non-ECMO subpopulation, hypotension within 6 hours associated with decreased survival; adjusted OR 0.34 (0.12, 0.93); p=0.035. However, no relationship with use of hypothermia or normothermia. (unadjusted OR 0.75 (95%CI 0.38 to 1.49).	Secondary analysis of RCT data. No difference in HT and NT group.
Magee, A, 2021	Observational study, Retrospective, Australia. N=239	OHCA and IHCA	After regression adjustment, TH (as opposed to no TH) was associated with higher physical (mean difference, 15.8; 95% CI, 3.5–27.9) and psychosocial scores (13.6 [5.8–21.5]) in a health related quality of life scores. No association between use of TH and PICU mortality (adjusted odds ratio, 1.30; 95% CI, 0.57–2.98).	No difference in survival; however, after regression adjustment, induced hypothermia was associated with significant improvement in two health related quality of life measures (higher physical and psychosocial scores)

OHCA: Out of hospital cardiac arrest, IHCA: In hospital cardiac arrest, THAPCA: Therapeutic hypothermia after pediatric cardiac arrest (Trial (3, 4)). aOR (adjusted Odds Ratio). HT Hypothermia therapy, NT Normothermia therapy.

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

On Sept 7<sup>th</sup> 2021 an Evidence Update was performed by the PLS task force following the original search strategy and research question published by Buick *et al.* (2) No new RCTs were identified. Eight additional publications fulfilled inclusion criteria; however, seven were secondary analysis of subgroups of the Therapeutic Hypothermia After Pediatric Cardiac Arrest (THAPCA) RCT primary trial data for the OHCA, IHCA or combined cohorts. (6-12) One new retrospective observational cohort study was identified from Australia comparing induced hypothermia (<35°C) and normothermia (36-36.5°C). The THAPCA secondary analysis data showed no difference between temperature groups (32-34 versus 36-37.5°C) in any of the following subgroups; ECMO or ECPR, hypotension post-ROSC, open chest resuscitation, combined cohort OH and IH and acute kidney injury. In the Australian study by Magee *et al.*, there was no difference in survival; however, after regression adjustment, induced hypothermia was associated with significant improvement in two health related quality of life measures (higher physical and psychosocial scores). (13) The task force did not identify sufficient new data to proceed to repeating the full systematic review and the task force no longer wished to express a preference.

The PLS task force recommendations from 2020 for the pediatric population therefore remain unchanged in 2021 with minor wording clarification of temperature targets:

**We suggest that for infants and children who remain comatose following ROSC from OHCA or IHCA, active control of temperature be used to maintain a central temperature  $\leq 37.5^{\circ}\text{C}$  (weak recommendation, moderate-certainty evidence).**



**There is inconclusive evidence to support or refute the use of induced hypothermia (32°C to 34°C) compared with active control of temperature at normothermia (36°C to 37.5°C) (or an alternative temperature) for children who achieve ROSC but remain comatose after OHCA or IHCA.**

The PLS task force recognizes that there remains uncertainty about the application of temperature management in pediatric IHCA and OHCA (target temperature, timing, duration, technique); moreover, in circumstances where hypothermia may be considered, there is still no evidence to guide rewarming. Further pediatric research and clinical trials are urgently needed to answer these important questions.

	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

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**\*\*CONFIDENTIAL DO NOT DISTRIBUTE\*\*****2022 Evidence Update Worksheet****Worksheet author(s):** Ming-Ju Hsieh**Task Force:** Education, Implementation & Teams (EIT)**Date Submitted:** Jan 19, 2022**SAC Rep:** Judith Finn**Worksheet ID:** EIT 626 Willingness to preform CPR**PICO / Research Question:** Willingness to provide CPR and/or defibrillation (EIT 626)**Population:** Bystanders (laypersons) in actual situation of adult or pediatric patients with out-of-hospital cardiac arrest (OHCA)**Intervention (Exposures):** Factors (barriers or facilitators) that affected the willingness of bystanders to perform cardiopulmonary resuscitation (CPR) and/or use an automated external defibrillator (AED)**Comparators:** No such factor or any other factor that affected the willingness of bystanders to perform CPR and/or use an AED**Outcomes:** Bystander CPR rate; rate of bystander defibrillation with an AED; willingness to provide CPR in actual situation; willingness to provide defibrillation with an AED in actual situation**Type (intervention, diagnosis, prognosis):** intervention.**Additional Evidence Reviewer(s):** Ying-Chih Ko (RCA), Tasuku Matsuyama (RCA)**Conflicts of Interest (financial/intellectual, specific to this question):** none.**Year of last full review:** 2020**Last ILCOR Consensus on Science and Treatment Recommendation:**

To increase willingness to perform CPR, laypeople should receive training in CPR. This training should include the recognition of gasping or abnormal breathing as a sign of cardiac arrest when other signs of life are absent. Laypeople should be trained to start resuscitation with chest compressions in adult and pediatric victims. If unwilling or unable to perform ventilation, rescuers should be instructed to continue compression-only CPR. EMS dispatchers should provide CPR instructions to callers who report cardiac arrest. When providing CPR instructions, EMS dispatchers should include recognition of gasping and abnormal breathing. (ILCOR 2020 CoSTR, unchanged from 2010)

**Search Strategy for 2021 updated ILCOR CoSTR:****Pubmed:**

("Out-of-Hospital Cardiac Arrest"[MeSH Terms] OR ("out of hospital"[All Fields] AND "cardiac"[All Fields] AND "arrest"[All Fields]) OR "Out-of-Hospital Cardiac Arrest"[All Fields] OR ("out"[All Fields] AND "hospital"[All Fields] AND "cardiac"[All Fields] AND "arrest"[All Fields]) OR "Out-of-Hospital Cardiac Arrest"[All Fields] OR "OHCA"[All Fields] OR ("Heart Arrest"[MeSH Terms] OR ("heart"[All Fields] AND "arrest"[All Fields]) OR "Heart Arrest"[All Fields] OR ("cardiac"[All Fields] AND "arrest"[All Fields]) OR "cardiac arrest"[All Fields]) OR "Out-of-Hospital Cardiac Arrest"[MeSH Terms] OR "Heart Arrest"[MeSH Terms]) AND (((("bystander"[All Fields] OR "bystander s"[All Fields] OR "bystanders"[All Fields] OR "bystanding"[All Fields]) AND ("Cardiopulmonary Resuscitation"[MeSH Terms] OR ("cardiopulmonary"[All Fields] AND "resuscitation"[All Fields]) OR "Cardiopulmonary Resuscitation"[All Fields] OR "cpr"[All Fields])) OR

"BCPR"[All Fields] OR (("public"[All Fields] OR "public s"[All Fields] OR "publically"[All Fields] OR "publication s"[All Fields] OR "publications"[MeSH Terms] OR "publications"[All Fields] OR "publicity"[All Fields] OR "publicize"[All Fields] OR "publicized"[All Fields] OR "publicizing"[All Fields] OR "publics"[All Fields] OR "publishing"[MeSH Terms] OR "publishing"[All Fields] OR "publication"[All Fields]) AND ("access"[All Fields] OR "accessed"[All Fields] OR "accesses"[All Fields] OR "accessibilities"[All Fields] OR "accessibility"[All Fields] OR "accessible"[All Fields] OR "accessing"[All Fields]) AND ("defibrillator"[All Fields] OR "defibrillate"[All Fields] OR "defibrillated"[All Fields] OR "defibrillates"[All Fields] OR "defibrillating"[All Fields] OR "defibrillations"[All Fields] OR "defibrillator s"[All Fields] OR "Defibrillators"[MeSH Terms] OR "Defibrillators"[All Fields] OR "defibrillator"[All Fields] OR "Electric Countershock"[MeSH Terms] OR ("electric"[All Fields] AND "countershock"[All Fields]) OR "Electric Countershock"[All Fields] OR "defibrillation"[All Fields])) OR ((("bystander"[All Fields] OR "bystander s"[All Fields] OR "bystanders"[All Fields] OR "bystanding"[All Fields]) AND ("defibrillator"[All Fields] OR "defibrillate"[All Fields] OR "defibrillated"[All Fields] OR "defibrillates"[All Fields] OR "defibrillating"[All Fields] OR "defibrillations"[All Fields] OR "defibrillator s"[All Fields] OR "Defibrillators"[MeSH Terms] OR "Defibrillators"[All Fields] OR "defibrillator"[All Fields] OR "Electric Countershock"[MeSH Terms] OR ("electric"[All Fields] AND "countershock"[All Fields]) OR "Electric Countershock"[All Fields] OR "defibrillation"[All Fields])) OR "AED"[All Fields] OR ("Defibrillators"[MeSH Terms] OR "Defibrillators"[All Fields] OR ("automated"[All Fields] AND "external"[All Fields] AND "defibrillator"[All Fields]) OR "automated external defibrillator"[All Fields]) OR "Cardiopulmonary Resuscitation"[MeSH Terms] OR "Defibrillators"[MeSH Terms] OR "Electric Countershock"[MeSH Terms] OR "Heart Massage"[MeSH Terms] OR "Chest compression"[All Fields]) AND ("barrier"[All Fields] OR "barrier s"[All Fields] OR "barriers"[All Fields] OR ("facilitate"[All Fields] OR "facilitated"[All Fields] OR "facilitates"[All Fields] OR "facilitating"[All Fields] OR "facilitation"[All Fields] OR "facilitations"[All Fields] OR "facilitative"[All Fields] OR "facilitator"[All Fields] OR "facilitator s"[All Fields] OR "facilitators"[All Fields]) OR ("decrease"[All Fields] OR "decreased"[All Fields] OR "decreases"[All Fields] OR "decreasing"[All Fields]) OR ("increase"[All Fields] OR "increased"[All Fields] OR "increases"[All Fields] OR "increasing"[All Fields] OR "increasings"[All Fields]) OR ("improve"[All Fields] OR "improved"[All Fields] OR "improvement"[All Fields] OR "improvements"[All Fields] OR "improves"[All Fields] OR "improving"[All Fields] OR "improvmnt"[All Fields]) OR ("deter"[All Fields] OR "deterred"[All Fields] OR "detering"[All Fields] OR "deters"[All Fields]) OR ("epidemiology"[MeSH Subheading] OR "epidemiology"[All Fields] OR "frequency"[All Fields] OR "epidemiology"[MeSH Terms] OR "frequence"[All Fields] OR "frequencies"[All Fields] OR "frequencies"[All Fields]) OR "rate"[All Fields] OR ("proportion"[All Fields] OR "proportions"[All Fields]) OR "willingness"[All Fields] OR ("associate"[All Fields] OR "associated"[All Fields] OR "associates"[All Fields] OR "associating"[All Fields] OR "association"[MeSH Terms] OR "association"[All Fields] OR "associations"[All Fields]))

#### EMBASE:

('out of hospital cardiac arrest'/exp OR 'ohca' OR 'out of hospital cardiac arrest' OR 'out of hospital cardiac arrests' OR 'out of hospital cardiopulmonary arrest' OR 'out of hospital cardiopulmonary arrests' OR 'out of hospital heart arrest' OR 'out-of-hospital cardiac arrest' OR 'heart arrest'/exp OR 'cardiac arrest' OR 'heart arrest') AND ('bystander cpr':ti,ab OR bcp:ti,ab OR 'bystander defibrillation':ti,ab OR 'automated external defibrillator'/exp OR aed:ti,ab OR 'public access defibrillation':ti,ab OR 'defibrillator'/exp OR 'cardioverter defibrillator':ti,ab,kw OR 'defibrillator':ti,ab,kw OR 'defibrillator, cardioverter':ti,ab,kw OR 'defibrillators':ti,ab,kw OR 'cardioversion'/exp OR 'cardioconversion':ti,ab,kw OR 'cardioversion':ti,ab,kw OR 'cardioversion, electric':ti,ab,kw OR 'counter shock':ti,ab,kw OR 'countershock':ti,ab,kw OR 'electric cardioversion':ti,ab,kw OR 'electric conversion':ti,ab,kw OR 'electric countershock':ti,ab,kw OR 'electrical cardioversion':ti,ab,kw OR 'electrocardioversion':ti,ab,kw OR 'electroconversion':ti,ab,kw OR 'basic life support'/exp OR 'basic life support':ti,ab,kw OR 'chest compression':ti,ab OR 'cardiopulmonary resuscitation':ti,ab) AND (barrier:ti,ab OR facilitator:ti,ab OR decrease:ti,ab OR increase:ti,ab OR improve:ti,ab OR deter:ti,ab OR frequency:ti,ab OR rate:ti,ab OR proportion:ti,ab OR willingness:ti,ab OR association:ti,ab)

**2021 Search Strategy: As above**

**Last search date: 2020/07/18**

**Database searched: PubMed, EMBASE**

**Date Search Completed: 2021/09/30**

## Search Results (Number of articles identified / number identified as relevant): 2190/12

### Inclusion/Exclusion Criteria:

Inclusion: Randomized controlled trials (RCTs) and nonrandomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies, and questionnaire surveys) over all years were eligible for inclusion.

Exclusion: Simulation studies, survey data not from actual experience, unpublished studies (e.g., conference abstracts, trial protocols), letters, editorials, comments, case reports, systematic reviews, and grey literature, as well as studies that overlap with other ILCOR systematic reviews or scoping reviews (e.g. CPR training, community initiatives to improve delivery of CPR [EIT 641], first responder engaged by technology [EIT 878], public access AED program [BLS #347] and dispatcher-assisted CPR) were excluded from this scoping review.

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

Jadhav, 2021, 139: <https://pubmed.ncbi.nlm.nih.gov/33189804/>  
 Justice, 2020, 440: <https://pubmed.ncbi.nlm.nih.gov/33000068/>  
 Sato, 2021, 259: <https://pubmed.ncbi.nlm.nih.gov/32307352/>  
 Baert, 2020, 219: <https://pubmed.ncbi.nlm.nih.gov/33339538/>  
 Baldi, 2021, 100105: <https://pubmed.ncbi.nlm.nih.gov/34223367/>  
 Ball, 2020, 157: <https://pubmed.ncbi.nlm.nih.gov/32961304/>  
 Fothergill, 2021, 100066: <https://pubmed.ncbi.nlm.nih.gov/33521706/>  
 Lim, 2021, 3646: <https://pubmed.ncbi.nlm.nih.gov/33807454/>  
 Marijon, 2020, e437: <https://pubmed.ncbi.nlm.nih.gov/32473113/>  
 Ortiz, 2020, 230: <https://pubmed.ncbi.nlm.nih.gov/33049385/>  
 Uy-Evanado, 2021, 6: <https://pubmed.ncbi.nlm.nih.gov/33478713/>  
 Yu, 2021, 679: <https://pubmed.ncbi.nlm.nih.gov/34261763/>

### Summary of Evidence Update:

We searched PubMed, Ovid EMBASE databases to identify studies associated with willingness to provide CPR and/or defibrillation published from Jul.19, 2020 to Sep.30, 2021. After duplicates were removed, there were 2,190 records found. Finally, twelve nonrandomized trials were included, and nine of them were related with Coronavirus disease (COVID-19) pandemic [1-9]. Among 12 studies included, one study was performed in Singapore [5], one in Australia [3], two in France [1, 6], three in the US [8, 10, 11], one in UK [4], one in Spain [7], one in Japan [12], one in Switzerland [2], and one in Taiwan [9]. Several factors such as location of cardiac arrest, age, gender and socioeconomic status, or family-witnessed arrest were identified as promoting factors or barrier to bystander CPR [10-12]. Among the studies related to COVID-19 pandemic, the effect of the pandemic on bystander CPR rates varied. Three studies revealed an increased bystander CPR rate during the pandemic [3,4,9], whereas the other six studies found a decreased bystander CPR rate [1, 2, 5-8]. Seven studies had documented the rate of using bystander AED or public access defibrillators (PADs) for patients with out-of-hospital cardiac arrest (OHCA) [1-6, 8], and five out of them showed a significant decrease during the COVID-19 pandemic period, one did not show statistical difference [1], and the other one did not perform inferential statistical analysis [5].

### Evidence Update Process for topics not covered by ILCOR Task Forces

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(2):**

<b>Organisation (if relevant); Author; Year Published</b>	<b>Guideline or systematic review</b>	<b>Topic addressed or PICO(S)T</b>	<b>Number of articles identified</b>	<b>Key findings</b>	<b>Treatment recommendations</b>
Greif R (2020)[13]	Education, Implementation, and Teams: 2020 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations	Willingness to perform bystander CPR	18	The 2010 treatment recommendation remains valid.	To increase willingness to perform CPR, laypeople should receive training in CPR. This training should include the recognition of gasping or abnormal breathing as a sign of cardiac arrest when other signs of life are absent. Laypeople should be trained to start resuscitation with chest compressions in adult and pediatric victims. If unwilling or unable to perform ventilation, rescuers should be instructed to continue compression-only CPR. EMS dispatchers should provide CPR instructions to callers who report cardiac arrest. When providing CPR instructions, EMS dispatchers should include recognition of gasping and abnormal breathing. (ILCOR 2020 CoSTR, unchanged from 2010)
Matsuyama T(2020)[14]	Scoping review	Willingness to perform bystander cardiopulmonary resuscitation: A scoping review	18	Younger bystander, previous CPR training, higher education, multiple bystanders on scene, and compression-only CPR were associated with increased willingness to perform CPR. "Personal factors", "CPR knowledge", and "procedural issues" were associated with reduced willingness to respond to cardiac arrest.	CPR training, regional and national education programs, and dispatch instructions should take these factors into consideration, to improve CPR performance of lay rescuers in the actual settings

CPR, cardiopulmonary resuscitation.

**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
	<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 (12)**Non-COVID-19 Study

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)	Promote factors/ Barrier factors
Justice JM (2020, US) [11]	Retrospective cross-sectional study	Out-of-hospital cardiac arrest events in the Memphis (N=2792)	White patients were more likely to receive bystander CPR compared to black patients (44.0% vs 29.8%, aOR = 1.70; 95% CI = 1.40–2.05). Patients in areas of increased economic hardship were less likely to receive bystander CPR (OR = 0.713, 95% CI = 0.569–0.894).	Promote factor: younger in age, witnessed arrest. Barrier factor: race, lower socioeconomic areas.
Jadhav S (2021, US) [10]	Retrospective cross-sectional analysis	Bystander AED cases from National Emergency Medical Services Information System (NEMSIS) database (N=1,144,969)	Compared female patients, the RR for bystander AED usage for male patients was 1.34 (95% CI [1.3310, 1.3557], $p < 0.001$ ). Using urban patients as a baseline, resulted in a RR of 0.87 for suburban patients (95% CI [0.8572, 0.8833], $p < 0.001$ ), 0.39 for rural patients (95% CI [0.3849, 0.3971], $p < 0.001$ ), and 0.36 for frontier patients (95% CI [0.3515, 0.3726], $p < 0.001$ ).	Barrier factor: female sex, rural and frontier areas
Sato N (2021, Japan) [12]	Prospective observational study	All adult patients with witnessed OHCA of medical origin in Niigata City, Japan (N=818)	OHCA patients witnessed by family were less likely to receive bystander CPR compared to those witnessed by non-family members (260=609 [42.7%] versus 119=209 [56.9%], $p = 0.017$ )	Barrier factor: witnessed by family.

**Abbreviations:** AED, automated external defibrillator; OHCA, out-of-hospital cardiac arrest; RR, relative risk; aOR, adjusted odds ratio; CI, confidence interval; CPR, cardiopulmonary resuscitation.

COVID-19 Study

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)	Promote factors/ Barrier factors
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Baert V (2020, France) [1]	Before-and-after observational study	OHCA of medical origin (N=2625; study period, n=1005, control period, n=1620)	During the COVID-19 period, bystanders and first aid providers initiated CPR less frequently (49.8% versus 54.9%; $p = 0.011$ ), and a decrease in CPR initiation was observed regardless of whether patients were suspected of SARS-CoV-2 infection or not. No differences were observed between the use of AED by bystanders. (7.5% versus 7.5%, $p = 0.939$ )	COVID-19
Baldi E (2021, Switzerland) [2]	Observational study	All OHCAs (N=1844; 933 and 911 OHCAs occurred in the 2019 and 2020 study)	OHCA location was significantly more frequent at home, a bystander CPR was less frequently started (56.5% versus 62.8%; $p = 0.04$ ) and an AED was less frequently used (8.6% versus 13%; $p = 0.03$ ).	COVID-19
Ball J (2020, Australia) [3]	Retrospective cohort study	Adult OHCA patients who received resuscitation (N=1598; COVID-19 pandemic period (n=380); comparator period (n=1218))	Arrests in public locations decreased in the pandemic period (20.8% versus 10.0%; $p < 0.001$ ), as did initial shocks by public access defibrillation/first-responders ( $p = 0.037$ ). Bystander CPR significantly increased during the pandemic period (78.7% versus 73.0%; $p = 0.026$ ); it was bystander CPR provided in private residences and not in public locations that significantly increased.	COVID-19
Fothergill RT (2021, UK) [4]	Retrospective observational study	All EMS-initiated OHCA (N=4846; COVID-19 pandemic period [n=3122]; comparator period [n = 1724])	During the pandemic, OHCA occurring in a private location was more frequent (92.9% vs 85.5%, $p < 0.001$ ) with an increased bystander CPR rate (63.3% vs 52.6%, $p < 0.001$ ). Fewer resuscitation attempts (36.4% vs 39.6%, $p = 0.03$ ) was found, and a PAD was less frequently use (4.1% vs 8.9%, $p < 0.001$ ).	COVID-19
Lim SL (2021, Switzerland) [5]	Retrospective cohort study	All EMS-attended adult OHCAs (N= 3893, pandemic period [n=1400], pre-pandemic period [n=2493])	OHCAs during the pandemic period more likely occurred at home (aOR: 1.48; 95% CI: 1.24–1.75) and were witnessed (aOR: 1.71; 95% CI: 1.49–1.97). During the pandemic period, OHCA patients received less bystander CPR (aOR: 0.70; 95% CI: 0.61–0.81) despite 65% of witnessed arrests by a family member.	COVID-19
Marijon E (2021, France) [6]	Retrospective observational study	Non-traumatic OHCAs (N= 3573, pandemic period	A higher rate of OHCA at home (90.2% vs 76.8%; $p < 0.001$ ), less bystander cardiopulmonary	COVID-19



		[n=521], pre-pandemic period [n=3052])	resuscitation (47.8% vs 63.9%; $p < 0.001$ ) and less PAD use (0.4% vs 3.0%; $p < 0.001$ ) were found during the pandemic period while patient demographics did not change substantially.	
Rosell Ortiz F (2020, Spain) [7]	Prospective cohort study	All EMS-treated OHCA cases (N=3168; COVID period [n=1446], non-COVID period [n=1723])	Relative to the non-COVID period, OHCA was more likely to occur at home and bystander CPR was less frequent (42.6% versus 51.1%, $p < 0.001$ ) during the COVID period, with these differences remaining even when cardiac arrest was witnessed. There was no significant difference in AED use between two periods (9.0% versus 11.2%, $p = 0.05$ ) (Whether AEDs were used by bystanders or professional personnel did not be described in the manuscript.)	COVID-19
Uy-Evanado A (2021, US) [8]	Retrospective observational study	OHCA cases (N=509; COVID period [n=278], non-COVID period [n=231])	OHCA cases receiving bystander CPR was lower in COVID period (61% to 51%, respectively; $p = 0.02$ ), and bystander use of AED declined (5% to 1%, respectively; $p = 0.02$ ).	COVID-19
Yu JH (2021, Taiwan) [9]	Retrospective observational study	Adult non-traumatic OHCA cases (N=1192; COVID period (n=622)), non-COVID period (n=570))	During the pandemic, OHCA cases were more likely to occur at home (65.6% vs 52.1%, $p < 0.01$ ); bystander CPR and defibrillation with AED by EMTs were more common (52.81% vs 65.76%, $p < 0.001$ , and 23.51% vs 31.67%, $p = 0.001$ , respectively).	COVID-19

**Abbreviations:** EMS, emergency medical service; AED, automated external defibrillator; PAD, public access defibrillator; OHCA, out-of-hospital cardiac arrest; aOR, adjusted odds ratio; CI, confidence interval; CPR, cardiopulmonary resuscitation; COVID-19, coronavirus disease 2019; EMT, emergency medical technician.

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

In our evidence-update review, twelve new observational studies were included. Three of them identified some factors associated with willingness to perform CPR. These factors had been found by a prior scoping review [14].

The other nine articles depicted the association of the COVID-19 pandemic with the rate of performing CPR and using AED by bystanders. Among them, six studies found that bystander CPR rate decreased [1,2,5,6,7,8] and five studies showed a significant decrease in the rate of using bystander AED or PAD during the COVID-19 pandemic period [2-4,6,8]. Due to the design of the studies included in our review, some factors associated with bystander CPR and AED were found but it cannot lead to infer a causal relationship among these factors and bystander CPR and AED. It remains unknown how these factors affect willingness to perform bystander CPR and AED exactly. It was speculated that COVID-19, the infectious disease, reduced the willingness to perform bystander CPR because of the fear of being infected. OHCA occurred less at public area during the pandemic period and it might decrease the chance of patients with OHCA receiving bystander AED. Therefore, the rate of bystander AED decreased subsequently. It is reasonable to adjust the content of the

educational courses for laypersons after considering the benefit and risk of performing CPR during the pandemic period.

After reviewing these twelve studies published during the searching period, the evidence triggers did not change in the wording and the treatment recommendation for willingness to provide CPR and/or defibrillation (EIT 626) published in ILCOR 2020 CoSTR.

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**\*\*CONFIDENTIAL DO NOT DISTRIBUTE\*\*****2022 Evidence Update Worksheet  
Rapid Response Systems in adults (EIT #638)****Worksheet author(s):** Joyce Yeung**Task Force:** EIT**Date Submitted to SAC rep for peer review and approval:****SAC rep:** Judith Finn**Worksheet ID:** Rapid Response Systems in adults (EIT #638)**PICOST / Research Question:**

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

***Population:*** Adults who are at risk of cardiac or respiratory arrest in hospital***Intervention:*** Rapid Response System (includes Rapid Response Team (RRT) or Medical Emergency Team MET))***Comparators:*** No Rapid Response System***Outcomes:*** Survival to hospital discharge with good neurological outcome; Survival to hospital discharge; In-hospital incidence of cardiac/respiratory arrest***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.***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 10 December 2019.**Year of last full review:** 2019**Current ILCOR Consensus on Science and Treatment Recommendation for this PICOST:**

For the critical outcome of hospital discharge with favourable neurological outcome, we did not find any study.

For the critical outcome of survival to hospital discharge, we have found low-quality evidence (downgraded for risk of bias and inconsistency) from 2 RCTs {Priestley 2004 1398; Hillman 2005 2091} and very-low-quality evidence (downgraded for risk of bias, inconsistency, and indirectness) from 35 non-RCTs.{Bristow 2000 236; Buist 2002 387; Bellomo 2003 283; Subbe 2003 797; Kenward 2004 257; Dacey 2007 2076; Baxter 2008 223; Chan 2008 2506; Rothschild 2008 417; Snyder 2009 834; Vazquez 2009 449; Konrad 2010 100; Lighthall 2010 679; Santamaria 2010 445; Beitler 2011 R269; Hayani 2011 1138; Jones 2011 83; Laurens 2011 707; Lim 2011 373; Moon 2011 150; Patel 2011 1455; Sarani 2011 415; Shah 2011 1361; Howell 2012 2562; Rothberg 2012 98; Scherr 2012 32; Simmes 2012 20; Al-Qahtani 2013 506; Chen 2014 167; Salvatierra 2014 2001, Kim 2017 e562; Al Rajhi 2016 478; Joshi 2017 369; Jung 2016 494; Oh 2018 1303; Davis 2016 352; Chen 2016 47}

Of the 2 RCTs, one demonstrated no significant difference between control hospitals (functioned as usual) and intervention hospitals (introduced a MET team) for both unadjusted ( $P=0.564$ ; Diff,  $-0.093$ ; 95% CI,  $-0.423$  to  $0.237$ ) and adjusted ( $P=0.752$ ; OR,  $1.03$ ; 95% CI,  $0.84$ – $1.28$ ) survival.{Hillman 2005 2091} The other study demonstrated a significant difference between control wards and intervention wards (introduction of a critical care outreach service) with all patients (OR,  $0.70$ ; 95% CI,  $0.50$ – $0.97$ ), and matched randomized patients (OR,  $0.52$ ; 95% CI,  $0.32$ – $0.85$ ).{Priestley 2004 1398}

Of the 34 nonrandomized studies reporting mortality, no studies reported statistically significant worse outcomes for the intervention. For studies not reporting adjusted outcomes:

16 studies with no adjustment demonstrated no significant improvement {Subbe 2003 797; Kenward 2004 257; Baxter 2008 223; Rothschild 2008 417; Snyder 2009 834; Vazquez 2009 449; Hayani 2011 1138; Jones 2011 83; Lim 2011 373; Patel 2011 1455; Shah 2011 1361; Rothberg 2012 98; Scherr 2012 32; Simmes 2012 20; Al Rajhi 2016 478; Oh 2018 1303};  
 10 studies with no adjustment demonstrated significant improvement {Buist 2002 387; Bellomo 2003 283; Laurens 2011 707; Moon 2011 150; Al-Qahtani 2013 506; Kim 2017 e562, Joshi 2017 369, Jung 2016 494; Davis 2016 352; Chen 2106, 47};  
 1 study with no adjustment reported on rates, which improved with MET, but did not report on significance {Dacey 2007 2076};  
 1 study with no adjustment demonstrated significant improvement for medical patients but not surgical patients (combined significance not reported){Sarani 2011 415}  
 For studies reporting adjusted outcomes:

3 studies with adjustment demonstrated significant improvement both before and after adjustment {Konrad 2010 100; Beitler 2011 R269; Chen 2014 167};  
 3 studies with adjustment demonstrated significant improvement before adjustment but not after adjustment {Lighthall 2010 679; Salvatierra 2014 2001; {Todd 1998 364};  
 2 studies with adjustment demonstrated no significant improvement both before and after adjustment {Bristow 2000 236; Chan 2008 2506};  
 1 study that reported on both unexpected mortality and overall mortality showed significant improvement both before and after adjustment for unexpected mortality but no significant improvement both before and after adjustment for overall mortality {Santamaria 2010 445};  
 1 before-after study that presented “after” data for unexpected mortality in 3 separate time bands demonstrated significant improvement in time band 3 before adjustment and in time bands 2 and 3 after adjustment.{Howell 2012 2562}  
 The heterogeneous nature of the studies prevents pooling of data; however, there is a suggestion of improved hospital survival in those hospitals that introduce a RRS, and a suggestion of a dose-response effect, with higher-intensity systems (eg, higher RRS activation rates, senior medical staff on RRS teams) being more effective.

For the critical outcome of in-hospital incidence of cardiac arrest, we found low-quality evidence (downgraded for risk of bias and indirectness) from 1 RCT {Hillman 2005 2091} and very-low-quality evidence (downgraded for risk of bias, inconsistency, and indirectness) from 33 further non-RCTs.{Bristow 2000 236; Buist 2002 387; Bellomo 2003 283; Subbe 2003797; DeVita 2004 251; Kenward 2004 257; Dacey 20072076; Offner 2007 1223; Baxter 2008 223; Benson 2008 743; Rothschild 2008 417; Moldenhauer 2009 164; Vazquez 2009 449; Konrad 2010 100; Lighthall 2010 679; Santamaria 2010 445; Beitler 2011 R269; Laurens 2011 707; Lim 2011 373; Moon 2011 150; Sarani 2011 415; Shah 2011 1361; Rothberg 2012 98; Scherr 2012 32; Simmes 2012 20; Al-Qahtani 2013 506; Chen 2014 167; Ludikhuize 2015 2544; Oh 20181303; Chen 2106 47; Joshi 2017 369; Kim 2017 e562; Nishijima 2016 12}.

For the 1 RCT, {Hillman 2005, 2091} no significant difference between control hospitals and intervention hospitals, for both unadjusted ( $P=0.306$ ; Diff,  $-0.208$ ; 95% CI,  $-0.620$  to  $0.204$ ) and adjusted ( $P=0.736$ ; OR,  $0.94$ ; 95% CI,  $0.79-1.13$ ) analyses.

Of the 32 observational studies reporting on cardiac arrest rates:

17 studies with no adjustment demonstrated significant improvement in cardiac arrest rates after the introduction of a MET system {Bellomo 2003 283; Dacey 20072076; Offner 2007 1223; Baxter 2008 223; Benson 2008 743; Moldenhauer 2009 164; Konrad 2010 100; Lighthall 2010 679; Beitler 2011 R269; Laurens 2011 707; Moon 2011 150; Sarani 2011 415; Rothberg 2012 98; Al-Qahtani 2013 506; Ludikhuize 2015 2544; Oh 2018 1303; Chen 2106 47};  
 7 studies with no adjustment demonstrated no significant improvement in cardiac arrest rates after the introduction of a MET system {Kenward 2004 257; Rothschild 2008 417; Vazquez 2009 449; Lim 2011 373; Shah 2011 1361; Scherr 2012 32; Simmes 2012 20};  
 1 before-after study using an aggregated weighted scoring system (Modified Early Warning Score [MEWS]) reported significantly higher cardiac arrest rates in MEWS bands 3 to 4 after intervention, but not in MEWS bands 0 to 2 or 5 to 15, and overall cardiac arrest rate significance was not reported {Subbe 2003 797};  
 3 studies with adjustment demonstrated significant improvement in cardiac arrest rates after the introduction of a RRS both before and after adjustment {Buist 2002 387; DeVita 2004 251; Chen 2014167};

1 study with contemporaneous controls demonstrated no significant improvement in cardiac arrest rates after the introduction of a RRS both before and after adjustment {Bristow 2000 236};

1 study with contemporaneous controls demonstrated significant improvement in cardiac arrest rates after the introduction of a RRS both before and after adjustment {Chen 2014 167};

1 study with adjustment demonstrated significant improvement before adjustment for whole of hospital and non-intensive care unit (ICU) cardiac arrest rates, but only for non-ICU cardiac arrest rates after adjustment {Chan 2008 2506};

1 before-after study that presented “after” unadjusted data for cardiac arrest in 3 separate time bands demonstrated significant improvement in time bands 2 and 3. {Santamaria 2010 445}

The heterogeneous nature of the studies prevents pooling of data. However, there is a suggestion of a reduced incidence of cardiac arrest in those hospitals that introduce a RRS, and a suggestion of a dose-response effect, with higher-intensity systems (eg, higher RRS activation rates, senior medical staff on RRS teams) being more effective.

### Treatment Recommendations

We suggest that hospitals consider the introduction of rapid response system (rapid response team/medical emergency team) to reduce the incidence of IHCA and in-hospital mortality (weak recommendation, low-quality evidence).

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

((("Hospital Rapid Response Team"[MeSH Terms] OR "code blue"[Title/Abstract] OR "code team"[Title/Abstract] OR "medical emergency team"[Title/Abstract] OR "medical emergency teams"[Title/Abstract] OR "medical emergency response team"[Title/Abstract] OR "rapid-response system"[Title/Abstract] OR "rapid-response systems"[Title/Abstract] OR "rapid-response system"[Title/Abstract] OR "rapid-response systems"[Title/Abstract] OR "rapid-response team"[Title/Abstract] OR "rapid-response teams"[Title/Abstract] OR "rapid-response team"[Title/Abstract] OR "rapid-response teams"[Title/Abstract] OR "modified early warning score"[Title/Abstract] OR "early warning score"[Title/Abstract] OR "early warning scoring"[Title/Abstract] OR "critical care outreach"[Title/Abstract] OR "patient at risk team"[Title/Abstract] OR "patient care team"[All Fields] OR "track and trigger"[Title/Abstract] OR "Early Warning System"[Title/Abstract] OR "Early Warning Systems"[Title/Abstract] OR "ICU outreach"[Title/Abstract])) AND ("Heart Arrest"[MeSH Terms] OR "cardiac arrest"[Title/Abstract] OR "cardiac arrests"[Title/Abstract] OR "cardiovascular arrest"[Title/Abstract] OR "Heart Arrest"[Title/Abstract] OR "heart arrests"[Title/Abstract] OR "asystole"[Title/Abstract] OR "cardiopulmonary arrest"[Title/Abstract] OR "cardiopulmonary arrests"[Title/Abstract] OR "respiratory arrest"[Title/Abstract])) NOT (((("animals"[MeSH Terms] NOT "humans"[MeSH Terms]) NOT "child"[MeSH Terms]) NOT "infant"[MeSH Terms]) NOT ("letter"[Publication Type] OR "comment"[Publication Type] OR "editorial"[Publication Type] OR "case reports"[Publication Type]))) AND "2019/12/10 07:03":"2022/01/02 06:14"[Date - MeSH]

Database searched: Pubmed

Time Frame: (existing PICOST) – updated from 10 December 2019

Date Search Completed: 2 January 2022

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

228 unique articles generated from the search. After title and abstract screening, 35 articles were reviewed as full texts. One relevant systematic review and 11 non-randomized studies were included in evidence update.

### 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
McGaughey; 2021{McGaughey 2021 Cd005529}	Cochrane review	To determine the effect of EWS and RRS implementation on adults	11 studies included: 4 randomized studies	No meta-analysis was conducted due to clinical and methodological	Given the low-to-very low certainty evidence for all outcomes from non-randomised studies, we have drawn our conclusions from the randomised evidence.

		who deteriorate on acute hospital wards compared to people receiving hospital care without EWS and RRS in place.	(455226 participants), 7 non-randomized studies (210905 participants)	<p>heterogeneity. Studies were assessed to be at high/critical risk of bias.</p> <p>Low-certainty evidence that EWS and RRS may lead to little or no difference in hospital mortality, unplanned ICU admissions, length of hospital stay or adverse events; and moderate-certainty evidence of little to no difference on composite outcome.</p>	<p>The review highlights the diversity in outcome selection and poor methodological quality of most studies investigating EWS and RRS.</p> <p>As a result, no strong recommendations can be made regarding the effectiveness of EWS and RRS based on the evidence currently available.</p>
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**RCT: None identified**

#### 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)
Bhonagiri 2020{Bhonagiri 2021 375}	Before and after study. Retrospective analyses using registry data with propensity scoring; 70688439 admissions, 5506 cardiac arrest patients	35 hospitals with an ICU, aged $\geq$ 18	The cardiac arrest rate per 1000 hospital admissions declined from 0.91 in the implementation period to 0.70. Propensity score analysis showed significant declines in ICU and hospital mortality and length of stay for cardiac arrest patients admitted to the ICU (all $p < 0.001$ ).	Between the flag (BTF) two-tier RRS was associated with a significant reduction in cardiac arrests in hospitals and ICU admissions secondary to cardiac arrests  Multicenter study.
Heller 2020 {Heller 2020 100}	Before and after study. Retrospective analyses; 3827 patients	Post-surgical patients	Rate of cardiac arrests reduced from 5.3 to 2.1 per 1000 admissions ( $p < 0.001$ ). Reduced number of unplanned ICU admissions from 3.6% to 3.0% ( $p < 0.001$ ), increase surgical team reviews.	Introduction of EWS with automatic paging capability in established MET system improved early detection of clinical deterioration.
Paul 2021 {Paul 2021 }	Before and after study. Retrospective analysis of rapid response registry; 176 cardiac arrest patients	Aged $\geq$ 18, DNAR order, cardiac arrest call for reasons other than cardiac arrest	IHCA prevalence was unchanged	MET introduction did not affect prevalence of IHCA
Song 2021 {Song 2021 1841}	Before and after study. 1483 pre RRS,	Patients admitted with hip fractures	No significant differences in unexpected admission to ICU	RRS implementation improved early detection of deteriorating

	1315 post RRS patients		and in-hospital mortality. Length of hospital stay was reduced from 24.9 days to 15.4 days ( $p < 0.001$ ). The 5-year survival rate was 57% in the pre-RRS group and 72% in the post-RRS group (HR 0.73 [0.61-0.87], $p < 0.001$ ).	patients admitted with hip fractures and reduced length of hospital stay. No effect on hospital mortality.
Viana 2020 {Viana 2021 96}	Before and after study; 308 cardiac arrests	Excluding cardiac arrests in ICU, ER or operating theatre	Reduction in cardiac arrests from 4.2 to 2.5 cardiac arrests/1000 admissions ( $p < 0.001$ ). ROSC (OR 1.4 [0.70-2.81], $p = 0.103$ ) and hospital mortality (OR 0.89 [0.40-2.02], $p = 0.95$ ) was not associated with RRS implementation	RRS reduced number of cardiac arrests but did not improve ROSC or hospital mortality.
Yang 2020 {Yang 2020 77}	Before and after study; 61315 before RRS, 75119 post RRS general surgical patients	Excluding patients in ICU, ER and medical wards	No significant difference in rate of cardiac arrest/1,000 admissions (RR 0.53 [0.25-1.13], $p = 0.099$ ). Number of preventable cardiac arrests was significantly lower (RR 0.31 [0.11-0.88], $p = 0.028$ ). No statistical differences in in-hospital mortality or patient outcomes. DNAR decisions significantly increased (RR 1.91 [1.40-2.59], $p < 0.001$ ).	Day time RRS system reduced the number of preventable cardiac arrests.
Khan 2020 {Khan 2020 149}	39966 pre RRS, 39656 post RRS hospital admissions	Aged $\geq 18$ , excluding patients with DNAR orders.	The incidence of IHCA per 1000 hospital admissions was 14.6% lower than before but not statistically significant (RR 0.86 [0.55-1.34], $p > 0.05$ ). There is a trend for higher rate of survival to home discharge after IHCA (RR 2.13 [0.65-6.93], $P > 0.05$ ) with good neurological outcome.	Automated monitoring system and MET activation was added as extension of existing RRS system. Result has shown a trend in reducing cardiac arrest incidence.
Fogas 2021 {Fogas 2021 782}	Before and after study. 507 pre RRS, 286 post RRS.	Unclear	Reduction of hospital mortality rate from 2.983% pre RRS decreased to 2.932% was not significant.	Introduction of RRS did not reduce hospital mortality.
Gong 2020 {Gong 2020 317}	Before and after study. 144673 pre and 348687 post RRS admissions	Mixed adult patients from tertiary hospital. No exclusions stated.	No difference in rate of cardiac arrests (0.23 vs. 0.17 per 1,000 patient days, $p = 0.379$ ). A significant 40% decrease of overall hospital mortality from 2.95 to 1.77 per 1,000 non-obstetric patients after the implementation of RRT ( $P = 0.001$ ). The increase of RRT activations was significantly correlated with the decrease	RRT implementation reduced overall hospital mortality

			of hospital mortality (P=0.025).	
Ou 2020 {Ou 2020 162}	Before and after Between the flag (BTF) system as well as before and after RRS. 48139 pre and 118042 post BTF patients	Emergency surgical patients	Before BTF, RRS hospitals had a lower rate of in hospital cardiopulmonary arrests (IHCA) (4.7 vs 7.8 per 1000 admissions, P < 0.001), a lower rate of IHCA related deaths (3.0 vs 4.4 per 1000 admissions, P = 0.03) compared with patients in non-RRS hospitals. There were no significant differences in overall in-hospital mortality and 30-day mortality between the two cohorts.	BTF program was associated with a significant reduction in IHCA and IHCA deaths for emergency surgical patients in non-RRS hospitals but not in RRS hospitals.  Both BTF and RRS evaluated. Potential confounding/interaction in results.
Higashino 2021 {Higashino 2021 e26856}	Retrospective analysis of RRS and advanced care plans (ACP). 15048 pre and 25296 post RRS and ACP.	Mixed adult patients. No exclusions stated.	RRS led to a reduction in the relative risk of unpredicted IHCA (RR 0.618 [0.453–0.843]). The reduction in unpredicted IHCA was attributed partly to the increased number of patients with ACP, and a significant correlation was observed between these parameters (R <sup>2</sup> =0.992, P<.001).	Both RRS and ACP were evaluated. Potential confounding/interaction in results

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

There are no new randomized studies found in evidence updates. The findings from 11 non-randomized studies were mixed and majority suffer from high risk of bias. There is insufficient evidence to recommend a 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))**

**New studies only listed**

{Bhonagiri 2021 375} <https://pubmed.ncbi.nlm.nih.gov/32133760/>  
 {Fogas 2021 782} <https://pubmed.ncbi.nlm.nih.gov/33999855/>  
 {Gong 2020 317} <https://pubmed.ncbi.nlm.nih.gov/32355761/>  
 {Heller 2020 100} <https://pubmed.ncbi.nlm.nih.gov/29771722/>  
 {Higashino 2021 e26856} <https://pubmed.ncbi.nlm.nih.gov/34397894/>  
 {Khan 2020 149} <https://pubmed.ncbi.nlm.nih.gov/33129913/>  
 {McGaughey 2021 Cd005529} <https://pubmed.ncbi.nlm.nih.gov/34808700/>  
 {Ou 2020 162} <https://pubmed.ncbi.nlm.nih.gov/32004664/>  
 {Paul 2021 } <https://pubmed.ncbi.nlm.nih.gov/34865306/>  
 {Song 2021 1841} <https://pubmed.ncbi.nlm.nih.gov/33883073/>  
 {Viana 2021 96} <https://pubmed.ncbi.nlm.nih.gov/33886858/>  
 {Yang 2020 77} <https://pubmed.ncbi.nlm.nih.gov/32506872/>



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- Heller, A. R., S. T. Mees, B. Lauterwald, C. Reeps, T. Koch and J. Weitz (2020). "Detection of Deteriorating Patients on Surgical Wards Outside the ICU by an Automated MEWS-Based Early Warning System With Paging Functionality." Ann Surg **271**(1): 100.
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- McGaughey, J., D. A. Fergusson, P. Van Bogaert and L. Rose (2021). "Early warning systems and rapid response systems for the prevention of patient deterioration on acute adult hospital wards." Cochrane Database Syst Rev **11**(11): Cd005529.
- Ou, L., J. Chen, K. Hillman, A. Flabouris, M. Parr and M. Green (2020). "The effectiveness of a standardised rapid response system on the reduction of cardiopulmonary arrests and other adverse events among emergency surgical admissions." Resuscitation **150**: 162.
- Paul, R. A., C. Beaman, D. A. West and G. J. Duke (2021). "CoBRA: COde Blue Retrospective Audit in a Metropolitan Hospital." Intern Med J.
- Song, I. A., Y. K. Lee, J. W. Park, J. K. Kim and K. H. Koo (2021). "Effectiveness of rapid response system in patients with hip fractures." Injury **52**(7): 1841.
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## 2022 Evidence Update Worksheet

**Worksheet author(s):** Andrea Scapigliati, Drieda Zace, Janet Bray, Robert Greif

**Task Force:** EIT

**Date Submitted to SAC rep for peer review and approval:** 10. Jan 2022

**SAC rep:** Approved Judith Finn – 17 Jan 2022

**Worksheet ID:** EIT 641 Community Initiatives to promote BLS implementation

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

Community initiatives to promote BLS implementation (EIT 641)

Population: Within the general population of children and adults suffering an out-of-hospital cardiac arrest,

Intervention: Do community initiatives promoting Basic Life Support (BLS),

Comparison: In comparison to current practice,

Outcomes: Have any impact on:

- 1) the survival to hospital discharge with good neurological outcome,
- 2) survival to hospital discharge,
- 3) return of spontaneous circulation (ROSC),
- 4) time to first compression,
- 5) bystander CPR rates,
- 6) proportions of the population trained in BLS.

Type (intervention, diagnosis, prognosis): observational: 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.

**Year of last full review: (insert year where this PICOST was most recently reviewed) /** 10 Nov 2019

### **Current ILCOR Consensus on Science and Treatment Recommendation for this PICOST:** from the 2015 CoSTR

Consensus on science:

For the critical outcome of survival to 180 days with good neurologic outcome, we found no data.

For the critical outcome of survival to hospital discharge, we identified very-low-quality evidence (downgraded for imprecision, risk of bias, and indirectness) from 11 observational studies. Seven studies showed that implementation of resuscitation guidelines improved survival (RR, 1.25; 95% CI, 1.16–1.35), and 4 studies were neutral.

For the important outcome of ROSC, we identified very-low-quality evidence (downgraded for imprecision, risk of bias, and indirectness) from 10 observational studies. Seven studies showed that implementation of resuscitation guidelines improved ROSC (RR, 1.15; 95% CI, 1.11–1.20), and 3 studies were neutral.

For the important outcome of CPR performance, we identified very-low-quality evidence (downgraded for imprecision, risk of bias, and indirectness) from 4 observational studies that implementation of resuscitation guidelines improved the hands-off ratio of emergency medical services CPR performance (mean 0.28 versus 0.42).

Treatment recommendations

We recommend implementation of resuscitation guidelines within organizations that provide care for patients in cardiac arrest in any setting (strong recommendation, very-low-quality evidence).

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

**PubMed** (Search performed on 10/11/2019, filters: only humans)

((("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 (defibrillators [Mesh] OR defibrillator\* [TIAB] OR "automated external defibrillator\*" OR AED OR "External Defibrillator\*" OR "Electric Shock Cardiac Stimulator\*" OR "Electric Defibrillation" OR Electric Countershock [Mesh] OR "Electrical Cardioversion\*" [TIAB] OR "Cardiac Electroversion\*")) AND (bystander\*[TIAB] OR "first responder"[TIAB] OR "first-responder"[TIAB] OR Layperson\*[TIAB] OR "lay people"[TIAB] OR "lay rescuer"[TIAB] OR "lay public" OR witness\*[TIAB] OR "non-healthcare professional" [TIAB] )) AND (((community OR public OR local OR social OR population\* OR citizen\*) AND (initiative\* OR intervention\* OR action\* OR participation OR involvement\* OR engagement OR preparation\* OR implement\* OR project\* OR strategy\* OR program OR programs OR network\* OR training\* OR campaign\* OR education OR coaching OR information\* OR learning OR instruction\* OR guidance\* OR response\* OR responsiveness OR reply OR reaction OR awareness OR alertness OR realization OR sensibility OR sensitivity OR consciousness) OR "community-based initiative\*" OR "community-driven initiative\*"))

**EMBASE** (Search performed on 10/11/2019, no filters)

((('heart arrest' OR 'cardiac arrest\*' OR 'cardiovascular arrest\*' OR 'cardiopulmonary arrest\*' OR 'cardio-pulmonary arrest' OR 'out of hospital cardiac arrest' OR ohca OR 'out-of-hospital cardiac arrest\*' OR 'outside-of-hospital cardiac arrest') OR ('heart massage 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\*' OR defibrillator\* OR "automated external defibrillator\*" OR AED OR "External Defibrillator\*" OR "Electric Shock Cardiac Stimulator\*" OR "Electric Defibrillation" OR Electric Countershock OR "Electrical Cardioversion\*" OR "Cardiac Electroversion\*")) AND ('layperson' 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')) AND ((community OR public OR population\* OR citizen\*) AND (initiative\* OR intervention\* OR action\* OR participation OR involvement\* OR engagement OR implement\* OR program OR programs OR network\* OR training\* OR campaign\* OR guidance\* OR response\* OR responsiveness OR reply OR awareness OR alertness OR sensibility OR sensitivity OR consciousness OR 'community-based initiative\*' OR 'community-driven initiative\*'))))

**COCHRANE** (Search performed on 10/11/2019, no filters)

(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 OR defibrillator\* OR "automated external defibrillator\*" OR AED OR "External Defibrillator\*" OR "Electric Shock Cardiac Stimulator\*" OR "Electric Defibrillation" OR Electric Countershock OR "Electrical Cardioversion\*" OR "Cardiac Electroversion\*"):ti,ab,kw) AND ((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) AND (community OR public OR local OR social OR population\* OR citizen\* OR person OR people):ti,ab,kw AND (initiative\* OR intervention\* OR action\* OR participation OR involvement\* OR engagement OR preparation\* OR implement\* OR project\* OR strategy\* OR program OR programs OR network\* OR training\* OR campaign\* OR education OR coaching OR information\* OR learning OR instruction\* OR guidance\* OR response\* OR responsiveness OR reply OR reaction OR awareness OR alertness OR realization OR sensibility OR sensitivity OR consciousness OR "community-based initiative\*" OR "community-driven initiative\*"):ti,ab,kw

**New Search strategy: (for a new PICOST should be outlined here as per Evidence Update Process)** – no new search strategy

**Database searched:** PubMed, EMBASE and Cochrane

**Time Frame: (existing PICOST)** – updated from 10. Nov 2019

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

**Date Search Completed:** 2. Sept 2021

**Search Results (Number of articles identified and number identified as relevant):** 2 new non-randomized studies were found since Nov 2019 – non relevant to change recommendation

<https://pubmed.ncbi.nlm.nih.gov/31806058/>

<https://pubmed.ncbi.nlm.nih.gov/31705910/>

### Summary of Evidence Update:

We searched PubMed, EMBASE and Cochrane databases to identify studies associated with Community initiatives to promote BLS implementation published from Nov 11, 2019 to Sep 2, 2021. Two new nonrandomized trials were found from South Korea and the USA and included in a scoping review, which was published in a peer-reviewed journal in December 2021 and served as basis for this evidence update. (Scapigliati A, Zace D, Matsuyama T, Pisapia L, Saviani M, Semeraro F, Ristagno G, Laurenti P, Bray JE, Greif R.

Community Initiatives to Promote Basic Life Support Implementation-A Scoping Review. J Clin Med. 2021 Dec 7;10(24):5719. doi: 10.3390/jcm10245719) [2].

#### 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
Greif 2020 [1]	Education, Implementation, and Teams: 2020 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations	Community initiatives to promote BLS implementation (EIT 641)	17	The 2015 treatment recommendation remains valid.	We recommend implementation of resuscitation guidelines within organizations that provide care for patients in cardiac arrest in any setting (strong recommendation, very low quality of evidence).
Scapigliati [2]	Community Initiatives to Promote Basic Life Support Implementation-A Scoping Review	Community initiatives to promote BLS implementation (EIT 641)	19	The 2015/ 2020 treatment recommendation remains valid.	We recommend implementation of resuscitation guidelines within organizations that provide care for patients in cardiac arrest in any setting (strong recommendation, very low quality of evidence).

#### 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)
Kim, 2019 [3]	<b>Retrospective, Before-After Study</b> South Korea; N = 1155 OHCA included	1,155 OHCAs, 777 from the pre-intervention period and 378 from the post-intervention period	-“train the trainer” instruction to EMS dispatchers who are responsible for instructing bystanders in CPR. - <b>hands-only CPR training</b> sessions for laypersons. -The Korean Society of EMS Physicians performed lectures for dispatchers and instituted regular review of dispatch records. -dispatchers conducted the CPR trainings for first responders, such as police officials, as well as laypersons. -Korea University Ansan Hospital instituted regular skills training sessions for EMTs in that service area. -A detailed data collection instrument to be completed by EMTs for each cardiac arrest.	Bystander CPR before and after intervention 13.2% vs 37.4% (risk difference [RD] 24.2%; 95% CI, 18.2%–29.4%) p value not available  <b>Training Hands-only CPR training sessions for laypersons</b>
Cone, 2020 [4]	<b>Retrospective cohort</b> USA;	HEARTSafe-designated communities and non-designated	<b>CPR training</b> , availability of automated external defibrillators (AEDs) on first responder vehicles and through public access defibrillation initiatives, and	Bystander CPR: Lay person 399 (25.45%) in HEART Safe communities vs 337 (24.91%) in non HEART Safe. CPR

	N = 2922 communities and 1569 (54%) were HEARTSafe-designated	communities. 2922 SCA cases (CARES): 1569 (54%) occurred in towns that were HEARTSafe-designated	availability of post-arrest therapeutic hypothermia and percutaneous coronary intervention at receiving hospitals	performed by bystander vs other Unadjusted OR 1.019, (95% CI 0.814, 1.275), p= 0.8722 Adjusted OR 1.147, (95% CI 0.893, 1.473), p= 0.2838
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**Reviewer Comments: (including whether this PICOST should have a systematic or scoping review)**

In this evidence-update based on a published scoping review [2] two new retrospective studies were found since the last review in 2019. The Korean study describes a train-the-trainer program and its effect on bystander CPR before and after which was more than doubled. The US study made AED training on first responder vehicles for public access available and compared that to communities that did not have such a program and found no difference in bystander CPR rate. Similar results have been found in the 2020 scoping review [1]. This evidence update does not trigger a systematic review and wording of the treatment recommendation on community initiatives to promote BLS implementation (EIT 641) published in ILCOR 2020 CoSTR [1] remains unchanged.

**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 Greif R, Bhanji F, Bigham BL, Bray J, Breckwoldt J, Cheng A, Duff JP, Gilfoyle E, Hsieh MJ, Iwami T, Lauridsen KG, Lockett AS, Ma MH, Monsieurs KG, Okamoto D, Pellegrino JL, Yeung J, Finn JC, Baldi E, Beck S, Beckers SK, Blewer AL, Boulton A, Cheng-Heng L, Yang CW, Coppola A, Dainty KN, Damjanovic D, Djärv T, Donoghue A, Georgiou M, Gunson I, Krob JL, Kuzovlev A, Ko YC, Leary M, Lin Y, Mancini ME, Matsuyama T, Navarro K, Nehme Z, Orkin AM, Pellis T, Pflanzl-Knizacek L, Pisapia L, Saviani M, Sawyer T, Scapigliati A, Schnaubelt S, Scholefield B, Semeraro F, Shammert S, Smyth MA, Ward A, Zace D. Education, Implementation, and Teams: 2020 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. *Resuscitation*. 2020 Nov;156:A188-A239. doi: 10.1016/j.resuscitation.2020.09.014.
- 2 Scapigliati A, Zace D, Matsuyama T, Pisapia L, Saviani M, Semeraro F, Ristagno G, Laurenti P, Bray JE, Greif R. Community Initiatives to Promote Basic Life Support Implementation-A Scoping Review. *J Clin Med*. 2021 Dec 7;10(24):5719. doi: 10.3390/jcm10245719.
- 3 J. Y. Kim *et al.*, "Application of the Plan-Do-Study-Act Model to Improve Survival after Cardiac Arrest in Korea: A Case Study," *Prehosp. Disaster Med.*, vol. 35, no. 1, pp. 46–54, 2020, doi: 10.1017/S1049023X19005156.
- 4 D. C. Cone, K. Burns, K. Maciejewski, J. Dziura, B. McNally, and K. Vellano, "Sudden cardiac arrest survival in HEARTSafe communities," *Resuscitation*, vol. 146, no. October, pp. 13–18, 2020, doi: 10.1016/j.resuscitation.2019.10.029.

**\*\*CONFIDENTIAL DO NOT DISTRIBUTE\*\*****2022 Evidence Update Worksheet**

**Worksheet author(s):** Taylor Sawyer, Nicole Yamada, Joe Fawke,

**Task Force:** EIT and NLS

**Date Submitted to SAC rep for peer review and approval:** January 21, 2022

**SAC rep:** Judith Finn

**Worksheet ID:** EIT 645 Debriefing of Resuscitation Performance

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

EIT 645: Debriefing of Resuscitation Performance

- Population: Among healthcare providers performing resuscitation in any setting
- Intervention: does clinical event debriefing
- Comparator: compared with no debriefing
- Outcome: improve resuscitation skills performance in actual resuscitations, quality of resuscitation skill, quality of resuscitation (e.g., reduce hands-off time, allowing for continuous compressions), and cognitive knowledge, or survival outcomes in actual resuscitation).

**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:**

**EIT 645: Debriefing of Resuscitation Performance (SysRev, 2020):**

**Consensus on Science:** There were no studies comparing briefing as an intervention. For debriefing, data from 3 in-hospital observational before-and-after studies (2 in adults {Edelson 2008 1063; Couper 2016 130} and 1 in pediatrics {Wolfe 2014 1688}), involving a total of 591 patients, and data from 1 out-of-hospital observational before-and-after study in adults {Bleijenbergh 2017 1}, involving a total of 124 patients, was analyzed. All studies included data-driven debriefing interventions using CPR quality metrics such as chest compression depth, chest compression rate, or CCF.

For the critical outcome of survival with favorable neurological outcome, we identified very low-certainty evidence (downgraded for inconsistency, indirectness, and imprecision) from 2 observational studies {Wolfe 2014 1688; Couper 2016 130} including 367 patients. One study {Wolfe 2014 1688} demonstrated significantly increased survival with favorable neurological outcome from the use of the intervention compared with no debriefing, while the other {Couper 2016 130} demonstrated no significant improvement from the use of the intervention compared with no debriefing. Meta-analysis demonstrates no significant effect from the use of debriefing compared with no debriefing on this outcome (RR, 1.41; 95% CI, 0.86–2.32; P=0.18; I<sup>2</sup>=28%).

For the critical outcome of survival to discharge, we identified very low-certainty evidence (downgraded for indirectness and imprecision) from 4 observational studies {Edelson 2008 1063; Wolfe 2014 1688; Couper 2016 130; Bleijenbergh 2017 1} including 715 patients. One study {Wolfe 2014 1688} reported a trend toward improved survival to hospital discharge from the use of the intervention compared with no debriefing, while 3 other studies {Edelson 2008 1063; Couper 2016 130; Bleijenbergh 2017 1} demonstrated no improvement in survival to hospital discharge from the use of the intervention compared with no debriefing. Meta-analysis demonstrates a significant effect from the use of debriefing compared with no debriefing on this outcome (RR, 1.41; 95% CI, 1.03–1.93; P=0.03; I<sup>2</sup>=0%).

For the critical outcome of ROSC, we identified very low-certainty evidence (downgraded for inconsistency, indirectness, and imprecision) from 3 observational studies {Edelson 2008 1063; Wolfe 2014 1688; Couper 2016 130} including 591 patients. One study {Edelson 2008 1063} reported improved ROSC from the use of the intervention compared with no debriefing, while the other 2 studies {Wolfe 2014 1688; Couper 2016 130} reported no improvement in ROSC from the use of the intervention compared with no debriefing. Meta-analysis demonstrates a significant effect from the use of debriefing compared with no debriefing on this outcome (RR, 1.18; 95% CI, 1.03–1.44; P=0.02; I<sup>2</sup>=0%).

For the critical outcome of chest compression depth (mean depth), we identified very low-certainty evidence (downgraded for inconsistency and indirectness) from 3 observational studies {Edelson 2008 1063; Wolfe 2014 1688; Couper 2016 130} including

591 patients. One study {Edelson 2008 1063} reported improved mean chest compression depth from the use of the intervention compared with no debriefing, and a second study {Couper 2016 130} demonstrated no improvement in mean chest compression depth from the use of the intervention compared with no debriefing. A third study {Wolfe 2014 1688} that reported improved compliance with chest compression depth targets from the use of the intervention compared with no debriefing was not included in the meta-analysis because of differing outcome measures. Meta-analysis of 2 studies {Edelson 2008 1063; Couper 2016 130} demonstrated a significant effect from the use of debriefing compared with no debriefing on this outcome (mean difference, 4.00 mm; 95% CI, 0.18–7.82; I<sup>2</sup>=79%).

For the critical outcome of chest compression rate (mean rate), we identified very low-certainty evidence (downgraded for inconsistency and indirectness) from 4 observational studies {Edelson 2008 1063; Wolfe 2014 1688; Couper 2016 130; Bleijenberg 2017 1} including 715 patients. Two studies {Edelson 2008 1063; Bleijenberg 2017 1} reported improved mean chest compression rate from the use of the interventions compared with no debriefing, while a third study {Couper 2016 130} demonstrated no improvement in mean chest compression rate from the use of the intervention compared with no debriefing. The last study {Wolfe 2014 1688} reported improved compliance with chest compression rate targets from the use of the intervention compared with no debriefing but was not included in meta-analysis because of differing outcome measures. Meta-analysis of 3 studies {Edelson 2008 1063; Couper 2016 130; Bleijenberg 2017 1} demonstrates no significant effect from the use of the intervention compared with no debriefing on this outcome (mean difference, 5.81 bpm; 95% CI, -0.08 to 11.70; I<sup>2</sup>, 91%).

For the critical outcome of CCF, we identified very low-certainty evidence (downgraded for risk of bias, inconsistency, indirectness, and imprecision) from 2 observational studies {Couper 2016 130; Bleijenberg 2017 1} including 397 patients. Whereas one study {Bleijenberg 2017 1} demonstrated improved CCF from the use of debriefing compared with no debriefing, the other {Couper 2016 130} did not. Meta-analysis of these studies demonstrates no significant effect from the use of the intervention compared with no debriefing on this outcome (mean difference, 4.11%; 95% CI, -1.17 to 9.39; I<sup>2</sup>, 89%).

### Treatment Recommendations

- We suggest data-driven, performance-focused debriefing of rescuers after IHCA for both adults and children (weak recommendation, very low-certainty evidence).
- We suggest data-driven, performance-focused debriefing of rescuers after OHCA in both adults and children (weak recommendation, very low-certainty evidence).

### NLS 1562: Briefing/Debriefing (ScopRev, 2020)

**Task Force Insight:** We conclude that briefing or debriefing may improve short-term clinical and performance outcomes for infants and staff. The effects of briefing or debriefing on long-term clinical and performance outcomes are uncertain.

**Treatment Recommendation:** There was no previous treatment recommendation on the topic. This scoping review did not identify sufficient evidence to prompt a SysRev.

### Current Search Strategy (for an existing PICOST)

2019 Search Strategy - EIT 645: Debriefing of Resuscitation Performance

((((((((((heart arrest[MH] OR cardiopulmonary resuscitation[MH] OR "cardiac arrest"[TIAB] OR CPR[TIAB] OR "cardiopulmonary resuscitation"[TIAB] OR "advanced cardiac life support"[TIAB] OR "basic life support"[TIAB] OR "advanced life support"[TIAB] OR "heart arrest"[TIAB] OR "ventricular fibrillation"[TIAB] OR ACLS[TIAB] OR Ventricular Fibrillation[MH] OR "asystole"[TW] OR "pulseless electrical activity"[TW] ))) AND ((Briefing[TW] OR Debriefing[TW] OR Briefings[TW] OR Debriefings[TW] OR debrief[TW] OR "Audiovisual Aids"[Mesh:NoExp] OR "Video Recording"[Mesh] OR "Feedback"[Mesh:NoExp] OR feedback[TIAB] OR "feed back"[TIAB] OR "performance review"[TW] OR "performance evaluation"[TW])))) NOT ((animals[mh] NOT humans[mh]) NOT ("letter"[pt] OR "comment"[pt] OR "editorial"[pt] OR Case Reports[ptyp])))) NOT (("instrumentation" [Subheading] OR "Monitoring, Physiologic"[Mesh:NoExp]))

**New Search strategy: (for a new PICOST should be outlined here as per Evidence Update Process) 2021 search strategy developed by a research librarian at Stanford University**

### PubMed (259)

(resuscitation[mesh] OR resuscitat\*[tiab] OR cardiopulmonary resuscitation[Mesh] OR "cardiopulmonary resuscitation\*" [tw] OR "cardio-pulmonary resuscitation\*" [tw] OR CPR[TIAB] OR heart arrest[Mesh] OR "heart arrest"[TIAB] OR "cardiac arrest"[TIAB] OR "cardiopulmonary arrest" OR "cardio-pulmonary arrest" OR "asystole"[TW] OR "pulseless electrical activity"[TW] OR "ventricular fibrillation"[TIAB] OR Ventricular Fibrillation[Mesh] OR "mouth to mouth"[tiab] OR "advanced cardiac life support"[TIAB] OR

"advanced life support"[TIAB] OR "basic life support"[TIAB] OR ACLS[TIAB] OR "ALS"[tiab] OR "BLS"[tiab] OR "BCLS"[tiab]) AND (debrief\*[TW] OR feedback[Mesh] OR "formative feedback"[Mesh] OR feedback\*[tiab] OR "after action review"[TW] OR "performance evaluation"[TW] OR "performance review"[TW]) NOT (animals[Mesh] NOT humans[Mesh]) NOT ( training[ti] OR simulation[ti] OR "amyotrophic lateral sclerosis") AND 2019/09/30:2021/12/01[dp]

### Embase (300)

('resuscitation'/exp OR resuscitat\*:ti,ab OR 'cardiopulmonary resuscitation\*':ti,ab,kw OR 'cardio-pulmonary resuscitation\*':ti,ab,kw OR 'cpr':ti,ab OR 'heart arrest'/exp OR 'heart arrest':ti,ab OR 'cardiac arrest':ti,ab OR 'cardiopulmonary arrest' OR 'cardio-pulmonary arrest' OR 'asystole':ti,ab,kw OR 'cardiac death':ti,ab,kw OR 'pulseless electrical activit\*':ti,ab,kw OR 'ventricular fibrillation':ti,ab,kw OR 'heart ventricular fibrillation'/exp OR 'mouth to mouth':ti,ab OR 'advanced cardiac life support':ti,ab OR 'advanced life support':ti,ab OR 'basic life support':ti,ab OR 'acls':ti,ab OR 'als':ti,ab OR 'bcls':ti,ab OR 'bcls':ti,ab) AND (debrief\*:ti,ab,kw OR 'feedback system'/de OR 'constructive feedback'/exp OR feedback\*:ti,ab,kw OR 'feed back\*':ti,ab,kw OR 'after action review':ti,ab,kw OR 'performance evaluation':ti,ab,kw OR 'performance review\*':ti,ab,kw) NOT ('animal'/exp NOT 'human'/exp) NOT ('training':ti OR 'simulation':ti OR 'amyotrophic lateral sclerosis') AND [30-9-2019]/sd NOT [7-11-2021]/sd AND ('article'/it OR 'article in press'/it OR 'editorial'/it OR 'erratum'/it OR 'letter'/it OR 'note'/it OR 'review'/it OR 'short survey'/it)

### CINAHL (154)

(MH "resuscitation+" OR TI "resuscitat\*" OR AB "resuscitat\*" OR MH "resuscitation, cardiopulmonary+" OR "cardiopulmonary resuscitation\*" OR "cardio-pulmonary resuscitation\*" OR TI "CPR" OR AB "CPR" OR MH "heart arrest+" OR TI "heart arrest" OR AB "heart arrest" OR TI "cardiac arrest" OR AB "cardiac arrest" OR "cardiopulmonary arrest" OR "cardio-pulmonary arrest" OR "asystole" OR "pulseless electrical activity" OR TI "ventricular fibrillation" OR AB "ventricular fibrillation" OR MH "Ventricular Fibrillation" OR TI "mouth to mouth" OR AB "mouth to mouth" OR "advanced cardiac life support" OR "advanced life support" OR "basic life support" OR "ACLS" OR "ALS" OR "BLS" OR "BCLS") AND (debrief\* OR MH "feedback" OR "formative feedback" OR TI "feedback\*" OR AB "feedback\*" OR "after action review" OR "performance evaluation" OR "performance review") NOT (MH "animals" NOT MH "human") NOT (TI "training" OR TI "simulation" OR "amyotrophic lateral sclerosis") Limiters: Published date: 20190901-

### Web of Science (296)

TS=(resuscitat\* OR "CPR" OR "heart arrest" OR "cardiac arrest" OR "cardiopulmonary arrest" OR "cardio-pulmonary arrest" OR asystole\* OR "pulseless electrical activit\*" OR "ventricular fibrillation" OR "mouth to mouth" OR "advanced cardiac life support" OR "advanced life support" OR "basic life support" OR "ACLS" OR "ALS" OR "BLS" OR "BCLS") AND TS=(debrief\* OR feedback\* OR "after action review" OR "performance evaluation" OR "performance review") NOT TI=(training OR simulation OR "amyotrophic lateral sclerosis") and 2021 or 2020 or 2019 (Publication Years) and Articles or Review Articles or Early Access or Editorial Materials or Letters or Corrections (Document Types)

### Cochrane Database of Systematic Reviews (0)

(debrief\* OR feedback\* OR "after action review" OR "performance evaluation" OR "performance review") in Title Abstract Keyword AND (resuscitat\* OR "CPR" OR "heart arrest" OR "cardiac arrest" OR "cardiopulmonary arrest" OR "cardio-pulmonary arrest" OR asystole\* OR "pulseless electrical activit\*" OR "ventricular fibrillation" OR "mouth to mouth" OR "advanced cardiac life support" OR "advanced life support" OR "basic life support" OR "BCLS" OR "ACLS" OR "ALS" OR "BLS") in Title Abstract Keyword NOT training OR simulation OR "amyotrophic lateral sclerosis" in Record Title - (Word variations have been searched) Limit to Publication date from 09/30/2019 to date

**Database searched:** PubMed, Embase, CINAHL, Web of Science, Cochrane Database of Systematic Reviews

**Time Frame: (existing PICOST) – updated from end of last search** January 1, 2014 – Sept 30, 2019

**Time Frame: (new PICOST) – at the discretion of the Task Force:** Sept. 30, 2019 to Nov. 5 2021

**Date Search Completed:** 5 November 2021

**Search Results (Number of articles identified and number identified as relevant):** 1009 articles identified, 426 duplicates removed, 539 studies were irrelevant, 44 full text assessed, 40 excluded (wrong outcome, study design, intervention), 4 studies included (one systematic review and 3 nonrandomized observational studies. No RCT was identified.

Couper, Resuscitation. 2020;151:166-172: <https://pubmed.ncbi.nlm.nih.gov/32304804/>

Malik et al, Circ Cardiovasc Qual Outcomes. 2020;13(11):e006695: <https://pubmed.ncbi.nlm.nih.gov/33201736/>

Ko et al, Resuscitation. 2020;157:156-165: <https://pubmed.ncbi.nlm.nih.gov/33129915/>



Heydarzadeh et al, Iranian Journal of Neonatology. 2020;11(2):60-65: [https://ijn.mums.ac.ir/article\\_15636.html](https://ijn.mums.ac.ir/article_15636.html)

### Summary of Evidence Update:

As part of the 2020 ILCOR science review, a systematic review was conducted by the Education, Implementation and Teams (EIT) Taskforce examining the effectiveness of briefing and debriefing of resuscitation performance by rescuers caring for patients in cardiac arrest in any setting (EIT 645). {Pflanzl-Knizacek 2019, December 10 ; Greif 2020 A188} In addition, a scoping review was performed by the Neonatal Life Support (NLS) taskforce examining the effectiveness of briefing and debriefing among health care professionals involved in the resuscitation or simulated resuscitation of a neonate (NLS 1562). {Wyckoff 2020 A156; Fawke 2021 100059} The EIT and NLS taskforces prioritized further examination of this question as a nodal PICOST, with revision of the two prior PICOSTs to focus exclusively on the impact of clinical event debriefing (excluding briefing as an intervention).

Our EvUp search found 4 studies published since the 2020 EIT and NLS reviews. {Couper 2020 166; Heydarzadeh 2020 60; Ko 2020 156; Malik 2020 e006695} One study was a SysRev on the effect of system performance improvement on patients with cardiac arrest. {Ko 2020 156} That SysRev identified 3 studies on CPR quality and debriefing. {Edelson 2008 1063; Wolfe 2014 1688; Couper 2016 130} All 3 of those studies were previously included in the 2020 ILCOR EIT SysRev. {Pflanzl-Knizacek 2019, December 10 ; Greif 2020 A188}

Two of the new studies in our EvUp examined the impact of debriefing on IHCA outcomes. {Couper 2020 166; Malik 2020 e006695} Couper et al. performed an observational study on the impact of resuscitation system factors on IHCA outcomes across UK hospitals. {Couper 2020 166} The study used linked resuscitation service provision data with IHCA audit data from the National Cardiac Arrest Audit (NCAA). The study included 12,285 eligible IHCA events from 110 hospitals in 76 trusts. Bayesian hierarchical logistic regression model, adjusted for patient level and trust level confounders, was used to explore the association between outcomes and pre-defined resuscitation system quality indicators, including debriefing. The study reported a 67% probability that hot debriefing increased the odds of hospital survival, with an odds ratio of 1.06 (95% credible interval (CI) 0.8 - 1.37). There was a 11% probability that cold debriefing increased the odds of hospital survival, with an odds ratio of 0.83 (95% CI 0.62 - 1.11). Malik et al. examined the association between hospital debriefing practices with adherence to resuscitation process measures and outcomes. {Malik 2020 e006695} The study involved a nationwide survey of hospital resuscitation practices which were then linked to data from the Get with The Guidelines-Resuscitation national registry for IHCA. The analysis included data on 44,477 IHCA events from 193 hospitals. Hospitals were stratified by reported debriefing frequency: rarely (0–20%), occasionally (21–80%), and frequently (81–100%). The study reported no association between the intensity of post-resuscitation debriefings and hospital rates of timely defibrillation or epinephrine administration. Mean hospital-level unadjusted rates of ROSC were lower in hospitals that conducted debriefing frequently (rarely: 70.1%, occasionally: 71.7% and frequently: 66.9%  $p=0.03$ ). Hospital rates of risk-adjusted ROSC and favorable neurological discharge were similar by hospital debriefing groups. (ROSC - rarely: mean hospital rate of 72.0%; occasionally: 73.0%; frequently: 70%,  $p = 0.06$ . Favorable neurological discharge - rarely: mean hospital rate of 22.0%; occasionally: 22.0%; frequently: 21.0%,  $p = 0.75$ )

One study in our EvUp examined short-term outcomes and quality of neonatal resuscitation after implementation of video-recorded debriefing. {Heydarzadeh 2020 60} Heydarzadeh et al. used a semi-experimental interrupted time series design with three time periods. In the first period, resuscitation cases were recorded as the control group. In the second period, all the members of the resuscitation teams participated in Neonatal Resuscitation Program (NRP) training workshops. In the third period, they participated in the video-assisted debriefing sessions. The study included 30 cases of neonatal resuscitation in each period (90 total cases). Results showed that the duration of breathing support was shorter in the debriefing period (debriefing  $80.7 \pm 42.2$ , NRP workshop  $169.8 \pm 136.1$ , control  $105 \pm 61.2$ ;  $P = 0.001$ ). Pulse improvement was faster in the debriefing period (debriefing  $77.5 \pm 45$ , NRP workshop  $132.3 \pm 90.2$ , control  $93.2 \pm 64.4$ ;  $P=0.01$ ). Returning of neonate's color to normal state was faster in the debriefing period (debriefing  $144.8 \pm 88.6$ , NRP workshop  $256.6 \pm 178.5$ , control  $232.3 \pm 128.1$ ;  $P=0.004$ ). Resuscitation quality was scored higher in the debriefing period (debriefing  $40.9 \pm 12.1$ , NRP workshop  $19.6 \pm 11.7$ , control  $14.3 \pm 9.9$ ;  $P < 0.001$ ). Apgar scores at 1, 5, and 10 min were higher in the debriefing period compared to other periods; however, the changes were not statistically significant.

### Relevant Guidelines or Systematic Reviews

Author; Year Published 1 <sup>st</sup> page number	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations
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{Ko 2020 156}	Systematic review	The effect of system performance improvement on patients with cardiac arrest	3	3 studies evaluated CPR quality and debriefing. All 3 studies were previously included in the 2020 ILCOR SysRev.	None
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#### 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)
{Couper 2020 166}	Observational study using linked resuscitation service provision data with IHCA audit data from the National Cardiac Arrest Audit (NCAA); Bayesian hierarchical logistic regression model, adjusted for patient level and trust level confounders, was used to explore the association between outcomes and our pre-defined resuscitation system quality indicators. N = 12,285 events	110 hospitals (76 trusts). 12,285 eligible in-hospital cardiac arrest events	67% probability that hot debriefing increased the odds of hospital survival, with an odds ratio of 1.06 (95% credible interval 0.8 - 1.37). 11% probability that cold debriefing increased the odds of hospital survival, with an odds ratio of 0.83 (95% credible interval 0.62 - 1.11).	Considerable uncertainty in the estimated odds ratios and a clinical benefit cannot be excluded for any factor
{Malik 2020 e006695}	Nationwide survey of hospital resuscitation practices in April of 2018, which were then linked to data from the Get with The Guidelines-Resuscitation national registry for IHCA; Hospitals were stratified by debriefing frequency - Rarely (0–20%), Occasionally (21–80%), and Frequently (81–100%) N = 44,477 events	193 hospitals comprising 44,477 IHCA events	There was no association between the intensity with which hospitals conducted post-resuscitation debriefings and hospital rates of timely defibrillation or epinephrine administration. Mean hospital-level unadjusted rates of ROSC were lower in hospitals which conducted debriefing frequently (rarely: 70.1%, occasionally: 71.7% and frequently: 66.9% p=0.03). Hospital rates of risk-adjusted ROSC (rarely: mean hospital rate of 72.0%; occasionally: 73.0%; frequently: 70%, p = 0.06) and favorable neurological discharge (rarely: mean hospital rate of 22.0%; occasionally: 22.0%; frequently: 21.0%, p = 0.75) were similar by hospital debriefing groups	Hospital debriefing frequency was not associated with better adherence to timely delivery of epinephrine or defibrillation or higher rates of IHCA survival.

{Heydarzadeh 2020 60}	Semi-experimental time-series study with three periods. In the first period, resuscitation cases were recorded as the control group. In the second period, all the members of the resuscitation teams participated in Neonatal Resuscitation Program training workshops, and in the third period, they participated in the debriefing sessions. N = 90 cases	90 cases of neonatal resuscitation (30 in each period)	Duration of breathing: debriefing 80.7±42.2, NRP workshop 169.8±136.1, control 105±61.2 (p = 0.001). Pulse improvement: debriefing 77.5±45, NRP workshop, 132.3±90.2, control 93.2±64.4 (p=0.01). Returning duration of neonate's color to normal state: debriefing 144.8±88.6, NRP workshop 256.6±178.5, control 232.3±128.1 (p=0.004) Resuscitation quality: debriefing 40.9±12.1, NRP workshop 19.6±11.7, control 14.3±9.9 (p<0.001). Apgar scores at 1, 5, and 10 min were higher in the debriefing group compared to those reported for other groups; however, these changes were not statistically significant.	Debriefing was associated with improvements in some short-term outcomes of neonatal resuscitation
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**Reviewer Comments: (including whether this PICOST should have a systematic or scoping review)**

Treatment Recommendations: No change in ILCOR treatment recommendations resulted from this EvUp as we did not find substantial new evidence to recommended consideration of a SysRev.

There continue to be several knowledge gaps in the published literature, which include:

- Effects of debriefing in isolation from other interventions.
- Effects of debriefing on important short- and long-term clinical outcomes of resuscitation including return of spontaneous circulation, survival-to-discharge, or favorable neurological outcome at discharge.
- Effects of debriefing facilitator training on outcomes of resuscitation.
- Effects of various specifications of debriefing, such as the format (group configuration, location, etc.), the timing (immediately after the event (hot debriefing) versus remote from event (cold debriefing), use of quality metrics (data-driven vs. non-data-driven), optimal length of debriefing, and facilitation (facilitated vs. non-facilitated debriefings).
- Emotional and psychological side effects of clinical event debriefing, including their incidence and nature.

**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))**

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## **2022 Evidence Update Worksheet**

**Spaced vs Massed learning (EIT 1601)**

**Worksheet author(s):** Joyce Yeung

**Task Force:** EIT

**Date Submitted to SAC rep for peer review and approval:**

**SAC rep:** Judith Finn

**Worksheet ID:** EIT 1601 Spaced vs. Massed Learning

### **PICOST / Research Question:**

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

***Population:*** All learners taking resuscitation courses (all course types and all age groups) and/or first aid courses.

***Intervention:*** Training or retraining which is distributed over time (“spaced” learning).

***Comparators:*** Training provided at one single time point (“massed” learning).

***Outcomes:*** Educational outcomes (skill performance 1 year after course conclusion; skill performance between course conclusion and 1 year; knowledge at course conclusion) and clinical outcome (quality of performance in actual resuscitations; patient survival with favorable neurologic 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) were eligible for inclusion. All original research articles (both prospective and retrospective) were included with no language restrictions. 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. Literature search updated to December 2, 2019.

**Year of last full review:** 2019

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

Seventeen studies in courses with mannequins and simulation were included in the narrative synthesis: 13 randomised studies {Patocka 2019 73; Anderson 2019 153; Lin 2018 6; Kurosawa 2014 610; Tabangin 2018 163; Sullivan 2015 8; Oermann 2011 447; Ernst 2014 505; Montgomery 2012 9; Kardong-Edgren 2012 9; Nishiyama 2015 56; Cepeda Brito 2017 354; Bender 2014 664} and 4 non-randomised studies {Patocka 2015 6; O'Donnell 1993 193; Breckwoldt 2016 249; Mduma 2015 1}. The included studies covered a range of resuscitation courses: 8 studies in basic life support {Sullivan 2015 8; Lin 2018 6; Nishiyama 2015 56; O'Donnell 1993 193; Andersen 2019 153; Montgomery 2012 9; Kardong-Edgren 2012 9; and Oermann 2011 447} with the latter 3 studies reporting results from same cohort of participants; 3 studies in pediatric advanced life support {Patocka 2019 73; Patocka 2015 6; Kurosawa 2014 610}; 5 studies in neonatal life support {Tabangin 2018 163; Mduma 2015 1; Bender 2014 664; Ernst 2014 505; Cepeda Brito 2017 354} and 1 study in Emergency Medicine skills course {Breckwoldt 2016 249}.

In all identified studies, practical skills were assessed using mannequins.

The overall certainty of evidence was rated as very low for all outcomes primarily due to a very serious risk of bias. The individual studies were all at moderate to serious risk of bias due to confounding. Because of this, and a high degree of clinical heterogeneity

(such as types, format of intervention, methods of outcome assessments), and methodologic heterogeneity (outcome assessments, duration of follow-up, timing of assessment), no meta-analyses could be performed.

For the critical outcome of skill performance 1 year after course conclusion, we identified very low certainty of evidence (downgraded for risk of bias, inconsistency and imprecision) from four RCTs {Lin 2018 6; Andersen 2019 153; Oermann 2011 447; Nishiyama 2015 56} which reported basic life support training and the number of participants able to provide chest compression of adequate depth (defined as >50mm) at 1 year.

#### *Spaced Learning* (1 randomised study)

One RCT {Lin 2018 6} (n=87) reported more participants were able to perform chest compressions of adequate depth with spaced learning compared with massed learning. At 12 months testing, the spaced learning group was superior to the control group for proportion of 'excellent' CPR, defined as achieving at least 90% of all AHA standards for chest compression depth, rate and recoil for each individual criterion (intervention: 25/46 (54.3%), control: 6/41 (14.6%),  $p < 0.001$ , OR 6.94 (95%CI 2.45 to 19.69). This study also reported improvement in other quality of chest compressions measures with use of spaced learning compared to massed learning: percentage of correct chest compression rate (100-120/min) improved from 78.0 (95%CI 70.8 to 85.1) to 92.7 (95%CI 86.0 to 99.4); percentage of chest compressions with complete recoil from 86.5 (95%CI 81.6 to 91.4) to 97.4 (95%CI 92.8 to 100.0). Similar improvements were also reported in paediatric CPR parameters.

#### *Booster Training* (3 randomised studies)

With booster training, three RCTs {Andersen 2019 153; Oermann 2011 447; Nishiyama 2015 56} (n=790) reported more participants were able to provide chest compression of adequate depth compared with no booster training. One RCT {Andersen 2019 153} compared booster training of different frequency (monthly, one session every 3 months, one session every 6 months) and control (annual). This study reported improved chest compression performance across all booster groups compared to control group; with monthly booster training showing the best skill performance but highest attrition rate. At 12 month testing, participants who trained monthly had a significantly higher rate of 'excellent' CPR performance (15/26, 58%) than those in all other groups (12/46, 26% in the 3-month group,  $p = 0.008$ ; 10/47, 21% in the 6-month group,  $p = 0.002$ ; and 7/48, 15% in the 12-month group,  $p < 0.001$ ). Excellent CPR was defined as a two-minute CPR session where three metrics were achieved: 1) 90% of compressions with correct depth (50–60 mm), 2) 90% of compressions with correct rate (100–120/minute), and 3) 90% of compressions with full chest recoil. The Oermann study {Oermann 2011 447} also reported improved CPR performance in participants who received brief monthly practice compared with no monthly practice at 12 month testing. In the booster training group (240 participants), students' mean compression depth was within acceptable range (mean 40.3mm SD 6.6) with 59.2% (SD 36.6) of compressions with adequate depth and no skill decay over the 12 months ( $p=0.31$ ). In contrast, the control group (301 participants) had a significant loss of ability to compress with adequate depth at 12 months (mean 36.5mm; SD 7.7) and only 36.5% (SD 33.6) of compressions were of adequate depth ( $p=0.004$ ). Students in booster training group had a significantly higher percentage of ventilations with adequate volume (booster group 52.2%, SD 30.9 compared with the no booster group 38.5%, SD 36.1,  $p<0.001$ ). At 12 months the mean ventilation volume was 565.4ml (SD 147.8) for the booster group compared with mean ventilation volumes of 430.7ml (SD 231.7) for the no booster group ( $p<0.0001$ ).

In a randomised study, Nishiyama et al compared BLS skill retention in laypeople initially trained with a 45min DVD-based program with and without a 15min refresher/booster training at 6 months {Nishiyama 2015 56}. During a 2 minute evaluation performed at 12 months, the number of total chest compressions was significantly greater in the booster group (57 participants) than in the no booster group (55 participants) (booster group mean 182.0, SD 41.7 compared with the no booster group mean 142.0, SD 59.1,  $p < 0.001$ ). The number of appropriate chest compressions (with depth over 50mm, correct hand position, complete recoil) performed was significantly greater in the booster group than in the no booster group (booster group mean 68.9, SD 72.3 compared with the no booster group mean 36.3, SD 50.8,  $p = 0.009$ ). Time without chest compressions was also significantly shorter in the booster group (booster group mean 16.1, SD 2.1 sec compared with the no booster group mean 26.9 SD 3.7 sec,  $p < 0.001$ ). There were no significant differences in time to first chest compression and AED operations between the two groups (booster group mean 29.6 SD 16.7 sec compared with the no booster group mean  $34.4 \pm 17.8$  sec,  $p = 0.172$ ).

For the critical outcome of skill performance between course conclusion and 1 year, we identified very low certainty of evidence (downgraded for risk of bias and imprecision) from two RCTs {Lin 2018 6; Oermann 2011 447}, n=201, for number of participants able to perform chest compressions with adequate depth (>50mm) at 6 months.

#### *Booster Training* (2 randomised studies)

In a randomised trial 87 healthcare professionals were randomised to spaced learning (monthly 2-min practice with real-time feedback) or massed learning (conventional recertification course) for their annual paediatric BLS training. {Lin 2018 6} At 3 month testing, chest compression performance improved in spaced learning group and sustained improvement in mean percentage of chest compression of adequate depth with little decay over 12 month study period (baseline mean% 56.7 95%CI 44.6, 68.7; 3 months 84.2 95%CI 74.9, 93.6; 6 months 83.2 95%CI 74.4, 92.1; 9 months 82.2 95%CI 73.5, 91.0; 12 months 81.2 95%CI 72.3, 90.2). Similar improvements were seen in mean % chest compressions with correct rate and mean % of chest compressions with complete chest recoil. In contrast, control group showed no improvement at 3 months and chest compression quality further decline over a 12 month period. Similar improvements in chest compression performance with booster training was also reported by a second study. {Oermann 2011 447} Six hundred and six nursing students who have completed instructor-led BLS course were recruited and randomised to either brief monthly practice (booster training) or no practice (control group). In the booster training group, students' mean compression depths were within the accepted range (between 38 and 51 mm), with no significant loss over the 12 months study period ( $p = 0.31$ ). The compression depths ranged from 38.6 (SD = 6.7) mm at 3 months to 40.3 (SD = 6.6) mm at 12 months and 39.9 (SD = 5.9) mm following booster training. In contrast, there was a significant skill decay with the ability to compress with adequate depth in the control group. The mean depth at 9 months was 39.6mm (SD 6.8) and at 12 months was 36.5mm (SD 7.7,  $p = 0.004$ ). With booster training, students improved their ability to ventilate with an adequate volume (6 months mean ventilation volume 514.0 mL (SD = 208.4), 12 months mean ventilation volume was 620.7 mL (SD = 211.0)). In the control group, the mean ventilation volumes remained less than the recommended minimum (500ml) throughout the 12 months.

Studies reporting other skill performance between course conclusion and 1 year

#### *Spaced learning* (3 studies – 2 randomised and 1 cohort study)

Three studies examined spaced learning in pediatric advanced life support. The first randomised study recruited 36 healthcare professionals and found an improved clinical performance score. Clinical performance score was made up of 21 items with maximum of 42 (each item rated as 0 = not performed; 1 = performed inappropriately or not in a timely manner; and 2 = performed correctly and in a timely manner). {Kurosawa 2014 610} Performance scores in the 17 participants in spaced learning group improved (baseline 16.3 SD 4.1 to post training 22.4 SD 3.9) compared with scores in the control group (19 participants) (baseline 14.3 SD 4.7 to post training 14.9 SD 4.4,  $p = 0.006$ ). The second study randomised 48 EMS providers to either spaced (26 participants, four weekly sessions) or massed learning (22 participants, two sequential days). {Patocka 2019 73} At 3 months testing, assessment scores for infant and adult chest compressions performance were similar in both groups but bag valve mask ventilation (BVM) and intraosseous insertion (IO) performance was superior in the spaced learning group (spaced learning group BVM score mean 2.2 SD 7,  $P = 0.005$ , IO score mean 3.1 SD 0.5,  $P = 0.04$ ; massed learning group BVM score mean 1.8 SD 0.5,  $P = 0.98$  IO score mean 2.7 SD 0.2,  $P = 0.98$ ). In the third study, the same research group recruited 45 medical students to a paediatric resuscitation course in either a spaced (23 participants) or massed format (22 participants) in a cohort study. {Patocka 2015 6}. Four weeks following course completion, participants were tested with a knowledge exam and their ability to perform bag-valve mask ventilation, intra-osseous insertion and chest compressions. The study found no significant difference in knowledge and overall performance but fewer critical procedural steps were missed by the spaced learning group.

#### *Booster training* (8 studies – 6 randomised and 2 cohort studies)

Sullivan et al randomised 66 nurses into four BLS training groups: massed training (control, 18 participants) and three groups that participated in 15 minute in-situ in-hospital cardiac arrest training sessions every two (15 participants), three (16 participants) or six months (17 participants) }{Sullivan 2015 8}. The study found more frequent (booster) training was associated with decreased median time (in seconds) to starting compressions (standard: 33 (IQR 25–40); 6 months: 21 (IQR 15–26) ; 3 months: 14 (IQR 10–20); 2 months: 13 (IQR 9–20);  $p < 0.001$ ) and to defibrillation (standard: 157 (IQR 140–254) vs. 6 months: 138 (IQR 107–158) vs. 3 months: 115 (IQR 101–119) vs. 2 months: 109 (IQR 98–129);  $p < 0.001$ ). In a randomised study of 605 BLS trained nursing students to monthly booster training or no booster training, the booster training group had superior compression (percentage of correct mean chest compressions: booster group (302 participants) mean 49.2 SD 33.2 vs control (303 participants) mean 39.7 SD 34.8 ( $p=0.003$ ) and ventilation performance (percentage of correct ventilations: booster group mean 48.0 SD 32.3 vs control mean 36.7 SD 33.7 ( $p<0.0001$ ). {Kardong-Edgren 2012 9}. In a separate report, the authors conducted a post-course survey of 357 participants (out of 605 participants). A higher percentage of students in booster training group reported being “confident” or “very confident” in their ability to perform CPR than control group after their initial training (booster, 157 of 165 respondents, 95% vs. control, 137 out of 176 respondents, 78%,  $p=0.003$ ). There was no difference in proportion of student satisfaction, with 153 out of 165 (93%) booster training respondents satisfied-very satisfied compared with from 156 out of 179 respondents (90%) from control group ( $p=0.23$ ). {Montgomery 2012 9}. O'Donnell also compared monthly booster, single booster at 3 month and no booster training in 100 nursing students undertaking BLS courses. {O'Donnell 1993 193}. At 6 months, they found improved knowledge test (recognition of arrest,

opening airway and initiation of CPR) in the booster training groups compared to control group (knowledge test score monthly practice mean 11.5/14, 3 monthly practice 10.68/14, no practice 9.50/14,  $p=0.05$ ). The study did not demonstrate a difference in practical performance between the three groups at 6 months.

Repeated booster practice was tested in neonatal resuscitation by Tabangin, who randomised 49 neonatal hospital providers to monthly practice for 6 months compared with three consecutive practices at 3, 5 and 6 months {Tabangin 2018 163}. The study concluded that repeated monthly testing resulted in improvements and maintenance of performance. Participants in the monthly practice group scored 1.3 points (SE 0.42) higher on the Observed Structured Clinical Examination than those who practiced less frequently. Over 6 months, monthly practice group had 2.9 times greater odds of passing on the first attempt compared with the group that practiced less frequently. Also in neonatal resuscitation, Ernst et al randomised 110 students training in neonatal intubation to massed learning with no booster training (control), once weekly booster training or one week of 4 consecutive day's booster training. {Ernst 2014 505}. After 6 weeks, students were assessed with video-based scenarios and booster training was associated with an improved neonatal intubation performance. In comparing scores in equipment selection and preparation, the median preparation score (maximum 11) for the weekly group (32 participants, median 9 IQR 8.0-9.5), and consecutive day (37 participants, median 8.0 IQR 7.5-9.0) groups were significantly higher than the control group (41 participants median 7.0 IQR 6.0-8.0,  $p<0.001$ ). The median performance score (maximum 8) was also significantly higher in weekly (median 7.0 IQR 6.5-7.5) and consecutive day (median 7.0 IQR 6.0-7.5) groups compared to the control group (median 5.5 IQR 4.0-6.0,  $p<0.001$ ). Bender et al conducted a randomised controlled trial comparing booster training at 9 months after a neonatal resuscitation training program with no booster training. In simulation testing at 15 months, the booster group (23 participants) scored significantly higher in procedural scores (out of maximum score of 107) compared with the no booster training group (27 participants) (71.6 versus 64.4,  $p=0.02$ ) and for teamwork behaviours (out of maximum score of 25) (18.8 versus 16.2,  $p=0.02$ ). No difference in knowledge scores was found {Bender 2014 664}. Cepeda Brito randomised 25 neonatal intensive care staff members in a neonatal resuscitation program to monthly booster training (7 participants), one booster every 3 months (7 participants) or one booster every 6 months (11 participants) {Cepeda Brito 2017 354}. The study did not find any statistical difference in CPR performance at 6 months across the three groups.

For the important outcome of knowledge at course conclusion, we found very low certainty evidence (downgraded for risk of bias and imprecision) from three cohort studies.

#### *Spaced Learning (2 cohort studies)*

Breckwoldt and colleagues designed an emergency medicine intensive course of 26 teaching hours and compared the knowledge of 156 students for a course delivered over 5 half-days with afternoon as private time or self-directed learning (spaced learning), compared with a course delivered over 3 full days (massed learning).{Breckwoldt 2016 249}. At course conclusion, participants were assessed by a video case-based key-feature knowledge test. Participants from the spaced group reached a mean score of 14.8 out of 22 points (SD 2.0), compared to mean score 13.7 (SD 2.0) in the massed group ( $p = 0.002$ ). In a randomised controlled trial, Patocka et al randomised 72 EMS providers to spaced learning (four 3.5hr sessions over 1 month) or massed learning (two sequential 7hr days). Forty eight participants completed the training and was tested with a 33-question standardized Pediatric Advanced Life Support Multiple Choice Question test at post-training and 3-months post-course. {Patocka 2019 73}. Participants from the spaced group maintained their MCQ score between course conclusion and 3 months post course (26 participants, end 30.3 SD 0.5 vs 3-months 29.7 SD 0.5,  $P= 0.39$ ) compared with a significant decay seen in the massed training group (22 participants, end 31.1 SD 0.5 vs 3-months 29.6 SD 0.5,  $P= 0.04$ ).

#### *Booster Training (1 cohort study)*

In an observational study, O'Donnell divided BLS trained nursing students into three groups: monthly booster training (33 participants), one booster training every 3 months (34 participants) and no booster training (33 participants) and tested them at 6 months. {O'Donnell 1993 193}. There was high number of dropouts with only 44 participants completing theory test and 60 participants completing practical tests. The study found higher mean test score (maximum 14) in theoretical knowledge in the booster learning groups compared to no booster group at 6 months (monthly practice mean score 11.5/14, 3 monthly practice 10.68/14, no practice 9.50/14,  $p=0.05$ ).

For the important outcome of quality of performance in actual resuscitations, we did not identify any studies.

For the important outcome of patient survival with favorable neurologic outcome, we did not identify any studies.



Whilst we did not find any study reporting performance at clinical resuscitation and patient survival with favorable neurological outcome, there was however, indirect evidence from one observational study for the impact of booster training on delivery room management of the newborn. {Mduma 2015 1} This study assessed the impact of frequent brief (3–5 minute weekly) on-site simulation training sessions on newborn management in the delivery room and the potential impact on 24-hour neonatal mortality. One hundred and seventeen healthcare workers were trained. Before and after data was collection from pre-implementation observations from February 2010 to January 2011 and post-implementation from February 2011 to January 2012. The number of stimulated neonates increased from 712 (14.5%) to 785 (16.3%) ( $p = 0.016$ ), those suctioned increased from 634 (13.0%) to 762 (15.8%) ( $p \leq 0.0005$ ). Mortality at 24-hours decreased from 11.1/1000 to 7.2/1000 ( $p = 0.040$ ).

### Treatment Recommendations

For learners undertaking resuscitation courses, we suggest that spaced learning (training or retraining distributed over time) may be used instead of massed learning (training provided at one single time point) (weak recommendation, very low certainty of evidence).

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

(((((("emergency treatment"[MeSH Terms] OR "emergency responders"[MeSH Terms] OR "life support care"[MeSH Terms] OR "resuscitation"[MeSH Terms]) AND "education"[MeSH Subheading]) OR (("advanced life saving"[Text Word] OR "ALS"[Text Word] OR "advanced life support"[Text Word] OR "basic lifesaving"[Text Word] OR "BLS"[Text Word] OR "basic life support"[Text Word] OR "cardiopulmonary resuscitation"[Text Word] OR "CPR"[Text Word] OR "emergency medical responder"[Text Word] OR "paramedic"[Text Word] OR "first aid"[Text Word] OR "lifeguard"[Text Word] OR "lifesaving"[Text Word] OR "resuscitation"[Text Word]) AND ("educability"[All Fields] OR "educable"[All Fields] OR "educates"[All Fields] OR "education"[MeSH Subheading] OR "education"[All Fields] OR "educational status"[MeSH Terms] OR ("educational"[All Fields] AND "status"[All Fields]) OR "educational status"[All Fields] OR "education"[MeSH Terms] OR "education s"[All Fields] OR "educational"[All Fields] OR "educative"[All Fields] OR "educator"[All Fields] OR "educator s"[All Fields] OR "educators"[All Fields] OR "teaching"[MeSH Terms] OR "teaching"[All Fields] OR "educate"[All Fields] OR "educated"[All Fields] OR "educating"[All Fields] OR "educations"[All Fields] OR "educat\*"[All Fields] OR ("education"[MeSH Subheading] OR "education"[All Fields] OR "training"[All Fields] OR "education"[MeSH Terms] OR "train"[All Fields] OR "train s"[All Fields] OR "trained"[All Fields] OR "training s"[All Fields] OR "trainings"[All Fields] OR "trains"[All Fields]) OR "train\*"[All Fields] OR ("certificate"[All Fields] OR "certificate s"[All Fields] OR "certificated"[All Fields] OR "certificates"[All Fields] OR "certification"[MeSH Terms] OR "certification"[All Fields] OR "certifications"[All Fields]) OR "certificat\*"[All Fields] OR ("learning"[MeSH Terms] OR "learning"[All Fields] OR "learn"[All Fields] OR "learned"[All Fields] OR "learning s"[All Fields] OR "learnings"[All Fields] OR "learns"[All Fields]) OR "learner\*"[All Fields] OR "learn\*"[All Fields])))) AND ((("models, educational"[MeSH Terms] AND "time factors"[MeSH Terms]) OR ("distributed practice\*"[Text Word] OR "distributed learning"[Text Word] OR "episodic memor\*"[Text Word] OR "learning schedul\*"[Text Word] OR "train frequenc\*"[Text Word] OR "frequency"[Text Word] OR "modular"[Text Word] OR "module"[Text Word] OR "spaced education"[Text Word] OR "spaced learning"[Text Word] OR "spaced practice"[Text Word] OR ("space"[All Fields] OR "space s"[All Fields] OR "spaces"[All Fields]) AND "train\*"[All Fields]) OR "top-up"[Text Word] OR "bolus"[Text Word]) OR (("bolus"[All Fields] AND "train\*"[Text Word]) OR ("bolus"[All Fields] AND "learn\*"[Text Word]) OR "massed train\*"[Text Word] OR "massed learning"[Text Word] OR "single session"[Text Word])))) NOT ("letter"[Publication Type] OR "comment"[Publication Type])) AND "2019/12/02 06:14":"2022/01/02 06:16"[Date - MeSH]

**Database searched: Pubmed**

**Time Frame: updated from end of last search 02 December 2019**

**Date Search Completed: 02 January 2022**

### Search Results:

333 articles were identified. After titles and abstract screening, 20 articles were reviewed as full text. There were 8 relevant articles: 3 randomised studies and 5 non-randomised studies. No relevant guidelines or systematic reviews were identified.

### Summary of Evidence Update:

**Relevant Guidelines or Systematic Reviews: None identified**

## 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
<b>Skill maintenance/ NLS, HCP</b>					
Haynes 2021 {Haynes 2021 }	To assess whether low dose high frequency training can improve positive pressure ventilation (PPV) in neonatal simulation scenario  RCT  187 multidisciplinary HCP	Excluding HCP working <50% employment	After 120-180min personalised training with ventilation, participants are randomised to:  Intervention – train twice a month (n=83)  Comparison – train as often as desired (n=104)	Test 2 at course conclusion Scores from both groups improved post course  Test 3 at 9 months: Intervention group scores were not higher than comparator group	Training twice a month did not competence.  Participants in training twice a month did not achieve 18 trainings as specified in protocol (mean 8 trainings compared with 2.8 trainings in comparator group)
Kamath-Rayne 2019 {Kamath-Rayne 2019 681}	To evaluate the impact on overall performance and bag-mask ventilation (BMV) skills with varying frequency and/or intensity of “just-in-place” simulation.  2 x 2 factorial pilot RCT  28 Pediatric residents	None stated	Intervention 1: Weekly retraining on NICU  Comparison 1: No retraining on NICU  Intervention 2: Retraining every 1 month for 1 year (n=13)  Comparison 2: Retraining every 3 months for 1 year (n=11)  Control: no training (n=14)	For the primary outcome, at the end of intern year, the 1- and 3-month groups had higher scores (18.8 vs 18.6 vs 14.4; P <0.01) and shorter time to effective BMV (10.6 vs 20.4 vs 52.8 seconds; P <0.05) No difference in score of time to BMV between 1- and 3-month groups	Increased practice intensity and or frequency improve simulated performance in neonatal resuscitation.  Pilot study. Very small numbers. Complicated study design
Spies 2021 {Spies 2021 }	Multidisciplinary HCP	None stated	Intervention group: standard education plus monthly updates with video teaching modules with skill and content	Significant difference between the groups in resuscitation rate (6% intervention vs 18% control group, P <0.05)  The post-test scores at 8-month were	Improved knowledge retention at 8 months and the lower need for resuscitation in the intervention group support the efficacy of the high-frequency, low-dose education.

			<p>refreshers for the providers.</p> <p>Control: standard education. One time workshop Help Babies Breathe</p>	<p>significantly better in the intervention group than in the control group (intervention mean rank 19.4 vs control mean rank 10.3; <math>P &lt; 0.05</math>).</p> <p>The success rate of resuscitation was not significantly different among the groups.</p>	Low resource setting Abstract only
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#### 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)
<b>Skill acquisition/BLS, Children</b>				
Abelairas-Gomez 2021 {Abelairas-Gómez 2021 e052478}	<p>Prospective longitudinal study; 472 children aged 8-12</p> <p>Control group (CG): BLS course (n=146) Standard group (SG): BLS + retraining at 1 year (n=124) Rolling-Refresher group (RRG): BLS + brief rolling refreshers every 4 months (n=202)</p>	<p>Children aged 8-12 Excluding those with physical or psychological impairment and those who did not attend both assessments</p>	<p>BLS skills assessed at 1 week: similar performance across all groups BLS skills at 2 years: Quality of CPR low in all groups, RRG participants reached a higher percentage of global quality CPR (CG: <math>16.4 \pm 24.1</math>; SG: <math>25.3 \pm 28.8</math>; RRG: <math>29.9\% \pm 29.4\%</math>), with a higher percentage of correct chest compressions by depth (CG: <math>3.9 \pm 11.8</math>; SG: <math>10.8 \pm 22.7</math>; RRG: <math>15.5 \pm 26.1</math> mm).</p>	<p>In 8-to-12- year-old schoolchildren, 4-month very brief rolling-refreshers were more effective than annual 50 min retraining sessions help to maintain BLS performance.</p>
<b>Skill maintenance/BLS, HCP</b>				
Kuyt 2021 {Kuyt 2021 14}	<p>Cohort study</p> <p>Resuscitation Quality Improvement (RQI) 3-monthly retraining: 3 hospitals (n=1374)</p> <p>No regular retraining: 1 hospital (n=487)</p>	<p>Multidisciplinary HCP. Excluding pre-qualification students</p>	<p>Assessment after 12 or 24 months</p> <p>RQI has significant improvement in the overall score between baseline and assessment for infant ventilations (n = 167, <math>p &lt; 0.001</math>), adult ventilations (n = 129, <math>p &lt; 0.001</math>), infant compressions (n = 163, <math>p &lt; 0.001</math>) adult compressions (n = 205, <math>p &lt; 0.001</math>), and adult CPR (n = 249, <math>p &lt; 0.001</math>). There was no significant improvement in the overall score for infant CPR (n = 206, <math>p = 0.08</math>).</p>	<p>Increased adherence with guidelines for high-quality CPR post-training with the RQI, for all adult and most infant measures, but not infant CPR.</p> <p>Compliance with the RQI curriculum varied and reduced over time.</p>

			<p>Data from the control site demonstrated a statistically significant improvement in mean score for adult CPR (n = 22, p = 0.02), but not for adult compressions (N = 18, p = 0.39) or ventilations (n = 17, p = 0.08).</p> <p>No statistically significant difference in improvement of mean scores was found between RQI sites and the control site.</p>	
Panchal 2020 {Panchal 2020 26}	<p>Before and after study</p> <p>RQI 3 monthly retraining: 2 nursing units (n=155)</p>	None stated	<p>Compression fraction improved Pre-RQI to Post RQI from 83% [73-95] to 93% [88-98] (p &lt; 0.001). Compression rate increased Pre-RQI to Post RQI (Pre: 109 [96-126] and Post: 120 [108-130], p = 0.008).</p>	Low dose high frequency CPR training enhanced CPR skill retention and improved in-hospital CPR quality
<b>Skill maintenance/PLS, HCP</b>				
Doymaz 2020 {Doymaz 2020 2333794x20970010}	<p>Before and after study</p> <p>6 months of weekly mock codes (n=43)</p>	Senior pediatric residents	<p>Team leadership performance improved after weekly practice mock code sessions (TEAM score 71.93 ± 18.50 vs 81.44 ± 11.84, P = 0.01).</p>	Increasing the frequency of mock code sessions improved team leadership performance in pediatric residents
<b>Skill maintenance/NLS, HCP</b>				
Niles 2021 {Niles 2021 100091}	<p>Before and after study</p> <p>Brief, repeated PPV-Refresher psychomotor skill practice (n=24)</p>	Nurses	<p>Significant improvement for total (57 [36-74] vs. 33 [26-46]; p = 0.0007) and target PPV (23 [13-23] vs. 11 [5-21]; p = 0.024), and a significant change in mean volume (mL) (11.5 [10.2-13] vs. 13.4 [11-16]; p = 0.02) and mean rate (vpm) (54 [45-61] vs. 40 [28-49]; p = 0.019).</p>	<p>A refresher program with brief, repeated psychomotor skill practice significantly improved PPV performance with the greatest improvement in total PPV and target PPV.</p> <p>Small study</p>

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

There is limited number of randomised studies on this topic. Included non-randomised studies were highly heterogeneous in outcome measures, type of resuscitation courses and participants. There is insufficient evidence to recommend a 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))**

## New references only

{Abelairas-Gómez 2021 e052478} <https://pubmed.ncbi.nlm.nih.gov/34848519/>  
 {Doymaz 2020 2333794x20970010} <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7675900/>  
 {Haynes 2021 } <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8700091/>  
 {Kamath-Rayne 2019 681} <https://pubmed.ncbi.nlm.nih.gov/31371386/>  
 {Kuyt 2021 14} <https://pubmed.ncbi.nlm.nih.gov/33883025/>  
 {Niles 2021 100091} <https://pubmed.ncbi.nlm.nih.gov/34223356/>  
 {Panchal 2020 26} <https://pubmed.ncbi.nlm.nih.gov/31730899/>  
 {Spies 2021 } <https://pubmed.ncbi.nlm.nih.gov/34743112/>

Abelairas-Gómez, C., S. Martinez-Isasi, R. Barcala-Furelos, C. Varela-Casal, A. Carballo-Fazanes, M. Pichel-López, F. Fernández Méndez, M. Otero-Agra, L. Sanchez Santos and A. Rodriguez-Nuñez (2021). "Training frequency for educating schoolchildren in basic life support: very brief 4-month rolling-refreshers versus annual retraining-a 2-year prospective longitudinal trial." *BMJ Open* **11**(11): e052478.

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Haynes, J., S. Rettedal, J. Perlman and H. Ersdal (2021). "A Randomised Controlled Study of Low-Dose High-Frequency In-Situ Simulation Training to Improve Newborn Resuscitation." *Children (Basel)* **8**(12).

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Kuyt, K., M. Mullen, C. Fullwood, T. P. Chang, J. Fenwick, V. Withey, R. McIntosh, N. Herz and R. J. MacKinnon (2021). "The assessment of a manikin-based low-dose, high-frequency cardiac resuscitation quality improvement program in early UK adopter hospitals." *Adv Simul (Lond)* **6**(1): 14.

Niles, D. E., C. Skåre, E. E. Foglia, E. Insley, C. Cines, T. Olasveengen, L. S. Ballester, A. Ades, M. Posencheg, V. M. Nadkarni and J. Kramer-Johansen (2021). "Effect of a positive pressure ventilation-refresher program on ventilation skill performance during simulated newborn resuscitation." *Resusc Plus* **5**: 100091.

Panchal, A. R., G. Norton, E. Gibbons, J. Buehler and M. C. Kurz (2020). "Low dose- high frequency, case based psychomotor CPR training improves compression fraction for patients with in-hospital cardiac arrest." *Resuscitation* **146**: 26.

Spies, L. A., C. Riley, R. Nair, N. Hussain and M. P. Reddy (2021). "High-Frequency, Low-Dose Education to Improve Neonatal Outcomes in Low-Resource Settings: A Cluster Randomized Controlled Trial." *Adv Neonatal Care*.

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## 2022 Evidence Update Worksheet

**Worksheet author(s):** Elaine Gilfoyle, Maddie Burdick, Jeffrey Lin

**Task Force:** EIT

**Date Submitted:** Jan 28, 22 (v1)

**Worksheet ID:** Team Leadership Training

### **PICO / Research Question:**

Population: learners undertaking an ALS course in an educational setting OR patients undergoing resuscitation in a real-life setting.

Intervention and comparator: the inclusion of specific leadership or team training compared to no such specific training.

Outcomes: improved patient survival; skill performance in actual resuscitations; skill performance at 3 to 15 months (patient tasks, teamwork, leadership); skill performance at course conclusion (patient tasks, teamwork, leadership), cognitive knowledge.

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

Timeframe: Nov 1, 2019 to Jan 10, 2022

**Type (intervention, diagnosis, prognosis):** Intervention

**Additional Evidence Reviewer(s):**

**Conflicts of Interest (financial/intellectual, specific to this question):** N/A

**Year of last full review: 2010 / 2015 / New question:** 2020 (last search October, 2019)

**Last ILCOR Consensus on Science and Treatment Recommendation:**

### **2010/2015 Search Strategy:**

(((((("Cardiopulmonary Resuscitation/education"[Mesh] OR "Cardiopulmonary Resuscitation/methods"[Mesh] OR Hunziker S[Author] OR "Advanced Cardiac Life Support "[Mesh] OR ACLS[TIAB] OR "advanced cardiac life support"[TIAB] OR "advanced life support"[TIAB] OR "advanced cardiopulmonary resuscitation"[TW] OR "advanced cardiovascular life support"[TW] OR "advanced resuscitation"[TW] OR "neonatal resuscitation program"[TW]))) AND (("resuscitation/education"[Mesh] OR "Emergency Medicine/education"[Mesh] OR

"Medicine/education"[Mesh] OR "Nursing/education"[Mesh] OR "Emergency Responders/education"[Mesh] OR "Emergency Medical Technicians/education"[Mesh] OR "Emergency Nursing/education"[Mesh] OR "Internal Medicine/education"[Mesh] OR "Emergency Treatment/education"[Mesh] OR "Education, Medical"[Mesh] OR "Education, Graduate"[Mesh] OR "Education, Medical, Undergraduate"[Mesh] OR "education"[mesh] OR "education"[TIAB] OR "Teaching"[Mesh] OR teach [TIAB] OR teaching[TIAB] OR teacher[TIAB] OR teachers[TIAB] OR "Inservice Training"[Mesh] OR "Learning"[Mesh] OR Inservice[TIAB] OR Train[TIAB] OR Training[TIAB] OR "course"[TIAB] OR "program"[TIAB] OR "Models, Educational"[Mesh] OR "Health Education/methods"[Mesh] OR "Curriculum"[Mesh] OR student[TIAB] OR students[TIAB])) AND ((Leadership [Mesh] OR Leader\* [TIAB] OR Lead [TIAB] OR Leads [TIAB] OR Lead's [TIAB] OR Leads' [TIAB] OR leading [TIAB] OR team\* [TIAB])) NOT (((animals[mh] NOT humans[mh]) NOT ("letter"[pt] OR "comment"[pt] OR "editorial"[pt] or Case Reports[ptyp]))

### 2019 Search Strategy:

(((((("Cardiopulmonary Resuscitation/education"[Mesh] OR "Cardiopulmonary Resuscitation/methods"[Mesh] OR Hunziker S[Author] OR "Advanced Cardiac Life Support "[Mesh] OR ACLS[TIAB] OR "advanced cardiac life support"[TIAB] OR "advanced life support"[TIAB] OR "advanced cardiopulmonary resuscitation"[TW] OR "advanced cardiovascular life support"[TW] OR "advanced resuscitation"[TW] OR "neonatal resuscitation program"[TW])) AND ("resuscitation/education"[Mesh] OR "Emergency Medicine/education"[Mesh] OR "Medicine/education"[Mesh] OR "Nursing/education"[Mesh] OR "Emergency Responders/education"[Mesh] OR "Emergency Medical Technicians/education"[Mesh] OR "Emergency Nursing/education"[Mesh] OR "Internal Medicine/education"[Mesh] OR "Emergency Treatment/education"[Mesh] OR "Education, Medical"[Mesh] OR "Education, Graduate"[Mesh] OR "Education, Medical, Undergraduate"[Mesh] OR "education"[mesh] OR "education"[TIAB] OR "Teaching"[Mesh] OR teach[TIAB] OR teaching[TIAB] OR teacher[TIAB] OR teachers[TIAB] OR "Inservice Training"[Mesh] OR "Learning"[Mesh] OR Inservice[TIAB] OR Train[TIAB] OR Training[TIAB] OR "course"[TIAB] OR "program"[TIAB] OR "Models, Educational"[Mesh] OR "Health Education/methods"[Mesh] OR "Curriculum"[Mesh] OR student[TIAB] OR students[TIAB])) AND ((Leadership [Mesh] OR Leader\* [TIAB] OR Lead [TIAB] OR Leads [TIAB] OR Lead's [TIAB] OR Leads' [TIAB] OR leading [TIAB] OR team\* [TIAB])) NOT (((animals[mh] NOT humans[mh]) NOT ("letter"[pt] OR "comment"[pt] OR "editorial"[pt] or Case Reports[ptyp]))

**Database searched:** PubMed

**Date Search Completed:** Jan 10, 2022

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

119 identified in search

Final number of relevant studies included=9

2 Systematic Reviews identified plus 1 scoping review

### Inclusion/Exclusion Criteria:

#### Inclusion:

- manikin and human studies;

- pre- and in- hospital cardiac arrest;
- arrests in adults, children, and neonates;
- involving resuscitation and trauma courses.

**Exclusion:**

- Studies evaluating scoring systems (no relevant outcome),
- studies with self-assessment as the only outcome,
- reviews and abstracts without full article.

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

<https://www.ncbi.nlm.nih.gov/sites/myncbi/1JC-b1sMa8g/collections/61475679/public/>

**Summary of Evidence Update:****Evidence Update Process for topics not covered by ILCOR Task Forces**

1. 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**

Organisation (if relevant); Author; Year Published	Guideline or systematic review	Topic addressed or PICO(S)T	Number of articles identified	Key findings	Treatment recommendations
Dewolf, 2021{Dewolf 2021 e10522}  PMID 34041431  PROSPERO: CRD4201706444 6	Systematic Review	P: a) medical students, trainees, interns, residents, physicians in training and in practice, and nurses. These participants will be included in the review. b) all patients sustaining cardiac arrest	40	NTS (7 studies): all showed improvement in time to completing clinical tasks, team management or teamwork knowledge Retention (8 studies): most studies showed a decline in knowledge/performance over time Feedback (10 studies): variable types of feedback included in studies	Focussed on non-technical skills (NTS), retention of skills and effect of debriefing. Simulation is the preferred method to teach NTS during ACLS training. Feedback and debriefing are valuable. Retention can occur up to 12-14 months



		<p>I: simulation training for ACLS</p> <p>C: no simulation training</p> <p>O:</p> <p>a) time skills</p> <p>b) process skills</p> <p>c) behaviour skills</p> <p>S:</p> <p>a) Sim training &amp; time management</p> <p>b) Simulation training &amp; process skills</p> <p>c) Simulation training &amp; behavior skills</p> <p>d) Simulation training &amp; patient outcome variables.</p>			
Evans, 2021{Evans 2021 167}	Scoping review	<p>Research question not specified.</p> <p>Aim is to provide future researchers and educators a clearer understanding of team dynamics and a common language for non-technical skills, particularly as they pertain to ad hoc</p>	61 studies, 46 reporting primary research	<p>Existing studies are very heterogeneous in terms of disciplines, methodologies, and scope.</p> <p>Taxonomy for non-technical skills described &amp; defined</p> <p>Parallel research programs reported, including disconnect between what is published in clinical and human factors or psychology journals</p>	None. Proposes ways in that future work can be standardized and connected better between areas of researchers

		prehospital, emergency department, and trauma resuscitation teams.			
Lindhard, 2021{Lindhard 2021 }	Systematic Review	<p>Research questions:</p> <p>a) Does simulation-based team training improve the performance of the team?</p> <p>b) Does it improve patient outcome and safety?</p> <p>P: HCPs with clinical responsibilities in the delivery room, NICU or other hospital settings with emergency care of the newborn, excluded studies involving students</p> <p>I: simulation-based team training of neonatal emergencies</p> <p>C:</p>	<p>24 studies, 2 with patient outcomes, 14 with team performance outcomes and 8 with knowledge/confidence outcomes.</p> <p>Only reporting studies with patient or team performance outcomes here</p>	<p>Pt outcomes (2 studies):</p> <ol style="list-style-type: none"> <li>1. 8 month neonatal survival significantly higher from 12 hospitals where team training was offered (high risk of bias)</li> <li>2. Neonatal mortality OR decreased over time after implementation of NRP-like course (moderate risk of bias)</li> </ol> <p>Clinical &amp; team performance outcomes (14 studies): not universally seen in all studies but trend to improvements in performance after training. Those studies reporting retention of skill generally demonstrated retention up to 15 months later</p>	<p>No evidence of effects on patient outcome following team training for neonatal teams</p> <p>Mostly consistent improvements in performance outcomes seen following training.</p> <p>Authors refrain from recommending team training. They suggest future studies examine real patient outcomes.</p>

		<ul style="list-style-type: none"> <li>a) performance before and after training,</li> <li>b) performance with no team training,</li> <li>c) performance over time</li> </ul> <p>O:</p> <ul style="list-style-type: none"> <li>a) Self-reported changes in knowledge, attitude, confidence, preparedness, self-efficacy, technical and non-technical skills</li> <li>b) Clinical performance or behaviour outcomes</li> <li>c) Patient outcomes (time to task completion, patient survival)</li> </ul>			
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## RCT: None

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
Fernandez, 2020{Fernandez 2020 73}	<p><b><u>Study Aim:</u></b> To assess impact of trauma leadership training on real patient clinical outcomes</p> <p><b><u>Study Type:</u></b> Single blind RCT. Training simulation-based, outcomes measured on real patients</p> <p><b><u>Study Size:</u></b> Learners n=79 randomized, final analysis n=60 Patients n=342 (data</p>	<p><b><u>Inclusion Criteria:</u></b></p> <ul style="list-style-type: none"> <li>• Learners: 2<sup>nd</sup> &amp; 3<sup>rd</sup> year emergency medicine and general surgery residents</li> <li>• Patients for outcome measurements: video-recorded trauma resusc lead by participant, met criteria as outlined in trauma registry (<u>unable to access</u>)</li> <li>• Patient exclusion criteria: Pregnant, pronounced dead or died within 5 min of arrival, DNR orders, in police custody, nontraumatic mechanism, isolated burn</li> </ul>	<p><b><u>Intervention:</u></b> 4h leadership training incl 1h didactic session about leadership behaviour, followed by several simulations &amp; debriefs</p> <p><b><u>Comparison:</u></b> Orientation to trauma team leader role: reviewing the responsibilities of the trauma team leader, administrative information, attendance policy, and available resources</p>	<p><b><u>1° endpoint:</u></b> Leadership score (prev published, max score 38) Control 7.23 (6.33-8.13) Intervention 11.29 (9.99-12.59), p&lt;0.001</p>	<ul style="list-style-type: none"> <li>• Patient care score (not separately published but validity evidence presented as suppl, max score variable according to event but normalized) Control 60.38 (57.69-63.07) Intervention 62.38 (58.43-66.33), p=0.99)</li> <li>• Modelling demonstrated significant predictive effect of patient care score from leadership score</li> </ul> <p><b><u>Study Limitations:</u></b></p> <ul style="list-style-type: none"> <li>• Only leaders received training. Other team members may have learned over time (study conducted over 2 years) and adapted their behaviour in the moment to accommodate gaps in leader behaviour</li> <li>• Team composition not standardized (impossible in real-life environ)</li> <li>• Single centre</li> <li>• Validity evidence of patient care score for development is strong but no prior use in studies with similar contexts</li> </ul>

	combined per learner)				
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### 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)
Armstrong, 2021{Armstrong 2021 255}	<b>Study Type:</b> Pre-post RN leadership intervention, cardiac arrest simulations, n=15 Simulations included other ED staff	<b>Inclusion Criteria:</b> Senior ED nurses (>5 years)	<b>1° endpoint:</b> Modified Trauma Non-technical skill score, broken down by category (modified by authors). OR/RR not reported, only mean diff and paired T test results <ul style="list-style-type: none"> <li>Leadership p=0.0031</li> <li>CRM p&lt;0.0001</li> <li>Communication p=0.1064</li> <li>Adherence to ALS algo p=0.0057</li> <li>Situation awareness &amp; coping with stress p=0.0008</li> </ul>	<ul style="list-style-type: none"> <li>Novel approach to assign some leadership tasks to RN team member</li> <li>Association between RN leadership training and improvement in teamwork behaviour</li> </ul> <p>Limitations:</p> <ul style="list-style-type: none"> <li>Unsure if assessors were blinded to whether pre or post training</li> <li>Assessment tool modified to different clinical context but no information provided on how that modification was carried out</li> <li>Other participants not trained and their behaviour not standardized so they could have modified to accommodate participants leadership behaviour</li> <li>Small sample size and single centre</li> </ul>
Brogaard, 2019{Brogaard 2019 1015}	<b>Study Type:</b> Prospective observational study: behaviour teams resuscitating	<b>Inclusion Criteria:</b> <ul style="list-style-type: none"> <li>Major PPH (not defined)</li> <li>Obstetrician attended delivery</li> </ul>	<b>1° endpoint:</b> Assoc between prev published non-technical score (AOTP) & clinical performance (TeamOBS-PPH) <ul style="list-style-type: none"> <li>Risk of high TeamOBS-PPH score 83.7% (68.5-94.1) if excellent AOTP</li> </ul>	<ul style="list-style-type: none"> <li>Demonstrated association between clinical performance and teamwork performance in real-life environment</li> <li>First in obstetrics</li> </ul> <p>Strengths:</p> <ul style="list-style-type: none"> <li>Trained &amp; Blinded raters (separate raters for 2 scores),</li> </ul>

	women with major post-partum hemorrhage (real-life video recording) N=260 eligible, 99 included	<ul style="list-style-type: none"> <li>Consent obtained from patient and staff</li> </ul>	<p>score vs 0.3% (0.01-15.2) if poor AOTP score (<math>p &lt; 0.001</math>)</p> <ul style="list-style-type: none"> <li>Risk of low Team OBS-PPH score 0.2% (0.01-1.2) if excellent AOTP score vs 8.0% (21.0-99.5) if poor AOTP score</li> </ul> <p><b>Other endpoint:</b> Delayed transfer to OR (EBL &gt;1500 mL). Risk 31.7% if poor AOTP score and 3.5% if excellent AOTP score (<math>p = 0.008</math>)</p>	<ul style="list-style-type: none"> <li>rigorous attempt at achieving reliability,</li> <li>validity evidence for scores used in same context</li> </ul> <p>Limitations:</p> <ul style="list-style-type: none"> <li>Many events not included, no consent &amp; OB left room for extended periods of time, biased sample?</li> <li>No mention of ongoing training occurring throughout study period</li> </ul>
Dewolf, 2021{Dewolf 2021 100171}	<b>Study Type:</b> Prospective observational study: patient outcome & behaviour mobile medical teams attending OHCA (real-life video recording) N=244 eligible, 114 included	<b>Inclusion Criteria:</b> <ul style="list-style-type: none"> <li>Adults OHCA</li> <li>at least 5 min resusc</li> <li>MMT at least 3 members</li> </ul>	<p><b>1° endpoint:</b> TEAM tool (previously published teamwork assessment tool for in hospital cardiac arrest teams) Overall TEAM score 34.4/44 (SD 5.5), 78.2%</p> <p><b>Other endpoints:</b> Assoc between TEAM score &amp; ROSC (40.4% of cohort) NS <math>p = 0.574</math> Assoc between TEAM score &amp; 1 month survival (8.8% of cohort) NS <math>p = 0.225</math> Descriptive stats presented for individual items for TEAM score</p>	<ul style="list-style-type: none"> <li>First published study to describe teamwork in real-life OHCA events</li> <li>No assoc with patient outcomes, but sample size very small</li> <li>Single centre and may not be generalizable to other parts of world where mobile medical teams (including MD) are not part of first responder system</li> </ul>
Dumas, 2020{Dumas 2020 544}	<b>Study Type:</b> Prospective observational study: patient outcome & behaviour of ED trauma	<b>Inclusion Criteria:</b> adult trauma patients undergoing emergency dept thoracotomy	<p><b>1° endpoint:</b> ROSC, 19/60=31%</p> <p><b>Other endpoint:</b> T-NOTECHS (prev published teamwork assessment tool for trauma teams, lower score better): median score 8 overall (IQR 6-10), median score 7 for</p>	<ul style="list-style-type: none"> <li>First published study to describe association between teamwork performance &amp; patient outcomes in real life trauma resuscitations</li> <li>Small sample size &amp; single centre</li> <li>Unsure of significance of association between 1 domain of teamwork and</li> </ul>

	teams (real-life video recording) N=61 eligible, all included		ROSC pts, median score 9 for non-ROSC patients, NS p=0.07 Regression revealed signif assoc between ROSC on 1 sub-item of T-NOTECHS (assessment & decision-making)	patient outcome given multiple data points assessed in small sample size
Herzberg, 2019{Herzberg 2019 e025314}	<b>Study Type:</b> Prospective observational study: simulation, pre-hospital pediatric emergency care N=44 teams, 176 simulated events	<b>Inclusion Criteria:</b> EMS teams incl EMT & paramedics	<b>1° endpoint:</b> Assoc between adverse event rate & CTS score (prev published teamwork assessment tool for obstetrics, also used for ped resusc studies). Mean CTS score significantly higher in simulations with no error than those with at least 1 error ( $7.16 \pm 1.95$ vs $5.76 \pm 2.04$ , p=0.0007), for every 1 unit increase in CTS adjusted OR 0.73 (0.59-0.89, p=0.0022), adjusted for scenario & mean years of EMS experience of team 82% of simulations contained at least 1 error	<ul style="list-style-type: none"> <li>Unsure of significance of this study since dichotomizing dependent variable to presence/absence of error is not that realistic given the vast majority of scenarios contained at least 1 error, which is reflective of real life as well</li> <li>For pediatric resuscitations, error rate is interesting outcome since survival is almost certain for most clinical situations</li> <li>Variability of EMS team composition may limit generalizability of results</li> </ul>
Jafri, 2021{Jafri 2021 163}	<b>Study Type:</b> Pre post simulation based study: pediatric resuscitation teams undergoing CRM training N=178 participants	<b>Inclusion Criteria:</b> Community hospital based pediatric resuscitation team members (interprofessional)	<b>1° endpoint:</b> Feasibility of offering curriculum in community hospital <b>Other outcomes:</b> <ul style="list-style-type: none"> <li>CPT (prev published PALS adherence assessment tool) score increased pre to post 61.7%-72.1%, p&lt;0.001</li> <li>CTS score (prev published teamwork assessment tool for obstetrics, also used for ped resusc studies). Score increased pre to post 42.8%-57.5%, p&lt;0.001</li> </ul>	<ul style="list-style-type: none"> <li>Unusual to report studies in community settings</li> <li>Large sample of learners but single centre</li> </ul>

			<ul style="list-style-type: none"> <li>Association between CPT &amp; CTS moderate <math>R=0.65</math> <math>R^2 0.43</math>, <math>p&lt;0.001</math></li> </ul>	
Kristiansen, 2020{Kristiansen 2020 A03190189}	<b>Study Type:</b> Pre-post study, trauma team training, real-life trauma patient outcomes N=43 trauma patients, unknown how many participants in training 23 pre & 20 post)	<b>Inclusion Criteria:</b> Interprofessional trauma team members	<b>1° endpoint:</b> Time to completion of 4 key clinical outcomes (CXR, CT, CT reported, departure from ED), as recorded on paper trauma record, no significant differences in any individual times pre vs post (57 min vs 62 min)	<ul style="list-style-type: none"> <li>With no records kept of participants, unsure of extent of training of individual team members</li> <li>Small sample size, single centre</li> </ul>
Peltonen, 2020{Peltonen 2020 162}	<b>Study Type:</b> Prospective observational study, real-life in-hospital ALS events, video-recorded, N=110 eligible, 20 included	<b>Inclusion Criteria:</b> In-hospital ALS events, did not define what an "ALS event was" Is it equivalent to IHCA? Video-recording complete	<b>1° endpoint:</b> Assoc between non-technical and technical scores (using previously published assessment tool, higher score better, individual items +2 to -2) Median TS 0.68 (IQR 0.89-0.21) Median NTS 0.66 (IQR 1.10-0.03) Assoc $R=0.48$ , $0.34-0.61$ , $p<0.001$	<ul style="list-style-type: none"> <li>First study to examine teamwork behaviour in real-life IHCA events and explore association with adherence to resuscitation guidelines</li> <li>Use of scoring systems including positive and negative individual scores makes a sum of scores difficult to interpret</li> <li>Most events excluded, primarily because team forgot to turn camera on, biased towards less significant events? No description provided of clinical events to understand context</li> <li>Single centre, small numbers</li> </ul>



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

- Previous Treatment Recommendations for 2010, 2015, 2020 suggested offering team and leadership training to resuscitation team members. Very low quality of evidence on average, so decision by TF to suggest was influenced on lack of potential harm with possible benefit rather than strength of evidence.
- New studies described above are also low to very low quality of evidence.
- General conclusion is that there is more published evidence supporting a positive association between teamwork/leader performance and clinical performance, as measured by surrogate patient outcomes (adherence to resuscitation and other clinical practice guidelines, avoidance of errors, time to definitive therapies). No new evidence demonstrating a positive effect of team training on patient outcomes eg survival.
- However, there are more studies involving real-life events published over the last 2 years, including several where examination of team performance in individual events was accomplished. These real-life studies were rare before and were primarily reported on an aggregate level (eg patient survival from a hospital over time). With investigators now discovering how to feasibly record real life events and to analyze them in a systematic way, it is likely that higher and higher quality evidence will be published over time.
- Overall, I do not believe that this EvUp requires a formal review because I do not believe that there is sufficient evidence to change our Treatment Recommendations from 2020.

	<b>Approval Date</b>
<b>Evidence Update coordinator</b>	
<b>ILCOR board</b>	

**\*Once approval has been made by Evidence Update coordinator, worksheet will go to ILCOR Board for acknowledgement.**

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## **2022 Evidence Update Worksheet**

**Worksheet author(s):** Nathan Charlton

**Task Force:** First Aid

**Date Submitted:** 7/3/2021; Updated 12/13/2021

**Worksheet ID:** FA 202 Caustic Ingestion

**PICO / Research Question:** Among adults and children in any setting (in-hospital or out-of-hospital) with a caustic substance ingestion (P) does oral dilution with any potential diluting agent available to a lay first aid provider (I), compared with oral dilution with any other diluting agent available to a lay first aid provider or no dilution (C), improve outcome (O)?

**Outcomes:** esophageal injury, gastric injury, viscus perforation, stricture, risk of cancer, mortality

**Type (intervention, diagnosis, prognosis):** intervention

**Additional Evidence Reviewer(s):** Michael Nemeth

**Conflicts of Interest (financial/intellectual, specific to this question):** None

**Year of last full review:** 2010

### **Last ILCOR Consensus on Science and Treatment Recommendation:**

FA-202A

#### **CONSENSUS ON SCIENCE:**

No human studies exist examining the treatment of oral caustic exposure with dilution therapy. An initial chemistry study (LOE 5) demonstrated no benefit from the administration of large volumes of diluent with either strong base or strong acid. Animal studies (LOE 5) demonstrated histological benefit to the esophagus following exposure to an alkali or acid when diluent was administered. The evidence of the benefit of administration of a diluent following ingestion of a caustic agent is indeterminate.

#### **TREATMENT RECOMMENDATION:**

Administration of a diluent in first aid may be considered if a caustic has been ingested, if advised to do so by a healthcare provider.

#### **2010/2015 Search Strategy:**

PubMed “caustic” or “alkali” or “acid” and “poisoning” or “overdose” and “milk” or “dilution” or “therapy” text word in abstract

AHA EndNote Master library

Cochrane database for systematic reviews and Central Register of Controlled Trials

Hand searches of journals, review articles, and books

#### **Inclusion and exclusion criteria:**

Only articles in the peer reviewed literature were included  
 No abstracts, only studies  
 Studies that do not specifically answer the question

## 2021 Search Strategy:

((("alkali\*" [Text Word] OR "acid" [Text Word]) AND ("injury" [Text Word] OR "poison\*" [Text Word] OR "ingest\*" [Text Word])) OR "burns, chemical" [MeSH Major Topic]) AND ("dilut\*" [Text Word] OR "milk" [Text Word] OR "neutralization therapy" [Text Word])

**Database searched:** Pubmed

**Date Search Completed:** 6/12/2021; Search Dates: 1/1/2008-6/14/2021

**Updated search 12/14/2021:** Search dates 06/01/2021-12/15/2021 31 results, 31 excluded by title and abstract screening.

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

1744 original articles / 1744 articles screened by title and abstract / 3 full text reviews / 2 included

## 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) animal studies, ex-vivo studies and case series of > 4 persons are eligible for inclusion. Relevant review articles are also eligible for inclusion. Unpublished studies (e.g., conference abstracts, trial protocols) are excluded.

Articles that evaluate the treatment of a caustic substance ingestion in the pediatric or adult population by dilution with any substance available to a first aid provider will be included.

Articles that specifically evaluate the neutralization of an acid with a base or vice versa will not be included.

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

Yasar M, Taskin AK, Kaya B, Aydin M, Ozaydin I, Iskender A, Erdem H, Ankatali H, Kandis H. The early anti-inflammatory effect of Kefir in experimental corrosive esophagitis. *Ann Ital Chir.* 2013 Nov-Dec;84(6):681-85. PMID: 23013643.

## Abstract

**Aim:** Corrosive esophageal burns are still an important problem. The aim of this study was to evaluate the effect of kefir in an experimental corrosive esophagitis model.

**Material and method:** Twenty-four male wistar albino rats were used in this experimental study. The rats were randomized into three groups according to the procedure and treatment type (each group has eight rats). Group I: (Control group), Group II: (Induction of corrosive esophagitis with 5 % NaOH without any treatment) and Group III: (Corrosive esophagitis treated with kefir). The rats were sacrificed on the first and seventh days. Mediastinum and abdominal cavity of rats were explored (sic). Approximately 1.5 cm of esophagus was removed for histopathological examination. Inflammation, injury in the muscularis mucosa and collagen deposition were evaluated.

**Results:** Histopathological results on the first day after caustic injury; inflammation was detected in three rats in Group II and there were no inflammation in rats in Group III. This difference was statistically significant ( $p<0.05$ ). Injury in muscularis mucosa was detected in three rats in Group II and in one rat in Group III. Histopathological results on the seventh days after caustic injury; Inflammation was positive in four rats in Group II and three rats in Group III. Injury in muscularis mucosa was equal in two groups (three rats each). Collagen deposition with high grade (Grade 2) was detected in two rats in Group II and in four rats in Group III ( $p<0.05$ ).

**Conclusion:** Kefir has anti-inflammatory effect specially (sic) in early phase of caustic injury. It has also some beneficial effect in wound healing.

Hoffman RS, Burns MM, Gosselin S. Ingestion of Caustic Substances. N Engl J Med. 2020 Apr 30;382(18):1739-1748. doi: 10.1056/NEJMr1810769. PMID: 32348645.

No abstract available. Available at <https://pubmed.ncbi.nlm.nih.gov/32348645/>

### Summary of Evidence Update:

One animal study was identified that evaluated the effect of kefir (a yogurt like drink) on 24 male wistar albino rats with caustic injury to the esophagus. Following sedation, the distal esophagus was tied and rats were randomized and given one of three experimental treatments. Group 1 had 1 ml of 0.9% saline instilled into the esophageal cavity as a control. Group 2 had 1 ml of 5% sodium hydroxide (NaOH) solution instilled through the esophagus for 3 minutes. The esophagus was then cleaned with distilled water for 1 minute. Group 3 had instillation of 5% NaOH for 3 minutes as above and then, after cleaning with 1 ml distilled water, 1 ml of kefir solution was instilled into the distal esophagus for 3 minutes; the kefir was also cleaned off with distilled water. Rats were sacrificed on either the first or seventh days. When sacrificed at one day there was no inflammation in rats in the control group. When compared to the NaOH group, the difference was significant ( $p<0.05$ ). On day one, inflammation was detected in three rats in the NaOH group, but there was no inflammation in rats in the group treated with kefir, which was statistically significant ( $p<0.05$ ). Injury in muscularis mucosa of the esophagus was detected in three rats in the NaOH group and in one rat in the group treated with kefir, but this was not statistically significant. When sacrificed at seven days tissue inflammation and injury to the muscularis mucosa was not statistically different between the NaOH group and the group treated with kefir, however, high grade collagen deposition was lower in the NaOH group the group treated with kefir (2/4 compared with 4/4;  $p<0.05$ ).

### Evidence Update Process for topics not covered by ILCOR Task Forces

1. 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

Hoffman 2020	Review Article	Neutralization and dilution therapy for caustic ingestion	2	<p>Homan CS, Singer AJ, Henry MC, Thode HC Jr. Thermal effects of neutralization therapy and water dilution for acute alkali exposure in canines. Acad Emerg Med 1997;4:27-32.</p> <p>Homan CS, Singer AJ, Thomajan C, Henry MC, Thode HC Jr. Thermal characteristics of neutralization therapy and water dilution for strong acid ingestion: an in-vivo canine model. Acad Emerg Med 1998;5:286-292.</p>	<p>“Even if this risk might be overstated, the clinical benefit of neutralization has never been shown (Homan 1997, Homan 1998). Further concerns over distention-induced injury of damaged tissues caused by gas generated during neutralization and the risk of emesis prevent recommendations for neutralization at this time. A single exception would be the use of water immediately after ingestion (usually at home) to irrigate adherent materials in the oropharynx or esophagus if the patient can swallow, speak clearly, and breathe without difficulty. Early irrigation is likely to be most useful for ingestion of powdered caustics, which can prolong injury by adhering to tissues.”</p>
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## 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
Yasar 2012	<p><b>Study Aim:</b> Evaluate the effect of kefir on alkali injury to the esophagus</p> <p><b>Study Type:</b> Randomized</p>	<p><b>Inclusion Criteria:</b> A rodent model of alkali ingestion (sodium hydroxide)</p>	<p><b>Intervention:</b> Kefir, plus distilled water irrigation</p> <p><b>Comparison:</b> Distilled water irrigation only.</p>	<p><b>1° endpoint:</b> Inflammation of the esophagus at 1 and 7 days.</p>	<p><b>Study Limitations:</b> Animal study, no irrigation control, low number of animals in each group.</p>

	Controlled trial in rodents				
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**Reviewer Comments (including whether meet criteria for formal review):**

Only one new study (Yasar 2012) was identified that evaluated the first aid treatment of caustic substance ingestion by dilution. Similar to studies found in the prior ILCOR review, this study was done in an animal model and evaluated histopathological outcomes. There continues to be no human studies identified on the topic. The study included in this update found a statistically significant difference in inflammation in rat esophagus resulting from sodium hydroxide in those treated with kefir compared to those that were not, however, this lost statistical significance by 7 days. There was increased amount of collagen deposition detected rats that were not treated with kefir. In this study both the injury groups had irrigation of the esophagus done with distilled water after then induced injury. There was no control done for the distilled water irrigation.

A single review article (Hoffman 2020) was identified that was relevant to the evidence update. This includes only two references which were both also identified in the 2010 ILCOR worksheet. The treatment recommendation in this review also contain unreferenced statements that appear to be author opinion. This recommendation suggests that water could be used immediately after an ingestion to “irrigate adherent materials in the oropharynx or esophagus if the patient can swallow, speak clearly, and breathe without difficulty.” This statement is consistent with the current ILCOR recommendation that dilution may be considered for a caustic ingestion if advised to do so by a healthcare provider.

There remains a paucity of literature on the topic and all studies to date are in animal models. The single new study identified does not demonstrate compelling evidence for treatment with dilution, therefore, this evidence update does not generate the need for an updated formal review.

	<b>Approval Date</b>
<b>Evidence Update coordinator</b>	
<b>ILCOR board</b>	

**\*Once approval has been made by Evidence Update coordinator, worksheet will go to ILCOR Board for acknowledgement.**

**Reference list**

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2. Hoffman RS, Burns MM, Gosselin S. Ingestion of Caustic Substances. *N Engl J Med.* 2020 Apr 30;382(18):1739-1748. doi: 10.1056/NEJMra1810769. PMID: 32348645.

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## 2022 Evidence Update Worksheet

**Worksheet author(s):** David C. Berry

**Task Force:** First Aid

**Date Submitted:** September 26, 2021; Updated December 14, 2021

**Worksheet ID:** FA511, Compression wrap for closed ankle joint injury

**Previous Title:** Compression wrap for closed extremity joint injury

**PICO / Research Question (FA 511)** Among adults in the prehospital setting with a closed ankle joint injury (P), does a compression wrap, elastic wrap (I), compared to no compression wrap or elastic wrap (C), change outcomes.

*Population:* Adults in the prehospital setting with a closed ankle joint injury.

*Intervention:* Compression wrap, elastic wrap.

*Comparators:* No compression wrap or elastic wrap.

*Outcomes:* Reduction of pain; reduction of swelling/edema (critical outcomes). Recovery time; range of motion; adverse effects (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. Last literature update, November 3, 2019.

**Outcomes:** Reduction of pain; reduction of swelling/edema (critical outcomes). Recovery time; range of motion; adverse effects (important outcomes).

**Type (intervention, diagnosis, prognosis):** Intervention

**Additional Evidence Reviewer(s):** NA

**Conflicts of Interest (financial/intellectual, specific to this question):** None

**Year of last full review: New question:** 2019, published 2020, *Journal of Athletic Training*  
<https://doi.org/10.4085/1062-6050-0093.20>

**Last ILCOR Consensus on Science and Treatment Recommendation:**

## **Compression (FA 511)**

### ***Consensus on Science***

For the critical outcome reduction of pain (measured by a visual analogue scale (VAS), we identified low-certainty evidence (downgraded for indirectness and imprecision) from 2 randomized controlled trials (RCT) (Boyce 2005 91; O'Connor 2011 255) and 1 non-randomized trial (NRT) (Bilgic 2015 1496) enrolling 122 adult patients with ankle sprains, not showing benefit from the use of a compression bandage, when compared with not using a compression bandage, using a splint or using an Aircast® ankle brace (SMD, 0.34; 95%CI, -0.10–0.79; P=0.12).

For the critical outcome free from walking pain after 4 days and 8 days (measured as having pain during walking, yes or no), we identified very-low-certainty evidence from 1 NRT (Linde 1984 177) enrolling 100 adult patients with ankle sprains, not showing benefit from the use of a compression bandage, when compared with not using a compression bandage (RR, 1.25; 95%CI, 0.78–2.11, P=0.33 and RR, 1.39; 95%CI, 0.98–1.95, P=0.06, respectively).

For the critical outcome pain at rest and pain at walking after 6-9 days (measured by a visual analogue scale (VAS)), we have identified very-low-certainty evidence from 1 NRT (Bendahou 2014 1005) enrolling 117 adult patients with ankle sprains, not showing benefit from the use of a compression bandage, when compared with use of a non-compressive stocking (MD, -4.4; 95%CI, -9.35–0.55; P=0.08 and MD, -3.30; 95%CI, -11.77–5.17; P=0.45, respectively).

For the critical outcome reduction of swelling/edema (measured by circumference measurement (cm) or ankle volume change (mL)), we identified very-low-certainty evidence (downgraded for risk of bias, indirectness and imprecision) from 3 RCT (Bendahou 2014 1005; Boyce 2005 91; Rucinski 1991 65) enrolling 172 patients with ankle sprains and 1 NRT (Bilgic 2015 1496) enrolling 51 adult patients with ankle sprains, not showing benefit from the use of a compression bandage, when compared with not using a compression bandage, or using a non-compressive stocking, a splint or an Aircast® ankle brace (SMD, 0.54; 95%CI, -0.14–1.22; P=0.12).

For the important outcome ankle joint function (measured by Karlsson score), we identified low-certainty evidence (downgraded for indirectness and imprecision) from 2 RCT (Boyce 2005 91; O'Connor 2011 255) enrolling 71 adult patients with ankle sprains not showing benefit from the use of a compression bandage after 10 days and 1 month, when compared with not using a compression bandage or using an Aircast® ankle brace (SMD, -0.34; 95%CI, -1.16–0.49; P=0.42 and SMD, -0.29; 95%CI, -1.11–0.53; P=0.49; respectively).

For the important outcome range of motion (ROM (% of the uninjured ankle range of motion)) after 3-5 days, 2 weeks and 4 weeks, we identified very-low-certainty evidence (downgraded for risk of bias, indirectness and imprecision) from 1 RCT (Leanderson 1995 529) enrolling 73 patients with ankle sprains not showing benefit from the use of a compression bandage when compared with using an Air Stirrup® ankle brace (MD, -7 %; MD, 0 % and MD, 2 %, respectively, 95%CI could not be calculated; P>0.05).

For the important outcome recovery time (time to return to normal walking, time to return to stair climbing, time to return to walking with full weight-bearing in days) we identified very-low-certainty evidence (downgraded for risk of bias, indirectness and imprecision) from 1 RCT (Beynnon 2006 1401)

enrolling 142 patients with ankle sprains, not showing benefit from the use of a compression bandage when compared with using an Air Stirrup® ankle brace (only mean number of days reported; 95%CI could not be calculated;  $P > 0.05$  for all outcomes).

For the important outcome return to work, we have identified very-low-certainty evidence (downgraded for risk of bias, indirectness and imprecision) from 3 RCT (Bendahou 2014 1005; Leanderson 1995 529; O'Connor 2011 255) enrolling 226 patients with ankle sprains. One study (Leanderson 1995 529) showed less benefit for use of a compression bandage when compared with using an Air Stirrup® ankle brace (only median number of days reported; absolute effects could not be calculated;  $P < 0.05$ ). Two other studies (Bendahou 2014 1005, O'Connor 2011 255) did not show benefit for use of a compression bandage when compared with not using compression bandage (MD, -2.10 days; 95%CI, -4.97–0.77;  $P = 0.15$ ) or use of non-compressive stockings (only median number of days reported; 95%CI could not be calculated;  $P = 0.20$ ).

For the important outcome return to sports, we have identified very-low-certainty evidence (downgraded for risk of bias, indirectness and imprecision) from 1 RCT (Bendahou 2014 1005) enrolling 117 adult patients with ankle sprains, showing benefit for use of a compression bandage when compared with use of non-compressive stockings (only median number of days reported; 95%CI could not be calculated;  $P < 0.02$ ).

### ***Treatment Recommendations***

We suggest either application of a compression bandage or no application of a compression bandage for adults with an acute closed ankle joint injury (weak recommendation, very low certainty evidence). Due to a lack of identified evidence, we are unable to recommend for or against use of a compression bandage for closed joint injuries besides the ankle.

### **2019 (most recent) Search Strategy:**

#### *PubMed*

1. "Sprains and strains"[Mesh] OR "Soft Tissue Injuries"[Mesh] OR "athletic injuries"[Mesh] OR strain\*[TIAB] OR sprain\*[TIAB] OR "Fractures, closed"[Mesh] OR fracture\*[TIAB] OR "Joint dislocations"[Mesh] OR dislocation\*[TIAB] OR distortion\*[TIAB] OR rupture\*[TIAB] OR "ankle injuries"[Mesh] OR "knee injuries"[Mesh] OR "wrist injuries"[Mesh] OR "tendon injuries"[Mesh:NoExp] OR overexertion[TIAB] OR ((ankle[TIAB] OR knee[TIAB] OR wrist[TIAB] OR elbow[TIAB]) AND (injur\*[TIAB]))  
"Compression Bandages"[Mesh] OR ((compression[TIAB] OR elastic[TIAB]) AND (bandag\*[TIAB] OR wrap\*[TIAB] OR dressing[TIAB]))
2. 1 AND 2

#### *Embase*

1. 'sprain'/exp OR 'joint injury'/de OR 'ankle injury'/exp OR 'knee injury'/exp OR 'wrist injury'/exp OR 'elbow injury'/exp OR 'ligament and tendon injury'/exp OR 'muscle injury'/exp OR 'overexertion'/exp OR 'Soft Tissue Injury'/exp OR 'sport injury'/exp OR strain\*:ab,ti OR sprain\*:ab,ti OR distortion\*:ab,ti OR rupture:ab,ti OR overexertion:ab,ti OR ((ankle:ab,ti OR knee:ab,ti OR wrist:ab,ti OR elbow:ab,ti) AND (injur\*:ab,ti))
2. 'Compression Bandage'/exp OR 'compression stocking'/exp OR 'compression sleeve'/de OR ((compression:ab,ti OR elastic:ab,ti) AND (bandag\*:ab,ti OR wrap\*:ab,ti OR dressing\*:ab,ti OR stocking:ab,ti OR sleeve:ab,ti))

## 3. 1 AND 2

*Cochrane library*

1. [mh "Sprains and strains"] OR [mh "Soft Tissue Injuries"] OR [mh "athletic injuries"] OR strain\*:ti,ab,kw OR sprain\*:ti,ab,kw OR distortion\*:ti,ab,kw OR rupture\*:ti,ab,kw OR [mh "ankle injuries"] OR [mh "knee injuries"] OR [mh "wrist injuries"] OR [mh ^"tendon injuries"] OR overexertion:ti,ab,kw OR ((ankle:ti,ab,kw OR knee:ti,ab,kw OR wrist:ti,ab,kw OR elbow:ti,ab,kw) AND (injur\*:ti,ab,kw))
2. [mh "Compression Bandages"] OR ((compression:ti,ab,kw OR elastic:ti,ab,kw) AND (bandag\*:ti,ab,kw OR wrap\*:ti,ab,kw OR dressing\*:ti,ab,kw OR stocking\*:ti,ab,kw OR sleeve\*:ti,ab,kw))
3. 1 AND 2

**Database searched:** Pubmed.gov, Cochrane library

**Date Search Completed:** September 26, 2021

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

Databases	Identified Records (11.19 to 09.21)	Excluded on Title, Abstract	Reviewed for Possible Inclusion	Included
<i>Pubmed.gov</i>	45	45	0	0
<i>Cochrane Library (Reviews)</i>	1	1	0	0
<i>Cochrane Library (Trial)</i>	25	23	2	0

**Date Search Completed:** December 14, 2021

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

Databases	Identified Records (09.27.21 to 12.14.2021)	Excluded on Title, Abstract	Reviewed for Possible Inclusion	Included
<i>Pubmed.gov</i>	7	7	0	0

**Inclusion/Exclusion Criteria:**

**Table 1. Inclusion and Exclusion Criteria.**

	Inclusion	Exclusion
<b>Population</b>	Adults in the prehospital setting who presented with a closed ankle joint injury (i.e. a suspected sprain or strain) that occurred within the last 72 h.	Children. Adults with a fracture, dislocation or an injury not consistent with a sprain or strain. Joints, other than ankle.
<b>Intervention</b>	Compressive, non-immobilizing interventions, such as compression bandage or wrap, elastic bandage or	Interventions that immobilize the joint. Non-compressive (tubular) bandages.

	wrap, tubular compression bandage or elastic stockings.	Compression devices that are not feasible in a prehospital setting.
<b>Comparison</b>	No treatment. Any treatment that does not provide compression (e.g. elevation of the injured limb, a brace, a splint or tape).	Any intervention not feasible in a prehospital setting (e.g. plaster cast).
<b>Outcome</b>	Critical outcomes: reduction of pain and reduction of swelling or oedema. Important outcomes: recovery time, range of motion, joint function and adverse events.	
<b>Study design</b>	Randomized controlled trials (RCTs) and non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies)	Unpublished studies (e.g. conference abstracts, trial protocols) and animal studies.
<b>Timeframe and language</b>	All years. All languages, as long as an English abstract is available.	Articles in a language other than English, for which no English abstract is available.

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

A total of 75 records were identified with this evidence update, with 73 excluded by title or abstract.

Two Cochrane Library studies underwent full text review due to a lack of an adequate abstract.

Javorac et al. (2020 517) compared the effects of an experimental novel protocol of intensive hydrotherapy with hydrogen-rich water (HRW) on injury recovery in male athletes who suffered an acute ankle sprain (AAS) and compared it with a RICE protocol (rest, ice, compression, elevation). On review, the article was excluded because the intervention did not offer compression and was deemed not feasible in a prehospital setting. The RICE group was not weight bearing, with ice packs administered for 20 min every 3 hours, with the injured ankle compressed with an elastic bandage for 24 hours and elevated at all possible times above the level of the heart. Therefore, the combination of rest, ice, compression, and elevation makes it challenging to extrapolate which RICE component was responsible for changes in outcomes.

Zeng et al. (2021 243) compared a modified Robert Jones 3M elastic bandage to a lower limb elastic compression device on fitness, convenience, safety, and comfort. On review, the manuscript failed to meet the inclusion criteria of a closed ankle injury. Additionally, the article was unavailable and was written in Chinese script.

### **Summary of Evidence Update:**

No new studies regarding the application of a compression bandage for closed ankle joint injury were identified in this evidence update, and an update to the previous systematic review is not indicated.

The previous 2019 treatment recommendation remains unchanged.

### **Evidence Update Process for topics not covered by ILCOR Task Forces**

1. 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

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:

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 (including whether meet criteria for formal review):

This evidence update did not identify any new studies describing the application of a compression bandage for closed ankle joint injury.

The task force discussed the previous treatment recommendation and due to the lack of any additional evidence for the application of a compression bandage for adults with an acute closed ankle joint injury the 2019 CoSTR was upheld.

In task force discussion, it was noted that due to the lack of evidence on the application of a compression bandage for adults with other closed extremity joint injury, any subsequent evidence updates will continue to focus on closed ankle joint injury as this appears to be the most commonly evaluated joint.

	<b>Approval Date</b>
<b>Evidence Update coordinator</b>	
<b>ILCOR board</b>	

**\*Once approval has been made by Evidence Update coordinator, worksheet will go to ILCOR Board for acknowledgement.**

### Reference list

Bendahou M, Khiami F, Saidi K, et al. Compression stockings in ankle sprain: a multicenter randomized study. *Am J Emerg Med*. 2014;32(9):1005-1010.

Beynnon BD, Renstrom PA, Haugh L, Uh BS, Barker H. A prospective, randomized clinical investigation of the treatment of first-time ankle sprains. *Am J Sports Med*. 2006;34(9):1401-1412.

Bilgic S, Durusu M, Aliyev B, et al. Comparison of two main treatment modalities for acute ankle sprain. *Pak J Med Sci*. 2015;31(6):1496-1499.

Boyce SH, Quigley MA, Campbell S. Management of ankle sprains: a randomised controlled trial of the treatment of inversion injuries using an elastic support bandage or an Aircast ankle brace. *Br J Sports Med*. 2005;39(2):91-96.

Javorac D, Stajer V, Ratgeber L, Olah A, Betlehem J, Acs P, Vukomanovic B, Ostojic SM. Hydrotherapy with hydrogen-rich water compared with RICE protocol following acute ankle sprain in professional athletes: a randomized non-inferiority pilot trial. *Res Sports Med*. 2021 Nov-Dec;29(6):517-525. doi: 10.1080/15438627.2020.1868468. Epub 2020 Dec 27.

Leanderson J, Wredmark T. Treatment of acute ankle sprain. Comparison of a semi-rigid ankle brace and compression bandage in 73 patients. *Acta Orthop Scand*. 1995;66(6):529-531.

Linde F, Hvass I, Jurgensen U, Madsen F. Compression bandage in the treatment of ankle sprains. A comparative prospective study. *Scand J Rehabil Med*. 1984;16(4):177-179.

O'Connor G, Martin AJ. Acute ankle sprain: is there a best support? *Eur J Emerg Med*. 2011;18(4):225-230.

Zeng LY, Wei XC, Wang T, Wang YZ, Zhang H, Wang K, Zhang ZQ. [Design of combined lower limb elastic compression device and comparative study with elastic bandage]. *Zhongguo Gu Shang*. 2021 Mar 25;34(3):243-8. Chinese. doi: 10.12200/j.issn.1003-0034.2021.03.011.

**\*\*CONFIDENTIAL DO NOT DISTRIBUTE\*\*****2022 Evidence Update Worksheet**

**Worksheet author(s):** Michael Nemeth; E.M. Singletary

**Task Force:** First Aid

**Date Submitted to SAC rep for peer review and approval:** 28 Oct 2021; Updated 15 Dec 2021

**Worksheet ID:** FA 513 Recognition of Anaphylaxis

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

**(Current/2019 Scoping Review PICOST):** Among adults and children experiencing anaphylaxis (P), does the description of any specific symptoms to the first aid provider (I), compared with the absence of any specific description (C) change the likelihood of anaphylaxis recognition (O)?

**Previous 2010 wording** (note: not in PICOST format): Can the First Aid Provider Appropriately Recognize the Signs and Symptoms of Anaphylaxis?

**Year of last full review:** CoSTR in 2010; Scoping review 2019/published 2020.

**Current ILCOR Consensus on Science and Treatment Recommendation for this PICOST: (2010)**

Four LOE 4(17–20) and 3 LOE 5(21–23) studies documented the difficulty that first aid providers have in assessing and recognizing signs and symptoms of anaphylaxis. Evidence from 1 LOE 4 study (24) demonstrated that parents of children with multiple anaphylactic reactions can more accurately begin to recognize the signs and symptoms indicating the need for administration of an auto-injector, but with a lack of training and experience, they are unable to provide appropriate care.

**Treatment Recommendation:** First aid providers should not be expected to recognize the signs and symptoms of anaphylaxis without repeated episodes of training and encounters with victims of anaphylaxis.”[Markenson 2010 S582].

**Knowledge Gaps:**

How can a first aid provider determine that a witnessed allergic reaction needs epinephrine? Are there anaphylactic reactions that do not respond to epinephrine?

**2019 Search Strategy**

Recognition of anaphylaxis by first aid providers (FA 513: ScopRev, search strategy used in 2019)

# Query

S15 S14 NOT (PT commentary OR PT letter OR PT editorial)

S14 S13 NOT (MH "Animals+") NOT ((MH "Human") AND (MH "Animals+"))

S13 S5 and S12

S12 S6 or S7 or S8 or S9 or S10 or S11



- S11 TI (first aid\* or "first respon\*" or EMT or "emergency medical technician\*" or paramedic\* or para-medic\* or ambulance\*) or AB (first aid\* or "first respon\*" or EMT or "emergency medical technician\*" or paramedic\* or para-medic\* or ambulance\*)
- S10 TI (self-manage\*) or AB (self-manage\*)
- S9 TI (patient\* N3 (educat\* or train\* or manage\* or instruct\* or confiden\* or complian\* or adheren\*)) or AB (patient\* N3 (educat\* or train\* or manage\* or instruct\* or confiden\* or complian\* or adheren\*))
- S8 TI (parent or parents or parental or communit\* or teacher\* or caregiver\* or care-giver\* or personnel\* or school\* or "child care worker\*" or "childcare worker\*" or aide\*) or AB (parent or parents or parental or communit\* or teacher\* or caregiver\* or care-giver\* or personnel\* or school\* or "child care worker\*" or "childcare worker\*" or aide\*)
- S7 TI (layperson\* or lay-person\* or laypeople\* or lay-people\* or nonprofessional\* or non-professional\*) or AB (layperson\* or lay-person\* or laypeople\* or lay-people\* or nonprofessional\* or non-professional\*)
- S6 MH ("Patient Education" or "Self Administration" or "Self Medication")
- S5 S1 or S2 or S3 or S4
- S4 TI (manage\* N1 anaphyla\*) or AB (manage\* N1 anaphyla\*)
- S3 TI ((comfort\* or discomfort\* or dis-comfort\* or uncomfortable or confiden\* or empower\*) N4 (anaphyla\* or epinephrin\* or adrenalin\* or epi-pen\* or epipen\*)) or AB ((comfort\* or discomfort\* or dis-comfort\* or uncomfortable or confiden\* or empower\*) N4 (anaphyla\* or epinephrin\* or adrenalin\* or epi-pen\* or epipen\*))
- S2 TI ((underus\* or under-us\* or underutili\* or under-utili\*) N4 (anaphyla\* or epinephrin\* or adrenalin\* or epi-pen\* or epipen\*)) or AB ((underus\* or under-us\* or underutili\* or under-utili\*) N4 (anaphyla\* or epinephrin\* or adrenalin\* or epi-pen\* or epipen\*))
- S1 TI ((recogni\* or knowledge\* or skill\* or educat\* or information\* or train\*) N4 (anaphyla\* or epinephrin\* or adrenalin\* or epi-pen\* or epipen\*)) or AB ((recogni\* or knowledge\* or skill\* or educat\* or information\* or train\*) N4 (anaphyla\* or epinephrin\* or adrenalin\* or epi-pen\* or epipen\*))

## 2021 Revised Search Strategy:

The 2019 search strategy (above) was revised by Peter Morley, October 28, 2021:

Ovid MEDLINE(R) and Epub Ahead of Print, In-Process, In-Data-Review & Other Non-Indexed Citations and Daily <1946 to October 22, 2021>

- 1 ((recogni\* or knowledge\* or skill\* or educat\* or information\* or train\*) adj5 (anaphyla\* or epinephrin\* or adrenalin\* or epi-pen\* or epipen\*))\*tw,kf. 896

2	((underus* or under-us* or underutili* or under-utili*) adj5 (anaphyla* or epinephrin* or adrenalin* or epi-pen* or epipen*)).tw,kf.	54
3	((comfort* or discomfort* or dis-comfort* or uncomfortable or confiden* or empower*) adj5 (anaphyla* or epinephrin* or adrenalin* or epi-pen* or epipen*)).tw,kf.	73
4	(manage* adj2 anaphyla*).tw,kf.	502
5	1 or 2 or 3 or 4	1329
6	Patient Education as Topic/	87507
7	Self Administration/	11868
8	Self-Management/	3770
9	(layperson* or lay-person* or laypeople* or lay-people* or nonprofessional* or non-professional*).tw,kf.	7652
10	(parent or parents or parental or communit* or teacher* or caregiver* or care-giver* or personnel* or school* or child care worker* or childcare worker* or aide*).tw,kf.	1435985
11	(patient* adj4 (educat* or train* or manage* or instruct* or confiden* or complian* or adheren*)).tw,kf.	324822
12	self-manage*.tw,kf.	23610

**Database searched:** PubMed

**Time Frame: (existing PICOST) – 1/1/2019 – December 2021**

**Date Search Completed:** A simple search of PubMed was conducted on June 4<sup>th</sup>, July 22<sup>nd</sup> and September 2<sup>nd</sup>, 2021. The formal search with revised search strategy was completed October 21 and was re-searched in December 2021.

**Search Results:** 103 articles returned; Title and abstract screening by MN and ES with 9 studies included. Additional studies identified by hand search: 3; total of 12 studies included for evidence update.

### **Summary of Evidence Update:**

The ability of a lay person to recognize anaphylaxis has been looked at indirectly in a few studies that assessed hesitation or non-use of epinephrine auto injectors (EAI) by self-administration, and by family members and paramedics in patients with a prior history of anaphylaxis and who subsequently required ED care for anaphylaxis. Reasons reported for the significantly lower rate of EAI use by patients, family and paramedics in confirmed anaphylaxis patients (ED) included failure to carry a prescribed EAI, lack of a prescription for an EAI, lack of 'comfort' with how to use an EAI, fear of using the injection (pain, possible harm), as well as a lack of recognition of anaphylaxis or underestimating the severity of an allergic reaction. These studies confirm the 2010 CoSTR and scoping review findings that first aid providers as well as pre-hospital personnel have difficulty with recognition of anaphylaxis.

This update also looked for evidence that an educational intervention, such as a class, brochures, an App, or a program including training in EAI use, is associated with improved recognition of anaphylaxis. We identified 5 survey studies reporting on knowledge of signs and symptoms of anaphylaxis immediately following educational classes or interventions, with increased self-reported confidence in both recognition and

management of anaphylaxis. No studies assessed these outcomes beyond the immediate post-course period, and this remains a research gap.

Other research gaps identified:

- No studies looked at the community level for a change in the actual rate of EAI use for anaphylaxis pre- and post- educational programs to help improve recognition of anaphylaxis.
- No studies reported on clinical outcomes in populations who have undergone courses, classes, training sessions or other educational interventions to improve the ability to recognize and manage anaphylaxis in the first aid setting.

### 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
Miles LM, Ratnarajah K, Gabrielli S, Abrams EM, Protudjer JLP, Bégin P, Chan ES, Upton J, Wasserman S, Watson W, Gerdtts J, Ben-Shoshan M. J Allergy Clin  Year of Publication 2021	Systematic review focusing on 4 domains: (1) epinephrine use in the pre-hospital setting; (2) barriers to epinephrine use in the pre-hospital setting; (3) cost evaluation and cost-effectiveness of epinephrine use; and (4) programs and strategies to improve epinephrine use during anaphylaxis.	Community use of EAI in children and adults	Epinephrine use in the pre-hospital setting was significantly higher for children compared with adults (20.98% [95% confidence interval (CI): 16.38%, 26.46%] vs 7.17% [95% CI: 2.71%, 17.63%], respectively, $P = .0027$ ). The pooled estimate of biphasic reactions among all anaphylaxis cases was 3.92% (95% CI: 2.88%, 5.32%). Our main findings indicate that pre-hospital use of epinephrine in anaphylaxis remains suboptimal. Major barriers to the use of epinephrine were identified as low prescription rates of	The main findings of our study demonstrated that across the globe, prompt epinephrine use in cases of anaphylaxis remains suboptimal. For practical recommendations, we would suggest considering stock epinephrine in schools and food courts to increase the use of epinephrine in the community. We recommend use of pamphlets in public areas (ie, malls, food courts, etc.) to assist in recognizing anaphylaxis and after that with	N/A

			epinephrine auto-injectors and lack of stock epinephrine in schools, which was determined to be cost-effective. Finally, in reviewing programs and strategies, numerous studies have engineered effective methods to promote adequate and timely use of epinephrine.	prompt epinephrine administration, to avoid the rare risk of fatality in anaphylaxis cases.	
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**RCT:**

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

<b>Study Acronym; Author; Year Published</b>	<b>Study Type/Design; Study Size (N)</b>	<b>Patient Population</b>	<b>Primary Endpoint and Results (include P value; OR or RR; &amp; 95% CI)</b>	<b>Summary/Conclusion Comment(s)</b>
<b>The Canadian anaphylaxis action plan for kids: development and validation.</b>  Alqurashi W, Awadia A, Pouliot A, Cloutier M, Hotte S, Segal L,	Observational / 230 participants	Pediatric population <17 years of age	Of the 230 participants enrolled, 205 (89%) completed the follow-up interview. The written contents of the Kid's CAP were modified to match grade 7 readability level. The total mean score of the Consumer Information Rating Form for comprehensibility was 23.1 (SD 2.4), and	Engaging children and parents in the design and contents of written anaphylaxis action plan is an innovative approach to produce a useful document for the end-users.

Barrowman N, Irwin D, Vaillancourt R  Year of Publication 2020			25.1 (SD 2.3) for design quality. The mean comprehension score was 11.3 (SD 1.8) (reference range 0-12), with no significant difference between participants with and without previous experience with anaphylaxis, or high vs. low literacy level.	
<b>Anaphylaxis at school. Are we prepared? Could we improve?</b>  Rodriguez Ferran L, Gomez Tornero N, Cortes Alvarez N, Thorndike Piedra F  Year of Publication 2020	Observational; Pre and post questionnaire assessment / 53 participants	Three schools were enrolled (with a total of 38 children with food allergy) and 53 participants (85% teachers, 15% canteen staff) were trained.	In the pre-training surveys, 83% said they had a student's allergic reaction management plan, 56% had met with parents, 83% recognized some symptoms of allergic reaction but only 41% recognized anaphylaxis, 16% knew when to use adrenaline, 15% knew how to use it and 19% knew how to act after administration. In the post-training questionnaires, 100% were satisfied and believed they had improved their knowledge, 93% recognized anaphylaxis and 95% the treatment of choice.	Prior to the intervention their knowledge was insufficient, but it improved considerably after simple training. It also increased the confidence of the staff, which will be decisive when responding to an anaphylactic reaction. We believe that a compulsory training program should be implemented universally in all schools.
<b>Factors contributing to underuse of epinephrine auto-injectors in pediatric patients with food allergy.</b>	Observational; Survey assessment / 200 participants	Pediatric patients with food allergies	A total of 164 surveys were completed; of which 118 (72%) of lifetime most severe reactions warranted EA use, but the EA was used in only 45 (38.1%). Reasons caregivers indicated for not administering the EA	Multiple factors contribute to underuse of EA in the treatment of severe allergic reactions. Results from this study highlight the need for continuous EA education in caregivers of and pediatric patients with food allergies,

Glassberg B, Nowak-Wegrzyn A, Wang J  Year of Publication 2021			included the following: reactions did not seem severe enough; it was the patient's first allergic reaction; use of other medication; and fear of using EA.	using a multipronged approach targeting clear symptom recognition and alleviation of fear of EA use.
<b>Multidisciplinary education improves school personnel's self- efficacy in managing food allergy and anaphylaxis.</b>  Polloni L, Baldi I, Lazzarotto F, Bonaguro R, Toniolo A, Gregori D, Muraro  Year of Publication 2020	Observational; School Personnel Self- Efficacy-Food Allergy and Anaphylaxis Questionnaire / 592 participants	School aged children with high risk food allergies	At baseline, school personnel reported low self-efficacy in anaphylaxis management (AM), especially in recognizing anaphylaxis symptoms and administering proper drugs. After the specific multidisciplinary training course, all scores improved. AM scores particularly showed a significant increase. School personnel's post- training self-efficacy was found to be related to initial levels. Some indicative threshold values emerged. Remarkably, participants with a low self-efficacy at baseline seemed to particularly benefit from the training.	Results highlighted the effectiveness of specific multidisciplinary training courses in improving teachers' and school caretakers' self-efficacy in managing food allergy and anaphylaxis. The S.PER.SE-FAAQ is confirmed to be an easy and helpful tool to assess the level of food allergy and anaphylaxis management in the school staff and training effectiveness.
<b>Analysis of the effectiveness of training school personnel in the management of food allergy and anaphylaxis.</b>  Gonzalez- Mancebo E, Gandolfo-Cano MM, Trujillo- Trujillo MJ,	Observational; Questionnaire with eight questions before and after a course to assess their self- efficacy in management of food allergy and anaphylaxis. / 191 participants	School aged children	A total of 191 people participated (51% dining- room monitors, 24% teachers, 13% cooks, and 12% other professions). The areas in which the attendees presented the lowest confidence before receiving the course were recognition of symptoms and treatment of the reactions/anaphylaxis.	Our study demonstrates the usefulness of a self- efficacy scale in school personnel as a tool to assess the ability to manage food allergy and anaphylaxis. It can help to identify problem areas in which more specific training programs can be implemented.

<p>Mohedano-Vicente E, Calso A, Juarez R, Melendez A, Morales P, Pajuelo F</p> <p>Year of Publication 2019</p>			<p>The mean score for each of the eight concepts evaluated improved after the training course. This improvement was significant in the management of anaphylaxis.</p>	
<p><b>Life-Threatening Allergies: Using a Patient-Engaged Approach.</b></p> <p>Gallagher JL, Rivera RD, Van Shepard K, Roushan T, Ahsan G, Ahamed SI, Chiu A, Jurken M, Simpson PM, Nugent M, Gobin KS, Wen CKF, Eldredge CE</p> <p>Year of Publication 2019</p>	<p>Observational; Smartphone based teaching tool / 22 participants</p>	<p>Adolescents at risk for anaphylaxis</p>	<p>Twenty-two adolescents were recruited. The median (range) baseline number of correct answers on the scenarios before the intervention was 9 (3-11). All subjects improved with decision support, increasing to 11 (9-12) (<math>p &lt; .001</math>). The median (range) demonstration score was 6 (5-6) for the video training module group and 4.5 (3-6) for the label group (<math>p &lt; 0.001</math>).</p>	<p>The results suggest that mobile health decision support technology for anaphylaxis emergency preparedness may support traditional methods of training by providing improved access to anaphylaxis training in the community setting.</p>
<p><b>Role of Food Allergy Education: Measuring Teacher Knowledge, Attitudes, and Beliefs.</b></p> <p>Canon N, Gharfeh M, Guffey D, Anvari S, Davis CM</p>	<p>Observational; Pre- and post-educational session survey / 375 participants</p>	<p>School aged children who were of similar age, socioeconomic status, ethnicity, and educational level.</p>	<p>Post-test, the intervention group had knowledge scores 19.58% points higher than control (95% confidence interval = 16.62-22.53; <math>P &lt; .001</math>) with no differences pretest. Odds of agreeing that injectable epinephrine is important was higher in the intervention schools post-education. Within the intervention group,</p>	<p>A 1-hour educational session improved knowledge and attitudes in personnel in the intervention schools. Given the growing prevalence of food allergy, the emphasis on food allergy education is crucial to allow for familiarization of the condition, early recognition of</p>

Year of Publication 2019			personnel were more likely to agree to injectable epinephrine use for children post-education.	anaphylaxis, and promotion of injectable epinephrine use.
<b>Patient/parent administered epinephrine in acute anaphylaxis.</b>  Murata MA, Yamamoto LG  Year of Publication 2020	Observational; Case series with review of physician notes and demographic factors of medical records / 217 records assessed	Patients-either with an ED diagnosis of peanut anaphylaxis or diagnosis of anaphylaxis with a known epinephrine prescription	Epinephrine was administered on-scene by 25.3% of anaphylaxis patients. Of the 6 health care professionals identified, 100% administered epinephrine on-scene. Females (32.2%) were administered epinephrine on-scene more frequently than males (19.8%; $p = 0.04$ ). Rate of epinephrine administration increased from 2010 through 2019 ( $p = 0.005$ ).	This study selected for individuals diagnosed with anaphylaxis, meaning EAI use should have been observed nearly 100% of the time. An administration rate of 22.6% observed among individuals not identified as health care professionals suggests that the majority of patients prescribed epinephrine have not used their EAI, even when presented an opportunity for application. The administration rate of 100% observed among health care professionals indicates that comfort with EAI facilitates willingness to administer on-scene.

### Reviewer Comments:

Epinephrine is a potentially life-saving intervention for anaphylaxis. The ability of a first aid provider to recognize anaphylaxis is a critical step prior to administering epinephrine. The studies identified in this evidence update are encouraging, with several surveys reporting improved ability to recognize anaphylaxis immediately following individual or community level educational engagements, however additional studies are needed to show persistent improvements beyond the immediate post-course period. In addition, studies are needed to demonstrate clinical outcomes that may be associated with improved recognition of anaphylaxis by first aid providers.

The First Aid Task Force acknowledges that the current PICOST, as worded (the description of any specific symptoms to the first aid provider, compared with the absence of any specific description), may not be capturing all the available evidence related to the education of recognition. As such the task force suggests that this PICOST be revised and considered for a future review with participation from other task forces. Until



such time that an updated PICOST is generated and reviewed, the previous treatment recommendation continues to be supported with the limited evidence identified with this update:

First aid providers should not be expected to recognize the signs and symptoms of anaphylaxis without repeated episodes of training and encounters with victims of anaphylaxis.

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**\*\*CONFIDENTIAL DO NOT DISTRIBUTE\*\*****2022 Evidence Update Worksheet**

**Worksheet author(s):** David C. Berry, Matthew Douma, Craig Goolsby

**Task Force:** First Aid

**Date Submitted:** October 27, 2021; Final submitted December 14, 2021

**Worksheet ID:** FA525, Management of Open Chest Wounds

**PICO / Research Question (FA 525):** Adults in the out-of-hospital setting with an open chest wound (P) does use of an occlusive strategy (dressing or device) (I) compared with a nonocclusive strategy (dressing or device) or no dressing (C) improve outcomes (O)?

**Outcomes:** Survival (yes/no) (critical), cardiopulmonary arrest (yes/no) (critical), hypoxia or hypoxemia (SpO<sub>2</sub>%) (critical), tension pneumothorax (yes/no) (critical), need for invasive airway management and mechanical ventilation (yes/no) (important), and adverse event (TBD) (important)

**Type (intervention, diagnosis, prognosis):** Intervention

**Additional Evidence Reviewer(s):** NA

**Conflicts of Interest (financial/intellectual, specific to this question):** None

**Year of last full review:** New/most recent CoSTR, 2015

**Last ILCOR Consensus on Science and Treatment Recommendation:** 2015

### **Open Chest Wounds (FA 525) 2015 CoSTR:**

#### ***Introduction***

Management of an open chest wound in out-of-hospital settings is challenging and requires immediate activation of EMS. The greatest concern is the improper use of a dressing or device that could lead to fatal tension pneumothorax.

#### ***Consensus on Science***

For the critical outcome of respiratory arrest, we identified very-low-quality evidence (downgraded for risk of bias, indirectness, and imprecision) from 1 animal study<sup>130</sup> showing benefit from using a nonocclusive device (RR, 0.059; 95% CI, 0.004–0.874). For the critical outcome of oxygen saturation, we identified very-low-quality evidence (downgraded for risk of bias, indirectness, and imprecision) from 1 animal study<sup>130</sup> showing benefit from using a nonocclusive device.

For the important outcome of therapeutic endpoint (tidal volume), we identified very-low-quality evidence (downgraded for risk of bias, indirectness, and imprecision) from 1 animal study<sup>130</sup> showing benefit from using a nonocclusive device in tidal volume (mL) (MD, 34.7; 95% CI, 28.8–40.6 mL).

For the important outcome of vital signs, we identified very-low-quality evidence (downgraded for risk of bias, indirectness, and imprecision) from the same animal study<sup>130</sup> showing benefit from using a nonocclusive device in HR (BPM) (MD, -32.0; 95% CI, -42.8 to 21.2) and respiratory rate (respirations per minute) (MD, 3.0; 95% CI, 1.5–4.5).

Finally, for the important outcome of vital signs, we also identified very-low-quality evidence (downgraded for risk of bias, indirectness, and imprecision) from the same animal study<sup>130</sup> showing no significant benefit from using a nonocclusive device in MAP (mm Hg) (MD, 4.6; 95% CI, -0.4 to 9.6).

We did not identify any evidence to address the critical outcome of survival. We did not identify any evidence to address the important outcome of rate of cardiac and respiratory arrests.

### ***Treatment Recommendations***

We suggest against the application of an occlusive dressing or device by first aid providers to individuals with an open chest wound (weak recommendation, very-low-quality evidence).

### ***Values, Preferences, and Task Force Insights***

In making this recommendation, we place higher value on the avoidance of the potential life-threatening complication of tension pneumothorax, compared with other risks associated with an open chest wound. Public comments expressed concern about making a recommendation based solely on a single animal study. The task force took into consideration the potential life-threatening complication of an unrecognized tension pneumothorax associated with the use of an occlusive dressing or device in the first aid setting. In addition, the review recognized the long-standing accepted clinical practice of treating a tension pneumothorax by creating and maintaining an open communication between the pneumothorax and ambient air. Furthermore, while this will require a change for some in current teaching, there was recognition of the practicality and acceptance in the first aid setting of leaving an open chest wound exposed to ambient air without a dressing or seal. The task force discussed the reality that many dressings, both initially and over time, may themselves produce inadvertent partial or full occlusion and that this needs to be recognized as a serious potential complication.

**2010/2015/2019 (utilized 2014 for 2021 EvUP) Search Strategy:** Last search update 04.17.2014

PubMed: ( Search Completed: May 05, 2014 ) April 17 2014

PubMed

158 results

((((((("Open Chest Wound"[TIAB] or "Open Chest Wounds"[TIAB] or "sucking chest wound"[TIAB] or "sucking chest wounds"[TIAB] OR "tension pneumothorax"[TIAB] or "tension pneumothoraces"[TIAB] or hemothorax[TIAB] or haemothorax[TIAB] or Hemopneumothorax[TIAB] or haemopneumothorax[TIAB] or "open pneumothorax"[TIAB] or "chest stab wound"[TIAB] or "chest stab wounds"[TIAB] or "penetrating chest trauma"[TIAB] OR "Hemothorax"[Mesh] OR "penetrating chest wound"[TIAB] OR "penetrating chest wounds"[TIAB])))) OR (((("Wounds and Injuries"[Mesh:NoExp] OR "Wounds, Gunshot"[Mesh] OR "Wounds, Stab"[Mesh] OR "Wounds, Penetrating"[Mesh:NoExp] OR "Fractures, Open"[Mesh] OR "Lacerations"[Mesh] OR "Multiple Trauma"[Mesh] OR "Rupture"[Mesh]) AND ("Thorax"[Mesh] OR chest[TIAB] OR "Pneumothorax"[Mesh])))) AND (((tulle[TIAB] OR bandages[TIAB] OR bandage[TIAB] OR film[TIAB] OR foam[TIAB] OR "plastic wrap"[TIAB] OR "cling film"[TIAB] OR clingfilm[TIAB] OR wrap[TIAB] OR wraps[TIAB] OR ointments[TIAB] OR ointment[TIAB] OR creams[TIAB] OR cream[TIAB] OR wax[TIAB] OR paraffin[TIAB] OR Petroleum[TIAB] OR petrolatum[TIAB] OR gauzes[TIAB] OR gauze[TIAB] OR hydrocolloid[TIAB] OR hydrogels[TIAB] OR hydrogel[TIAB] OR dressings[TIAB] OR dressing[TIAB] OR "Bandages"[Mesh] OR "heimlich chest device"[TIAB] or "flapper valve"[TIAB] or "flap-valve"[TIAB] or "chest wall valve"[TIAB] or "chest seal"[TIAB] OR "Wound Closure Techniques"[Mesh:NoExp]

OR "Negative-Pressure Wound Therapy"[Mesh] OR "Wound Healing"[Mesh]) NOT (("letter"[pt] OR "comment"[pt] OR "editorial"[pt] OR Case Reports[ptyp]))

Embase: ( Search Completed: May 05, 2014 ) April 17 2014

Embase

328 results

(estimated number of results after removal of duplicates = 126)

'wound'/exp OR 'open fracture'/exp OR 'laceration'/exp OR 'rupture'/de AND ('thorax'/exp OR 'thorax injury'/exp OR chest:ab,ti OR 'pneumothorax'/exp) OR 'open chest wound':ab,ti OR 'open chest wounds':ab,ti OR 'sucking chest wound':ab,ti OR 'sucking chest wounds':ab,ti OR 'tension pneumothorax':ab,ti OR 'tension pneumothoraces':ab,ti OR hemothorax:ab,ti OR haemothorax:ab,ti OR hemopneumothorax:ab,ti OR haemopneumothorax:ab,ti OR 'open pneumothorax':ab,ti OR 'chest stab wound':ab,ti OR 'chest stab wounds':ab,ti OR 'penetrating chest trauma':ab,ti OR 'hematothorax'/exp OR 'hematopneumothorax'/exp OR 'tension pneumothorax'/exp OR 'penetrating chest wound':ab,ti OR 'penetrating chest wounds':ab,ti OR 'thorax organ rupture'/exp OR 'thorax penetrating trauma'/exp AND (tulle:ab,ti OR bandages:ab,ti OR bandage:ab,ti OR film:ab,ti OR foam:ab,ti OR 'plastic wrap':ab,ti OR 'cling film':ab,ti OR clingfilm:ab,ti OR wrap:ab,ti OR wraps:ab,ti OR ointments:ab,ti OR ointment:ab,ti OR creams:ab,ti OR cream:ab,ti OR wax:ab,ti OR paraffin:ab,ti OR petroleum:ab,ti OR petrolatum:ab,ti OR gauzes:ab,ti OR gauze:ab,ti OR hydrocolloid:ab,ti OR hydrogels:ab,ti OR hydrogel:ab,ti OR dressings:ab,ti OR dressing:ab,ti OR 'bandages and dressings'/exp OR 'heimlich chest device':ab,ti OR 'flapper valve':ab,ti OR 'flap-valve':ab,ti OR 'chest wall valve':ab,ti OR 'chest seal':ab,ti OR 'wound closure'/exp OR 'wound healing promoting agent'/exp) NOT ([editorial]/lim OR [letter]/lim OR 'case report'/de) AND [embase]/lim

Cochrane: ( Search Completed: May 05, 2014 ) April 17 2014

Cochrane

7 results

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## Databases searched (2021):

### 1. Pubmed.gov

(((((("Open Chest Wound"[TIAB] or "Open Chest Wounds"[TIAB] or "sucking chest wound"[TIAB] or "sucking chest wounds"[TIAB] OR "tension pneumothorax"[TIAB] or "tension pneumothoraces"[TIAB] or hemothorax[TIAB] or haemothorax[TIAB] or Hemopneumothorax[TIAB] or haemopneumothorax[TIAB] or "open pneumothorax"[TIAB] or "chest stab wound"[TIAB] or "chest stab wounds"[TIAB] or "penetrating chest trauma"[TIAB] OR "Hemothorax"[Mesh] OR "penetrating chest wound"[TIAB] OR "penetrating chest wounds"[TIAB])) OR (((("Wounds and Injuries"[Mesh:NoExp] OR "Wounds, Gunshot"[Mesh] OR "Wounds, Stab"[Mesh] OR "Wounds, Penetrating"[Mesh:NoExp] OR "Fractures, Open"[Mesh] OR "Lacerations"[Mesh] OR "Multiple Trauma"[Mesh] OR "Rupture"[Mesh]) AND ("Thorax"[Mesh] OR chest[TIAB] OR "Pneumothorax"[Mesh])))) AND (((tulle[TIAB] OR bandages[TIAB] OR bandage[TIAB] OR film[TIAB] OR foam[TIAB] OR "plastic wrap"[TIAB] OR "cling film"[TIAB] OR clingfilm[TIAB] OR wrap[TIAB] OR wraps[TIAB] OR ointments[TIAB] OR ointment[TIAB] OR creams[TIAB] OR cream[TIAB] OR wax[TIAB] OR paraffin[TIAB] OR Petroleum[TIAB] OR petrolatum[TIAB] OR gauzes[TIAB] OR gauze[TIAB] OR hydrocolloid[TIAB] OR hydrogels[TIAB] OR hydrogel[TIAB] OR dressings[TIAB] OR dressing[TIAB] OR "Bandages"[Mesh] OR "heimlich chest device"[TIAB] or "flapper valve"[TIAB] or "flap-valve"[TIAB] or "chest wall valve"[TIAB] or "chest seal"[TIAB] OR "Wound Closure Techniques"[Mesh:NoExp] OR "Negative-Pressure Wound Therapy"[Mesh] OR "Wound Healing"[Mesh])))) NOT (("letter"[pt] OR "comment"[pt] OR "editorial"[pt] OR Case Reports[ptyp]))

### 2. Cochrane Central Register of Controlled Trials

("Open Chest Wound"ti, ab or "Open Chest Wounds"ti, ab or "sucking chest wound"ti, ab or "sucking chest wounds"ti, ab or "tension pneumothorax"ti, ab or "tension pneumothoraces"ti, ab or "hemothorax"ti, ab or "haemothorax"ti, ab or "Hemopneumothorax"ti, ab or "haemopneumothorax"ti, ab or "open pneumothorax"ti, ab or "chest stab wound"ti, ab or "chest stab wounds"ti, ab or "penetrating chest trauma"ti, ab or [mh Hemothorax] or "penetrating chest wound"ti, ab or "penetrating chest wounds"ti, ab or ([mh "Wounds and Injuries"] or [mh "Wounds, Gunshot"] or [mh "Wounds, Stab"] or [mh "Wounds, Penetrating"] or [mh "Fractures, Open"] or [mh Lacerations] or [mh "Multiple Trauma"] or [mh Rupture]) and ([mh Thorax] or chestti, ab or [mh Pneumothorax])) and ("tulle"ti, ab or "bandages"ti, ab or "bandage"ti, ab or "film"ti, ab or "foam"ti, ab or "plastic wrap"ti, ab or "cling film"ti, ab or "clingfilm"ti, ab or "wrap"ti, ab or "wraps"ti, ab or "ointments"ti, ab or "ointment"ti, ab or "creams"ti, ab or "cream"ti, ab or "wax"ti, ab or "paraffin"ti, ab or "Petroleum"ti, ab or "petrolatum"ti, ab or "gauzes"ti, ab or "gauze"ti, ab or "hydrocolloid"ti, ab or "hydrogels"ti, ab or "hydrogel"ti, ab or "dressings"ti, ab or "dressing"ti, ab or [mh Bandages] or "heimlich chest device"ti, ab or "flapper valve"ti, ab or "flap-valve"ti, ab or "chest wall valve"ti, ab or "chest seal"ti, ab or [mh "Wound Closure Techniques"] or [mh "Negative-Pressure Wound Therapy"] or [mh "Wound Healing"])

### 3. Embase

'wound'/exp OR 'open fracture'/exp OR 'laceration'/exp OR 'rupture'/de AND ('thorax'/exp OR 'thorax injury'/exp OR chest:ab,ti OR 'pneumothorax'/exp) OR 'open chest wound':ab,ti OR 'open chest wounds':ab,ti OR 'sucking chest wound':ab,ti OR 'sucking chest wounds':ab,ti OR 'tension pneumothorax':ab,ti OR 'tension pneumothoraces':ab,ti OR hemothorax:ab,ti OR haemothorax:ab,ti OR hemopneumothorax:ab,ti OR haemopneumothorax:ab,ti OR 'open pneumothorax':ab,ti OR 'chest stab wound':ab,ti OR 'chest stab wounds':ab,ti OR 'penetrating chest trauma':ab,ti OR 'hematothorax'/exp OR 'hematopneumothorax'/exp OR 'tension pneumothorax'/exp OR 'penetrating chest wound':ab,ti OR 'penetrating chest wounds':ab,ti OR 'thorax organ rupture'/exp OR 'thorax penetrating trauma'/exp AND (tulle:ab,ti OR bandages:ab,ti OR bandage:ab,ti OR film:ab,ti OR foam:ab,ti OR 'plastic wrap':ab,ti OR 'cling film':ab,ti OR clingfilm:ab,ti OR wrap:ab,ti OR wraps:ab,ti OR ointments:ab,ti OR ointment:ab,ti OR creams:ab,ti OR cream:ab,ti OR wax:ab,ti OR paraffin:ab,ti OR petroleum:ab,ti OR petrolatum:ab,ti OR gauzes:ab,ti OR gauze:ab,ti OR hydrocolloid:ab,ti OR hydrogels:ab,ti OR hydrogel:ab,ti OR dressings:ab,ti OR dressing:ab,ti OR 'bandages and dressings'/exp OR 'heimlich chest device':ab,ti OR 'flapper valve':ab,ti OR 'flap-valve':ab,ti OR 'chest wall valve':ab,ti OR 'chest seal':ab,ti OR 'wound closure'/exp OR 'wound healing promoting agent'/exp) NOT ([editorial]/lim OR [letter]/lim OR 'case report'/de) AND [embase]/lim

### Date Search Completed (2021):

1. Pubmed.gov, 04.14.2014 to 09.25.2021
2. Cochrane Central Register of Controlled Trials, 07.20.2021
3. Embase 04.14.2014 to 09.25.2021

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

Database	Identified Records (04.14.2014 to 09.25.2021)	Excluded via Duplicate, (Title, Abstract) or [Wrong Year]	Reviewed for Inclusion	Included
Pubmed.gov	38	(33)	3 (Animal) 1 (Gap/Review) 1 (Literature Review)	0
Cochrane Central Register of Controlled Trials	37	(37)	0	0
Embase	181	4, (163), [14]	0	

Total	256	251	256	
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#### 12.14.2021 Update Search

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

Database	Identified Records (09.26.2021 to 12.10.2021)	Excluded via Duplicate, (Title, Abstract) or [Wrong Year]	Reviewed for Inclusion	Included
Pubmed.gov	2	(1)	1	1
Total	2	1	1	1

#### Inclusion/Exclusion Criteria:

	Inclusion	Exclusion
<b>Population</b>	Adults in the out-of-hospital setting who presenting with an open chest wound.	Children.  Adults with closed chest trauma.  Animal and manikin studies.
<b>Intervention</b>	Occlusive dressing or device application.	Dressings or devices restricted to in-hospital use.
<b>Comparison</b>	Any non-occlusive treatment applied to an open chest wound.  No treatment.	Dressings or devices restricted to in-hospital use.
<b>Outcome</b>	1. Survival (yes/no) (critical) 2. Cardiopulmonary arrest (yes/no) (critical) 3. Hypoxia or hypoxemia (SpO2%) (critical) 4. Tension pneumothorax (yes/no) (critical) 5. Need for invasive airway management and mechanical ventilation (yes/no) (important) 6. Adverse event (TBD) (important)	

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

No new **human** records regarding the management of an open chest wound in out-of-hospital settings meeting the inclusion criteria were identified. Five records were reviewed after consultation with worksheet reviewers and TF Chairperson; three animal (swine) models (Arnaud 2016 2097, Kheirabadi 2017 182,

Schachner 2021), one gap/guideline recommendation paper (Hoggarth 2020 159), and one literature review (Kuhlwilm 2021 94).

Kuhlwilm (2021 94) conducted a literature search (paper is not registered as a systematic review) of studies reporting the efficacy of various chest seals for treating sucking chest wounds and the prevention of a tension pneumothorax. Included were four studies testing chest seals in a swine model of hemopneumothorax. Five studies testing the efficacy of various chest seals in treating sucking chest wounds were identified (5 out of 40 assessed papers). Vented and unvented chest seals stabilized cardiorespiratory parameters after an open pneumothorax, but only vented chest seals showed more success at preventing a tension pneumothorax. Chest seals with flutter valves seemed to be inferior. An additional study showed that vertical movements and soiled skin were more stressful on the applied chest seals. Concluded that vented chest seals seem superior to unvented chest seals, and most international guidelines have updated their recommendations for the use of vented chest seals. However, frequent physical examinations for early signs of a developing or worsening tension pneumothorax are the best medical care.

### **Summary of Evidence Update:**

No new human evidence regarding the application of occlusive strategy (dressing or device) by the first aid provider was identified. The 2015 review resulted in a recommendation (weak, very-low-quality evidence) against the application of an occlusive strategy by first aid providers to individuals with an open chest wound. Three articles identified in this EvUp were porcine models, addressing the following: (1) non-occlusive vented chest seal adhesiveness on the skin (Arnaud 2016 2097), (2) nonocclusive chest seals (5 FDA approved) to seal a bleeding chest wounds and to prevent tension hemopneumothorax (Kheirabadi 2017 182), and (3) the use of makeshift and commercial seals applied to sucking chest wounds (Schachner 2021 1). Two papers (porcine models and expert opinion) believed vented chest seals appeared superior to unvented chest seals to manage open or sucking chest wounds (Hoggarth 2020 159) and to prevent a tension pneumothorax Kuhlwilm (2021 94). Kuhlwilm (2021 94) does note the use of chest seal requires frequent physical examinations for early signs of a developing or worsening tension pneumothorax is necessary; however, this requires skills beyond a first aid provider.

### **12.14.2021 - Summary of Evidence Update:**

Paquette et al (2021 78) conducted a systematic review (and gray literature search) examining the efficacy of commercial chest seal adherence and tension pneumothorax prevention in human and animal models. Of the six studies two (Kheirabadi 2017 182; Arnaud 2016 2097) were identified above. The remaining four studies were published prior to 2014 with one animal model (Kheirabadi 2013 150) reported in the 2015 CoSTR (Singletary 2015). According to Paquette et al (2021 80) four studies tested adherence as a primary outcome with the FastBreathe Thoracic Seal (Fast Track Medical Solutions LLC, [www.fasttrackmedicalsolutions.com](http://www.fasttrackmedicalsolutions.com), Hyfin Vent Chest Seal (North American Rescue, [www.narescue.com](http://www.narescue.com)), and SAM Chest With Valve Seal (SAM Medical, [www.sammedical.com](http://www.sammedical.com)) having equally superior performance. Paquette et al (2021 80) also reported three studies tested the device's ability to avoid predefined tension pneumothorax-related parameters as a primary outcome with the Asherman Chest Seal (Teleflex Medical, [www.teleflex.com](http://www.teleflex.com)), Russell Chest Seal (Prometheus Medical Ltd., [www.prometheusmedical.co.uk](http://www.prometheusmedical.co.uk)), and Sentinel Chest Seal (Prometheus Medical Ltd, [www.prometheusmedical.co.uk](http://www.prometheusmedical.co.uk)) having equally superior performance.

### **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
Hoggarth 2020 159*	Guideline			It is, therefore, critical during the design and development process of such products to introduce design features that help support this objective and do not introduce further risks. The development of this new design for a vented chest seal has been tested for adhesion technology and venting properties and shown to have performance criteria suitable for the treatment of open pneumothorax and design features that have the potential to minimize risk of product failure during use.	The Tactical Combat Casualty Care (TCCC) advises that vented chest seal dressings are used to manage open or sucking chest wounds (Hoggarth 2020 159). Two key areas of risk in the application of vented chest seal dressings are adhesion failure and vent failure.

\*The guideline is: **TCCC Guidelines for Medical Personnel**. 1 August 2019.

[https://its.amedd.army.mil/assets/docs/cpgs/Tactical\\_Combat\\_Casualty\\_Care\\_Guidelines\\_01\\_Aug\\_2019.pdf](https://its.amedd.army.mil/assets/docs/cpgs/Tactical_Combat_Casualty_Care_Guidelines_01_Aug_2019.pdf) The article cited here is a product technology article,

## 12.14.2021 - 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
Paquette et al 2021	Systematic review	1) Which chest seals have superior adherence to skin as compared to other commercially available chest seals?  2) Which chest seals have a superior ability to prevent tension pneumothoraces, as compared to	<b>Study Model</b> Human = 1 Porcine = 5  <b>Publication Year</b> Unpublished study = 1 2007-2010 = 1 2011-2014 = 2 2015-2018 = 2  <b>Study Purpose</b> Adherence = 2 Vent/valve efficacy = 1	No statistically significant differences between the chest seal's total score as determined by a one-way ANOVA [ $F(5,26) = 1.288$ , $p = 0.299$ ] with $\alpha = 0.05$ due to a limited data set.  One human study (Supinski 2012) was an unpublished	Ordinal ranking analysis of the total scores suggests a consensus recommendation for the Hyfin Vent Chest Seal and the Russell Chest Seal as being the most effective chest seals previously investigated in predominately animal models.

		other commercially available chest seals?	Overall effectiveness = 1 Independence investigation of adherence & vent/vale efficacy in same study = 1	doctoral dissertation cited in a TCCC guideline.  Supinski DP, Nesbitt ME, Gerhardt RT. (2012) Chest seal adherence on human test subjects: a prospective study [Unpublished doctoral dissertation]. Baylor University. (Personal Communication from Paul Allen DSc), as cited in Butler FK, Dubose JJ, Otten EJ, et al. Management of open pneumothorax in Tactical Combat Casualty Care: TCCC guidelines change 13-02. J Spec Oper Med. 2013;13(3):81–86.	
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## 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>	
Arnaud et al (2016 2097)	Simple experiment, animal model, n=8; adherence of chest seal in extreme hot and cold temperatures	Yorkshire swine, 33kg mean, anesthetized, mechanically ventilated	No significant difference was found in skin adherence of the five vented chest seals at ambient temperature and four seals (Russell, Fast breathe, Hyfin and SAM) maintained superior adherence even after exposure to extreme temperatures	Five vented FDA cleared (or near clearance at the time of testing) chest seals were selected and assessed after storage at extreme temperatures for their adherence on swine skin using horizontal peeling and vertical pulling methods. Four of the five vented chest seals (Russell, Fast breathe, Hyfin and SAM) with different valve/vent types adhered well and sustained adhesive function after exposure to extreme environmental conditions without significant differences in adherence, thus assuring the best integrity of the product. These results suggest that other qualitative non-adhesive characteristics should be considered for a more specific down-selection of chest seals.  A follow-up future functional evaluation of these chest seals based on their vent function in preventing tension physiology is warranted.
Kheirabadi et al (2017 182)	Simple experiment, animal model, n=26, adhesion and vent function	Yorkshire swine, 43kg mean	Sealing the wounds with the chest seals restored improved breathing and oxygenation. Chest seals with one-way valves did not evacuate blood efficiently; pooled blood either detached the seals from skin and leaked out, or clotted and clogged the valve and led to tension pneumothorax Conversely, seals with laminar venting channels allowed escape of blood and air from the pleural cavity and maintained intrapleural pressure and oxygenation near normal levels.	Chest seal success rates were 100% for Sentinel and Russell (6/6); 67% for HyFin (4/6); 25% for SAM (1/4); and 0% for Bolin (0/4) CSs (p = 0.002). The sealant and valve function of vented CS differed widely in the presence of bleeding chest wounds.  A follow-up future evaluation of these chest seals based on their vent and drainage function in preventing tension physiology is warranted.
Hoggarth et al 2020 159	Simple experiment, healthy volunteer in vitro and in vivo seal adhesion and vent function	Adhesion test on steel plate, healthy volunteers, various environmental conditions, vent function over 48hrs	Surface conditions effect seal adhesion. There is a large standard deviation, which may reflect the differences in skin related to age, sex, and natural oils.	The recommended application of a vented chest seal in managing open pneumothorax by the TCCC is intended to provide the casualty with the optimal at-point care and increase the likelihood of survival. It is, therefore, critical during the design and development process of such products to introduce design features that help support this objective and do not introduce further risks. The development of this new design for a vented chest seal has been tested for adhesion technology and venting

			<p>The data indicate that half the vents occluded, allows effective use of the vent system.</p> <p>The data indicates that the vent system continues to operate effectively under equipment and armor, when applied under predicted normal conditions.</p> <p>The ability of the vents to hold negative pressure over 3 seconds and not hold positive pressure was assessed over a 48-hour period at various timepoints; at no point did the dressing function fail.</p>	properties and shown to have performance criteria suitable for the treatment of open pneumothorax and design features that have the potential to minimize risk of product failure during use.
Schachner et al (2021 Preprint)	Simple experiment, porcine chest wall	2 porcine chest walls	<p>Rescue blanket (RB), plastic foil from a gauze package (packaging material, PM) and a commercial chest seal (CS) were applied open pneumothorax model using a porcine chest wall and a vacuum-assisted drainage system was successfully established. RB segments achieved significantly higher rates of successful sealing than did plastic foils from a gauze package when applied to the moistened chest wall and fixed on three sides (5/5 (100%) vs. 0/5 (0%), <math>p=0.002</math>). Loosely fixed rescue blankets efficiently released injected air (10/10, 100%) and consequently sealed the wound in all cases (10/10).</p>	<p>Three different materials regarding their applicability for acute treatment of sucking chest wounds in pre-hospital emergency care, rescue blanket (RB), plastic foil from a gauze package (packaging material, PM) and a commercial chest seal (CS) were applied open pneumothorax model using a porcine chest wall and a vacuum-assisted drainage system was successfully established. Rescue blanket segments sized 70 x 100 mm achieved significantly higher rates of successful sealing than did plastic foils from a gauze package sized 100 x 100 mm when the devices were applied to the moistened chest wall and fixed on three sides (5/5 (100%) vs. 0/5 (0%), <math>p=0.002</math>). Loosely fixed rescue blankets efficiently released injected air (10/10, 100%) and consequently sealed the wound in all cases (10/10).</p>

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

A systematic review is not indicated at this time.

The previous 2015 treatment recommendation remains unchanged, therefore, “we suggest against the application of an occlusive dressing or device by first aid providers to individuals with an open chest wound (weak recommendation, very-low-quality evidence)” (Singletary 2015 S269).

**12.14.2021 Reviewer Comments Update:**

A systematic review is still not indicated at this time.

Based on the results of Paquette et al (2021 78) the previous 2015 treatment recommendation remains unchanged from above.

	<b>Approval Date</b>
<b>Evidence Update coordinator</b>	
<b>ILCOR board</b>	

**\*Once approval has been made by Evidence Update coordinator, worksheet will go to ILCOR Board for acknowledgement.**

## Reference list

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## 2022 Evidence Update Worksheet

**Worksheet author(s):** Aaron Orkin

**Task Force:** First Aid

**Date Submitted:** 15 December 2021

**Worksheet ID:** FA 534 asthma bronchodilators

### PICO / Research Question:

**Population:** Adults and children who are experiencing an asthma exacerbation or suspected asthma exacerbation and who are receiving care from a first aid provider

**Intervention:** Inhaled Bronchodilator administration

**Comparison:** Compared with no bronchodilator administration

### Outcomes

- Time to resolution of symptoms
- Time to resumption of usual activity
- Complications of any kind, including but not limited to transport to hospital, hospitalization, harm to patient
- Measures of disease including but not limited to oxygenation, ventilation, peak flows
- Harm to patient
- Need for advanced medical care

**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:  
2015

### Last ILCOR Consensus on Science and Treatment Recommendation:

#### 2015 Consensus on Science

After application of inclusion and exclusion criteria, the search strategy yielded 8 double-blind RCTs, (Littner 1983, 309; Bentur 1992, 133; Karpel 1997, 348; Politiek 1999, 988; van der Woude 2004, 816; Berger 2006, 1217; Hermansen 2006, 1203; Amirav 2007, 1) 2 observational studies, (Emerman 1990, 512; Weiss 1994, 873) and 1 meta-analysis. (Osmond 1995, 651) It is important to note that all of these trials involved administration of the bronchodilators in a healthcare setting (prehospital EMS setting, emergency department, or in-hospital setting); because none involved administration by first aid providers in a typical first aid setting, all have been downgraded for indirectness. Regarding the critical outcome of time to resolution of symptoms, 2 RCTs were found. Very-low-quality evidence (downgraded for risk of bias, imprecision, and indirectness) from 1 RCT (Bentur 1992, 133) with 28 participants aged 3 months to 2 years showed benefit in reduction of respiratory rate (MD, 5.1; 95% CI, 0.45–9.75), wheezing score (MD, 0.8; 95% CI, 0.36–1.24), accessory muscle score (MD, 0.85; 95% CI, 0.45–1.23), and total clinical score (MD, 2.5; 95% CI, 1.06–3.94) when treatment (albuterol/salbutamol nebulization) was compared with placebo. Low-quality evidence (downgraded for imprecision and indirectness) from another RCT (van der Woude 2004, 816) with 17 participants aged 18 to 41 years showed benefit in reduction of time to subjective improvement in dyspnea in participants treated with fast-acting  $\beta_2$ -adrenergic agonists (formoterol or salbutamol dry-powdered inhaler) compared with placebo dry-powdered inhaler or the slow-acting  $\beta_2$ -agonist (salmeterol dry-powdered inhaler). This

study also demonstrated a reduction in time to return to baseline symptoms in the fast-acting  $\beta_2$ -adrenergic agonist group compared with the placebo or slow-acting  $\beta_2$ -agonist groups (MD indeterminable). Regarding the critical outcome of time to resumption of usual activity, there were no human trials found. Regarding the important outcome of complications, very-low-quality evidence (downgraded for risk of bias, indirectness, and imprecision) from 1 RCT (Bentur 1992, 133) with 28 participants aged 3 months to 2 years failed to demonstrate a significant difference in mean HR between participants treated with nebulized albuterol/salbutamol and those treated with placebo (MD, 7; 95% CI, -9.6 to 23.6). Very-low-quality evidence (downgraded for risk of bias, imprecision, and indirectness) from a second RCT (Littner 1983, 309) comprising 11 participants aged between 9 and 16 years failed to demonstrate a difference in mean HR or mean blood pressure when albuterol/salbutamol metered-dose aerosol was compared with placebo. A total of 4 patients on the albuterol/salbutamol days reported tremors, compared with 6 on the placebo days. All tremors were “fine” in quality. Very-low-quality evidence (downgraded for risk of bias, imprecision, and indirectness) from a third RCT (Karpel 1997, 348) comprising 100 patients with an average age of 33 years failed to demonstrate a significant difference in potassium, SBP or DBP, tremor, headache, nervousness, weakness, palpitations, or dry mouth between the albuterol/salbutamol metered-dose aerosol given once group (T0), compared with every 30 minutes for 4 doses group (T30), compared with every 60 minutes for 2 doses group (T60). There was a statistically significant difference in mean HR change between the T30 compared with T0 groups, where the T30 group’s HR (beats per minute [BPM]) increased and the T0 group’s decreased (MD, 9.2; 95% CI, 3.51–14.93). Very-low-quality evidence (downgraded for risk of bias, imprecision, and indirectness) from an observational study (Emerman 1990, 512) comprising 52 participants with an average age of 33.6 years failed to demonstrate a significant difference in respiratory rate and HR between the treatment group (nebulized isoetharine) and the control group. One participant in the treatment group reported headache and 2 participants in the control group reported headache or nausea (MD undeterminable). Regarding the important outcome of harm to patient, there were no human trials found. Regarding the important outcome of therapeutic endpoints (eg, oxygenation and ventilation), 1 RCT (Littner 1983, 309-316) with very-low-quality evidence (downgraded for bias, imprecision, and indirectness) showed benefit in an improvement in percentage maximal achievable forced expiratory volume over 1 second (FEV1) and forced vital capacity (FVC) at 60 minutes when comparing inhaled albuterol/salbutamol metered-dose aerosol or isoproterenol metered-dose aerosol to placebo and at 360 minutes (MD undeterminable). A second RCT (Berger 2006, 1217) with very-low-quality evidence (downgraded for bias, imprecision, and indirectness) enrolled 134 participants with an average age of 8.3 years, which demonstrated a statistically significant improvement in FEV1 after initial treatment dose (day 0) for levalbuterol/salbutamol and albuterol/salbutamol compared with placebo (33.1%, 29.6% versus 17.8%; P

### **Treatment Recommendation:**

When an individual with asthma is experiencing difficulty breathing, we suggest that trained first aid providers assist the individual with administration of a bronchodilator (weak recommendation, very-low-quality evidence). Values, Preferences, and Task Force Insights: In making this recommendation, we place higher value in an intervention that may reduce mortality in a life-threatening situation over the risk of potential adverse effects. This review found evidence that use of a bronchodilator in asthmatics with acute difficulty breathing is effective for reducing wheezing, dyspnea, and respiratory rate, while improving measures of effectiveness such as FEV1 or PEFR, and with few reported side effects. As with the 2005 review and as noted above, no studies of bronchodilator administration in the first aid setting met the inclusion criteria; therefore, studies were used from the EMS and hospital settings. While these studies support the use of bronchodilators for asthmatics with difficulty in breathing, caution is required in extrapolating our findings to a first aid recommendation. The task force recognizes that first aid providers may be limited in their abilities to administer or assist with bronchodilator therapy due to clinical governance and local regulations. In addition, this recommendation must be appropriately operationalized by first aid organizations with due consideration to the setting and scope of practice in which the first aid is being applied.

### **2010/2015 Search Strategy:**

PubMed: ( Search Completed: February 28, 2014 ) (Bronchodilator\*[TIAB] OR "Bronchodilator Agents"[Mesh] OR beta-agonist\*[TIAB] OR "Adrenergic beta-Agonists"[Mesh] OR "beta-2 agonist"[TIAB] OR "beta-2 agonists"[TIAB]



OR "beta2-agonist"[TIAB] OR "beta2-agonists"[TIAB] OR "Albuterol"[Mesh] OR Albuterol[TIAB] OR salbutamol[TIAB]) AND ("Nebulizers and Vaporizers"[Mesh] OR "Metered Dose Inhalers"[Mesh] OR "Metered Dose Inhalers"[TIAB] OR "Metered Dose Inhaler"[TIAB] OR "Metered-Dose Inhalers"[TIAB] OR "Metered-Dose Inhaler"[TIAB] OR "rescue inhaler"[TIAB] OR reliever\*[TIAB] OR administer\*[TIAB] OR administration[TIAB] OR "Administration, Inhalation"[Mesh] OR nebuliz\*[TIAB] OR nebulis\*[TIAB]) AND ("short acting"[TIAB] OR short-acting[TIAB] OR "fast acting"[TIAB] OR fast-acting[TIAB] OR "rapid acting"[TIAB] OR "rapid-acting"[TIAB] OR rescue[TIAB] OR emergency[TIAB] OR attack\*[TIAB] OR acute[TIAB] OR "immediate care"[TIAB] OR "First aid"[Mesh] OR "first aid"[TIAB] OR "first response"[TIAB] OR "first responder"[TIAB] OR "first responders"[TIAB] OR "first-responder"[TIAB] OR "first-responders"[TIAB] OR bystander\*[TIAB] OR Layperson\*[TIAB] OR "lay people"[TIAB] OR "lay rescuer"[TIAB] OR "lay rescuers"[TIAB] OR witness\*[TIAB] OR "Emergency Treatment"[Mesh:NoExp] OR "Emergency Medical Services"[Mesh:NoExp] OR "emergency medicine"[MeSH Terms] OR "Emergency Medical Technicians"[Mesh] OR paramedic\*[TIAB] OR "EMS"[TIAB] OR "EMT"[TIAB] OR Prehospital[TIAB] OR Pre-hospital[TIAB] OR "out of hospital"[TIAB] OR "out-of-hospital"[TIAB] OR "outside of hospital"[TIAB]) AND (Asthma\*[TIAB] OR "Asthma"[Mesh]) NOT (chronic[TIAB] OR "magnesium sulphate"[TIAB] OR intravenous[TIAB] OR omalizumab[TIAB] OR naloxone[TIAB] OR fluticasone[TIAB]) NOT (animals[mesh] NOT humans[mesh]) NOT ("letter"[Publication Type] OR "comment"[Publication Type] OR "editorial"[Publication Type] OR Case Reports[Publication Type])

1509 results - February 25, 2014

Embase: ( Search Completed: February 28, 2014 ) (Bronchodilator\*:ti,ab OR 'bronchodilating agent'/de OR beta+agonist\*:ti,ab OR 'beta adrenergic receptor stimulating agent'/de OR "beta+2 agonist":ti,ab OR "beta+2 agonists":ti,ab OR "beta2-agonist":ti,ab OR "beta2-agonists":ti,ab OR 'salbutamol'/exp OR Albuterol:ti,ab OR salbutamol:ti,ab) AND ('nebulizer'/exp OR 'metered dose inhaler'/exp OR "Metered Dose Inhalers":ti,ab OR "Metered Dose Inhaler":ti,ab OR "Metered+Dose Inhalers":ti,ab OR "Metered+Dose Inhaler":ti,ab OR "rescue inhaler":ti,ab OR reliever\*:ti,ab OR administer\*:ti,ab OR administration:ti,ab OR 'inhalational drug administration'/exp OR nebuliz\*:ti,ab OR nebulis\*:ti,ab) AND ("short acting":ti,ab OR short+acting:ti,ab OR "fast acting":ti,ab OR fast+acting:ti,ab OR "rapid acting":ti,ab OR "rapid+acting":ti,ab OR rescue:ti,ab OR emergency:ti,ab OR attack\*:ti,ab OR acute:ti,ab OR "immediate care":ti,ab OR 'first aid'/exp OR "first aid":ti,ab OR "first response":ti,ab OR "first responder":ti,ab OR "first responders":ti,ab OR "first+responder":ti,ab OR "first+responders":ti,ab OR bystander\*:ti,ab OR Layperson\*:ti,ab OR "lay people":ti,ab OR "lay rescuer":ti,ab OR "lay rescuers":ti,ab OR 'witness'/exp OR witness\*:ti,ab OR 'emergency treatment'/de OR 'emergency health service'/exp OR 'emergency medicine'/exp OR 'rescue personnel'/exp OR "Emergency Medical Technician":ti,ab OR "Emergency Medical Technicians":ti,ab OR paramedic\*:ti,ab OR "EMS":ti,ab OR "EMT":ti,ab OR Prehospital:ti,ab OR Pre+hospital:ti,ab OR "out of hospital":ti,ab OR "out-of-hospital":ti,ab OR "outside of hospital":ti,ab) AND (Asthma\*:ti,ab OR Asthma) NOT (chronic:ti,ab OR "magnesium sulphate":ti,ab OR 'magnesium sulfate'/exp OR intravenous:ti,ab OR omalizumab:ti,ab OR 'omalizumab'/exp OR naloxone:ti,ab OR 'naloxone'/exp OR fluticasone:ti,ab OR 'fluticasone'/exp) NOT ('animal'/exp NOT 'human'/exp) NOT ([editorial]/lim OR [letter]/lim OR 'case report'/de) AND [embase]/lim

1709 results - February 25, 2014

Cochrane: ( Search Completed: February 28, 2014 ) (Bronchodilator\*:ti,ab OR [mh "Bronchodilator Agents"] OR beta-agonist\*:ti,ab OR [mh "Adrenergic beta-Agonists"] OR "beta-2 agonist":ti,ab OR "beta-2 agonists":ti,ab OR "beta2-agonist":ti,ab OR "beta2-agonists":ti,ab OR [mh "Albuterol"] OR Albuterol:ti,ab OR salbutamol:ti,ab) AND ([mh "Nebulizers and Vaporizers"] OR [mh "Metered Dose Inhalers"] OR "Metered Dose Inhalers":ti,ab OR "Metered Dose Inhaler":ti,ab OR "Metered-Dose Inhalers":ti,ab OR "Metered-Dose Inhaler":ti,ab OR "rescue inhaler":ti,ab OR reliever\*:ti,ab OR administer\*:ti,ab OR administration:ti,ab OR [mh "Administration, Inhalation"] OR nebuliz\*:ti,ab OR nebulis\*:ti,ab) AND ("short acting":ti,ab OR short-acting:ti,ab OR "fast acting":ti,ab OR fast-acting:ti,ab OR "rapid acting":ti,ab OR "rapid-acting":ti,ab OR rescue:ti,ab OR emergency:ti,ab OR attack\*:ti,ab OR acute:ti,ab OR "immediate care":ti,ab OR [mh "First aid"] OR "first aid":ti,ab OR "first response":ti,ab OR "first responder":ti,ab OR "first responders":ti,ab OR "first-responder":ti,ab OR "first-responders":ti,ab OR bystander\*:ti,ab OR Layperson\*:ti,ab OR "lay people":ti,ab OR "lay rescuer":ti,ab OR "lay rescuers":ti,ab OR witness\*:ti,ab OR [mh "Emergency Treatment"] OR [mh ^"Emergency Medical Services"] OR [mh ^"emergency medicine"] OR [mh "Emergency Medical Technicians"] OR paramedic\*:ti,ab OR "EMS":ti,ab OR "EMT":ti,ab OR Prehospital:ti,ab OR Pre-hospital:ti,ab OR "out of hospital":ti,ab OR "out-of-hospital":ti,ab OR "outside of

hospital":ti,ab) AND (Asthma\*:ti,ab OR [mh "Asthma"]) NOT (chronic :ti,ab OR "magnesium sulphate":ti,ab OR intravenous:ti,ab OR omalizumab:ti,ab OR naloxone:ti,ab OR fluticasone:ti,ab) NOT ([mh animals] NOT [mh humans])

868 results - February 25, 2014

## 2020 Search Strategy:

Bronchodilator\*[TIAB] OR "Bronchodilator Agents"[Mesh] OR beta-agonist\*[TIAB] OR "Adrenergic beta-Agonists"[Mesh] OR "beta-2 agonist"[TIAB] OR "beta-2 agonists"[TIAB] OR "beta2-agonist"[TIAB] OR "beta2-agonists"[TIAB] OR "Albuterol"[Mesh] OR Albuterol[TIAB] OR salbutamol[TIAB]) OR "anticholinergics"[TIAB] OR "ipratropium"[TIAB] OR "tiotropium"[TIAB] OR "magnesium sulphate"[TIAB] AND ("Nebulizers and Vaporizers"[Mesh] OR "Metered Dose Inhalers"[Mesh] OR "Metered Dose Inhalers"[TIAB] OR "Metered Dose Inhaler"[TIAB] OR "Metered-Dose Inhalers"[TIAB] OR "Metered-Dose Inhaler"[TIAB] OR "rescue inhaler"[TIAB] OR reliever\*[TIAB] OR administer\*[TIAB] OR administration[TIAB] OR "Administration, Inhalation"[Mesh] OR nebuliz\*[TIAB] OR nebulis\*[TIAB]) AND ("short acting"[TIAB] OR short-acting[TIAB] OR "fast acting"[TIAB] OR fast-acting[TIAB] OR "rapid acting"[TIAB] OR "rapid-acting"[TIAB] OR rescue[TIAB] OR emergency[TIAB] OR attack\*[TIAB] OR acute[TIAB] OR "immediate care"[TIAB] OR "First aid"[Mesh] OR "first aid"[TIAB] OR "first response"[TIAB] OR "first responder"[TIAB] OR "first responders"[TIAB] OR "first-responder"[TIAB] OR "first-responders"[TIAB] OR bystander\*[TIAB] OR Layperson\*[TIAB] OR "lay people"[TIAB] OR "lay rescuer"[TIAB] OR "lay rescuers"[TIAB] OR witness\*[TIAB] OR "Emergency Treatment"[Mesh:NoExp] OR "Emergency Medical Services"[Mesh:NoExp] OR "emergency medicine"[MeSH Terms] OR "Emergency Medical Technicians"[Mesh] OR paramedic\*[TIAB] OR "EMS"[TIAB] OR "EMT"[TIAB] OR Prehospital[TIAB] OR Pre-hospital[TIAB] OR "out of hospital"[TIAB] OR "out-of-hospital"[TIAB] OR "outside of hospital"[TIAB]) AND (Asthma\*[TIAB] OR "Asthma"[Mesh]) NOT (chronic[TIAB] OR "magnesium sulphate"[TIAB] OR intravenous[TIAB] OR omalizumab[TIAB] OR naloxone[TIAB] OR fluticasone[TIAB]) NOT (animals[mesh] NOT humans[mesh]) NOT ("letter"[Publication Type] OR "comment"[Publication Type] OR "editorial"[Publication Type] OR Case Reports[Publication Type])

(highlighted content is revised from 2015)

**Database searched:** Pubmed

**Date Search Completed:** 15 December 2021

**Search Results (Number of articles identified / number identified as relevant):** 385 / 12

## 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) are eligible for inclusion. Unpublished studies (e.g., conference abstracts, trial protocols) are excluded.

**Link to Article Titles and Abstracts (if available on PubMed):** N/A

## Summary of Evidence Update:

382 titles and abstracts screened

18 full-text review including 6 original studies (6 RCT, 5 cohort, 1 case control), 3 systematic reviews/umbrella reviews, 1 guideline, 1 protocol, 1 clinical review

No eligible new studies:

- Population exclusions: not asthma (1 cohort study), asthma maintenance not asthma exacerbations or acute asthma (1 guideline, 1 RCT)
- Intervention/control exclusions: study of nebulizer vs. MDI (2 RCTs), study of SABA+SAAC vs. SABA (1 RCT, 1 cohort), no bronchodilator (2 cohort, 1 case control, 1 review), comparison of SABA vs. LABA or comparison of bronchodilator with and without corticosteroid (1 review, 1 RCT), unmarketed bronchodilator phase IIa study (1 RCT)

- Outcome exclusion: ED length of stay (1 cohort)
- No independent findings (1 clinical review, 1 protocol)

#### Relevant Umbrella Review:

Pollock M, Sinha IP, Hartling L, Rowe BH, Schreiber S, Fernandes RM. Inhaled short-acting bronchodilators for managing emergency childhood asthma: an overview of reviews. *Allergy*. 2017 Feb;72(2):183-200. doi: 10.1111/all.13039. Epub 2016 Oct 5. PMID: 27588581.

Pollock et al summarized 13 systematic reviews encompassing 56 RCTS and 5526 patients. Among children with asthma exacerbations treated in the emergency department, short-acting beta-agonists (SABA) delivered by metered-dose inhaler decrease hospital admission in younger children and ED length of stay in older children. Short-acting anticholinergics (SAAC) in addition to SABA reduce hospital admission in older children in comparison with SABA or SAAC alone. In the first aid and prehospital context, this evidence from emergency department care is downgraded for indirectness.

#### Relevant Guidelines or Systematic Reviews

Pollock M, Sinha IP, Hartling L, Rowe BH, Schreiber S, Fernandes RM. Inhaled short-acting bronchodilators for managing emergency childhood asthma: an overview of reviews. *Allergy*. 2017 Feb;72(2):183-200. doi: 10.1111/all.13039. Epub 2016 Oct 5. PMID: 27588581.

#### RCT:

None

#### Nonrandomized Trials, Observational Studies

None.

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

No new studies evaluating the use of bronchodilators for the first aid management of asthma were identified. Previous studies included in the 2015 CoSTR are considered indirect evidence. There is inadequate evidence to support a formal systematic review, and as such, no revision is made to existing Treatment Recommendations.

	Approval Date
Evidence Update coordinator	
ILCOR board	

**\*Once approval has been made by Evidence Update coordinator, worksheet will go to ILCOR Board for acknowledgement.**

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## **2022 Evidence Update Worksheet**

**Worksheet author(s):** Therese Djarv

**Council:** First Aid

**Date Submitted:** 2021-12-08

**Worksheet ID:** FA 770 Duration of cooling for burns

**PICO / Research Question:** Among adults and children in first aid settings with a thermal burn, do active cooling using water as an immediate first aid intervention for 20 minutes or more duration compared to active cooling using water as an immediate first aid intervention for any other duration change any outcome?

**Outcomes:** Primary outcomes: Size (critical) – defined as percentage of total body surface area (TBSA) at any reported time point (continuous). Depth (critical) – as reported in articles by authors in three or four categories and analyzed from the negative dichotomous outcome of full thickness depth (including deep dermal partial thickness).

Secondary outcomes: Pain (important)- defined as any measurement of pain or administration of pain medications (continuous and/or categorized outcome). Adverse outcomes (important) – defined as any reported adverse outcome and a priori identified hypothermia (dichotomous outcome; yes/no). Wound healing (important) – defined as time to re-epithelization in days (continuous outcome). Complications within 24 hours (important)- defined as organ dysfunction, ICU-care, infections (within seven days), bleeding, rhabdomyolysis as well as surgical procedures such as fasciotomy and escharotomy.

**Type (intervention, diagnosis, prognosis):** Intervention

**Additional Evidence Reviewer(s):** NA

**Conflicts of Interest (financial/intellectual, specific to this question):** None

**Year of last full review:** 2020-2021

### **Last ILCOR Consensus on Science and Treatment Recommendation:**

In all, four observational studies together enrolling 5978 adults and children, all from Australia, were identified {Cuttle 2009 1028; Fein 2014 609; Griffin 2020 75; Wood 2016 11}.

For the critical outcome of burn size, we identified very low certainty of evidence (downgraded for risk of bias and indirectness) from three observational studies enrolling a total of 4616 adults and children, evaluating burn size as a percentage of TBSA {Fein 2014 609; Griffin 2020 75; Wood 2016 11}. In a meta-analysis of all three studies, a difference could not be demonstrated in burn size for burns cooled for 20 minutes or more compared with burns cooled for less than 20 minutes (Standardized Mean Difference [SMD] -0.05; 95% CI, -0.15 – 0.04, I<sup>2</sup>=35%).

For the critical outcome of any degree of a full thickness depth burn (yes/no), defined as deep dermal or full thickness burns, we identified very low certainty evidence (downgraded for risk of bias, inconsistency, indirectness and imprecision) from two observational studies enrolling a total of 4409 adults and children

{Griffin 2020 75; Wood 2016 11}. Significant heterogeneity limited meta-analysis, therefore, the overall direction of effect could not be determined and effect estimates were used to illustrate effect range as the synthesis method. In the cohort study in children {Griffin 2020 75}, the result was in favour of cooling for less than 20 minutes compared with cooling for 20 minutes or more (RR 0.90; 95% CI 0.83-0.97). However, in the study on adults {Wood 2016 11}, the result was opposite, i.e. in favour of cooling for 20 minutes or more over cooling for less than 20 minutes (RR 1.11, 95% CI 1.00-1.22).

Two observational studies of very low certainty evidence (downgraded due to risk of bias and indirectness) enrolling a total of 2491 children, assessed the important outcome of wound healing, defined as days to re-epithelialisation in non-grafted patients {Cuttle 2009 1028; Griffin 2020 75}. In a meta-analysis, a difference could not be demonstrated in days to re-epithelialisation for burns cooled for 20 minutes or more when compared with burns cooled for less than 20 minutes (SMD 0.01; 95% CI, -0.08 – 0.11, I<sup>2</sup>=0%).

For the important outcome of complications, we found very low certainty evidence (downgraded for risk of bias and indirectness) in three observational studies enrolling a total of 4620 adults and children {Cuttle 2009 1028; Griffin 2020 75; Wood 2016 11} reporting the need for skin grafting. A meta-analysis did not demonstrate any difference in the need for skin grafting for burns cooled for 20 minutes or more when compared with burns cooled for less than 20 minutes (RR, 1.37; 95% CI, 0.61 – 3.08, I<sup>2</sup>=95%).

For the important outcome of pain, one observational study enrolling 117 children less than five years of age {Fein 2014 609} provided information on cooling duration in 24/117 (21%) children. A proxy for pain was the administration of an analgesic. Our analysis of unpublished data revealed that the majority of these children (57-59%) received analgesics such as paracetamol and/or morphine, administered by paramedics (unknown administration route) with no obvious difference in pain scores between those cooled for less than 20 minutes and those cooled for 20 minutes or more.

For the important outcome of complications and adverse events including hypothermia, one observational study (Fein 2014 609) was identified. Evaluation of unpublished data showed that out of 117 children with a thermal burn who were cooled with water as a first aid intervention, five children (4%), all under four years of age, developed hypothermia (34-36 degrees Celsius, tympanic assessment, n=4) or were visibly cold with shivering (n=1). Four out of five of these cases had received whole body cooling in a shower.

Sensitivity analysis for cooling times between less than 10 minutes compared with both 10 minutes or more and 20 minutes or more showed no significant difference for any of the selected outcomes. There was no data for shorter durations, such as five minutes, compared with 10 minutes or longer durations than 20 minutes such as 30 minutes.

#### Treatment Recommendations:

We recommend the immediate active cooling of thermal burns using running water as a first aid intervention for adults and children (strong recommendation, very low certainty evidence).

Because no difference in outcomes could be demonstrated with the different cooling durations studied, a specific duration of cooling cannot be recommended.

Young children with thermal burns that are being actively cooled with running water should be monitored for signs and/or symptoms of excessive body cooling (Good Practice Statement).

#### Technical remarks

The duration of cooling used in the reviewed studies varied from two minutes to 75 minutes, with 48% of patients cooled for 20 minutes or more.

The temperature of the water used and the cooling technique (running vs immersion) was noted in three studies {Fein 2014 609; Griffin 2020 75; Wood 2016 11} as 'cool running water' and in one study as 'cold water' {Cuttle 2009 1028}.

Among the included studies, we only identified one complication reported in several studies (need for skin-grafting, n=4620) and one complication identified in unpublished data (hypothermia and shivering, n=5) and neither was significantly associated with duration of cooling.

**2010/2015 Search Strategy:** NA

**2019 Search Strategy:** se app 1.

**Database searched:** Medline, OVID, Cochrane, ClinicalTrials.gov

**Date Search Completed:** 2021-05-10

**Search Results (Number of articles identified / number identified as relevant):** 41

**Inclusion/Exclusion Criteria:**

- Included: Studies in all ages of the first aid cooling of thermal burns with running water.
- Excluded: Studies of ocular burns and burns other than thermal (chemical, electrical). Cooling with other methods or cooling mediums other than running water. No English abstract, animal studies.

**Dates searched** 2020-01-01 to 2021-12-01

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

**Summary of Evidence Update:** No new studies found.

**Evidence Update Process for topics not covered by ILCOR Task Forces**

1. 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**

None

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

**RCT:**

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

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

No new research studies found.

The ILCOR systematic review completed in 2020 was published in October 2021:

Djärv T, Douma M, Palmieri T, Meyran D, Berry D, Kloeck D, Bendall J, Morrison LJ, Singletary EM, Zideman D; Members of the International Liaison Committee on Resuscitation First Aid Task Force who met criteria as a collaborator include: Vere Borra, Jestin N Carlson; Pascal Cassan, Michael Nemeth, Richard Bradley, Wei-Tien Chang, Nathan P Charlton, Jonathan L Epstein, Aaron Orkin. Sakamoto Tetsuya, Craig Goolsby. Duration of cooling with water for thermal burns as a first aid intervention: A systematic review. Burns. 2021 Oct 26:S0305-4179(21)00294-1. doi: 10.1016/j.burns.2021.10.007. Epub ahead of print. PMID: 34916091.

Since no new observational studies or trials were found, an update of the 2020 ILCOR CoS and systematic review is not indicated. Therefore, the 2020 treatment recommendations remain unchanged.

	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**

Djärv T, Douma M, Palmieri T, Meyran D, Berry D, Kloeck D, Bendall J, Morrison LJ, Singletary EM, Zideman D; Members of the International Liaison Committee on Resuscitation First Aid Task Force who met criteria as a collaborator include: Vere Borra, Jestin N Carlson; Pascal Cassan, Michael Nemeth, Richard Bradley, Wei-Tien Chang, Nathan P Charlton, Jonathan L Epstein, Aaron Orkin. Sakamoto Tetsuya, Craig Goolsby. Duration of cooling with water for thermal burns as a first aid intervention: A systematic review. Burns. 2021 Oct 26:S0305-4179(21)00294-1. doi: 10.1016/j.burns.2021.10.007. Epub ahead of print. PMID: 34916091.



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## 2022 Evidence Update Worksheet

**Worksheet author(s):** Therese Djarv

**Council:** First Aid

**Date Submitted:** 2021-12-15

**Worksheet ID:** FA 798 Presyncope

**PICO / Research Question:** Adults and children with signs and/or symptoms of faintness or presyncope of suspected vasovagal or orthostatic origin any physical counter-pressure maneuvers, body positioning, hydration or other intervention when compared no intervention or each other change any outcome?

**Outcomes:** Prevention of Syncope (critical), Injuries or Adverse Events (critical), Symptom Improvement (important), Systolic Blood Pressure Change (important)

**Type (intervention, diagnosis, prognosis):** Intervention

**Additional Evidence Reviewer(s):** NA

**Conflicts of Interest (financial/intellectual, specific to this question):** None

**Year of last full review:** 2019

### Last ILCOR Consensus on Science and Treatment Recommendation:

Physical Counter-pressure Maneuver (PCM)

I. Any type of PCM compared with Control (No use of PCM/Standing)

Abortion of Syncope

For the critical outcome of abortion of syncope, we have identified one RCT (Brignole 2002 2053), which showed a benefit with the use of any PCM when compared with controls (RR, 1.80; 95%CI, 1.16 to 2.79;  $p = 0.01$ ; Risk Difference (RD) with PCM of 421 more patients per 1,000 had abortion of syncope (from 137 more to 468 more). The overall quality of the evidence (certainty) was rated very low due risk of bias, inconsistency, and indirectness.

For the critical outcome of abortion of syncope, we have identified very low certainty evidence (downgraded for risk of bias, inconsistency, and indirectness) from four observational studies (Clarke 2010 1019, Krediet 2002 1684, Krediet 2008 179, Kim 2005 1084) enrolling 92 adult participants with etiology of vasovagal and orthostatic presyncope, which showed no benefit with the use of any PCM when compared with controls (RR, 1.31; 95%CI, 0.98-1.75;  $p = 0.07$ ); RD with PCM of 184 more patients/1000 had abortion of syncope (from 12 fewer to 454 more).

For the critical outcome of abortion of syncope, we have identified very low certainty evidence (downgraded for risk of bias, inconsistency and indirectness) from a subgroup analysis of three observational studies

(Krediet 2002 1684, Krediet 2008 179, Kim 2005 1084) enrolling 64 adult patients with etiology of vasovagal syncope, which showed no benefit with the use of any PCM, when compared with controls (RR, 2.20; 95%CI, 0.96-5.05;  $p = 0.06$ ); RD with PCM of 333 more patients/1,000 had abortion of syncope (from 11 fewer to 1000 more).

For the critical outcome of abortion of syncope, we have identified very low certainty evidence (downgraded for risk of bias, inconsistency and indirectness) from two observational follow-up studies (Brignole 2002 2053, Croci 2004 287) enrolling 37 patients with VVS, which showed benefit with the use of PCM in 99.4% of episodes (349/351) (RR not estimable).

### Injuries or Adverse Events

For the critical outcome of injuries or adverse events related to the use of PCM, we have identified very low certainty evidence (downgraded for risk of bias, inconsistency, and indirectness) from two observational follow-up studies (Brignole 2002 2053, Croci 2004 287) enrolling 37 adult participants that reported no adverse events or injuries related to the use of PCM (0/37).

### Symptom Improvement

For the important outcome of symptom improvement, we identified one RCT (Brignole 2002 2053), which showed no benefit with the use of PCM when compared with controls (RR, 1.57; 95%CI, 0.98 to 2.51;  $p=0.06$ ); RD with PCM of 251 more patients/1,000 had symptom improvement with PCM (from 26 more to 409 more). The overall quality of evidence was rated as very low due to risk of bias, inconsistency, and indirectness.

For the important outcome of symptom improvement, we have identified one follow-up phase RCT (Alizadeh 2016 e5348) which showed no benefit with the use of PCM, when compared with controls (RR, 1.57; 95%CI, 0.98 to 2.51;  $p=0.06$ ); RD with PCM of 251 more patients/1,000 had symptom improvement with PCM (from 26 more to 409 more). The overall quality of the evidence was rated as very low due to risk of bias, inconsistency, and indirectness.

For the important outcome of symptom Improvement, we identified one observational study (Krediet 2002 1684) enrolling 21 adult participants with vasovagal etiology presyncope, with results favoring the use of PCM. The overall quality of evidence was rated as very low due to a very serious risk of bias due to confounding.

### Heart Rate

For the important outcome of change in heart rate (HR), we have identified very low certainty evidence (downgraded for risk of bias, indirectness, and imprecision) from one RCT (Brignole 2002 2053) enrolling 19 adult participants with vasovagal etiology presyncope, which showed no benefit with the use of PCM, when compared with control (MD, HR 8 beats per minute higher; 95% CI: 6.4 lower to 22.4 BPM higher;  $p = 0.28$ ).

### Blood Pressure

For the important outcome of change in systolic blood pressure (SBP), we have identified very low certainty evidence (downgraded for risk of bias, indirectness, and imprecision; upgraded for large effect size) from two observational studies (Krediet 2002 1684, Krediet 2008 179) enrolling 39 adult participants with vasovagal etiology presyncope, which showed benefit with the use of PCM, when compared with control (MD, SBP 21 mmHg higher; 95%CI, 18.25-23.41 mmHg higher;  $p < 0.0001$ ).

For the important outcome of change in systolic blood pressure (SBP), we identified one RCT (Brignole 2002 2053) enrolling 19 adults with vasovagal etiology presyncope, which showed benefit with the use of PCM, when compared with control (MD, SBP 32 mmHg higher; 95%CI, 12.48-51.52 BPM higher;  $p = 0.001$ ). The overall quality of evidence was rated as very low due to risk of bias, inconsistency, and indirectness.

For the important outcome of change in diastolic blood pressure (DBP), we have identified very low certainty evidence (downgraded for risk of bias, indirectness, and imprecision; upgraded for large effect size) from two observational studies (Krediet 2002 1684, Krediet 2008 179) enrolling 39 adult participants with vasovagal etiology presyncope, which showed benefit with use of PCM, when compared with control (MD, DBP 11 mmHg higher; 95%CI, 9.39 to 13.10 mmHg higher;  $p < 0.001$ ).

For the important outcome of change in diastolic blood pressure (DBP), we have identified very low certainty evidence (downgraded for risk of bias, indirectness and imprecision) from one RCT (Brignole 2002 2053) enrolling 19 adult participants with vasovagal etiology presyncope, which showed benefit with the use of PCM compared with control (MD, DBP 20 mmHg higher; 95%CI, 5.95 to 34.05 mmHg higher;  $p = 0.005$ ).

## II. Lower body PCM compared with Control (No use of PCM/Standing) Abortion of Syncope

For the critical outcome of abortion of syncope, we identified one observational study (Krediet 2002 1684) enrolling 18 adult participants with vasovagal etiology presyncope. The overall quality of evidence was rated as very low due to a very serious risk of bias due to confounding.

### Symptom Improvement

For the important outcome of symptom improvement, we have identified very low certainty evidence (downgraded for risk of bias, inconsistency, indirectness and imprecision) from one RCT (Alizadeh 2016 e5348) enrolling 96 adult participants with vasovagal presyncope, which showed benefit with the use of Lower Body PCM, when compared with control (RR, 1.66; 95%CI, 1.02 to 2.69;  $p = 0.04$ ); RD with PCM of 290 more patients/1,000 had symptom improvement with lower body PCM (from 9 more to 744 more).

### Blood Pressure

For the important outcomes of SBP and DBP, we identified one observational study (Krediet 2002 1684) enrolling 18 adult participants with vasovagal etiology presyncope with results favoring the use of Lower Body PCM. The overall quality of evidence was rated as very low due to a very serious risk of bias due to confounding.

## III. Upper Body PCM (handgrip or arm tensing) compared with Control (No use of PCM/Standing) Abortion of Syncope

For the critical outcome of abortion of syncope, we identified very low certainty evidence (downgraded for risk of bias, inconsistency, indirectness and imprecision) from one RCT (Brignole 2002 2053) enrolling 19 adult participants with vasovagal etiology presyncope, which showed benefit with the use of Upper Body PCM

when compared with control (RR, 1.80; 95%CI, 1.26-2.89;  $p=0.001$ ); RD with upper body PCM of 421 more patients/1,000 had abortion of syncope with lower body PCM (from 84 more to 952 more).

For the critical outcome of abortion of syncope, we identified very low certainty evidence (downgraded for risk of bias, inconsistency and indirectness) from two observational follow-up studies (Brignole 2002 2053, Croci 2004 287) enrolling 37 patients with VVS, which showed benefit with the use of PCM in 99.4% of episodes (349/351) (RR not estimable, no comparison group).

### Symptom Improvement

For the important outcome of symptom improvement, we identified evidence of very low certainty (downgraded for risk of bias, inconsistency, indirectness and imprecision) from one RCT (Brignole 2002 2053) enrolling 19 adult participants with vasovagal presyncope, which showed benefit with the use of Upper Body PCM when compared with control (RR, 6.00; 95%CI, 2.21-8.61;  $p=0.0096$ ); RD for upper body PCM of 526 more patients/1,000 had symptom improvement (58 more to 1000 more).

### Heart Rate

For the important outcome of change in heart rate (HR), we identified very low certainty evidence (downgraded for risk of bias, inconsistency, indirectness and imprecision) from one RCT (Brignole 2002 2053) enrolling 19 adult participants with vasovagal etiology presyncope, which showed no benefit with the use of Upper Body PCM, when compared with control (MD HR 8 beats per minute higher; 95%CI, 6.4 lower to 22.4 BPM higher;  $p = 0.28$ ).

### Blood Pressure

For the important outcome of change in SBP, we have identified very low certainty evidence (downgraded for risk of bias, inconsistency, indirectness and imprecision) from one RCT (Brignole 2002 2053) enrolling 19 adult participants with vasovagal etiology presyncope, which showed benefit with the use of upper body PCM when compared with control (MD, SBP 32 mmHg higher; 95% CI, 12.48 to 51.52 mmHg higher;  $p=0.036$ ).

For the important outcome of change in DBP, we have identified very low certainty evidence (downgraded for risk of bias, inconsistency, indirectness and imprecision) from one RCT (Brignole 2002 2053) enrolling 19 adult participants with vasovagal etiology presyncope, which showed benefit with the use of upper body PCM when compared with control (MD, DBP 20 mmHg higher; 95% CI, 5.57-34.43 mmHg higher;  $p < 0.001$ ).

## IV. Lower body PCM (Squat & leg crossing) compared with Upper limb PCM (Handgrip)

### Abortion of Syncope

For the critical outcome of abortion of syncope, we identified one observational study (Kim 2005 1084) enrolling 27 adult participants with vasovagal etiology syncope, with results favoring the use of lower body PCM (Squat & leg crossing) when compared with upper limb PCM (Handgrip). The overall quality of evidence was rated as very low due to inconsistency, indirectness and imprecision.

### Symptom Improvement

For the important outcome of symptom improvement, we identified very low certainty evidence (downgraded for inconsistency, indirectness and imprecision) from one RCT (Alizadeh 2016 e5348) enrolling 96 adult participants with vasovagal syncope, which showed no benefit with the use of lower body PCM (Squat), when compared with upper limb PCM (Handgrip) (RR 0.89; 95%CI, 0.65 to 1.22; p=0.46); RD for lower body PCM of 95 more patients/1,000 had symptom improvement (from 30 fewer to 130 more).

#### Heart Rate

For the important outcome of change in HR, we identified one observational study (Kim 2005 1084) enrolling 27 adult participants with vasovagal syncope, with results favoring the use of lower body PCM (Leg crossing) when compared with upper limb PCM (Handgrip). The overall quality of evidence was rated as very low due to inconsistency, indirectness and imprecision.

#### Blood Pressure

For the important outcomes of change in SBP and DBP, we identified one observational study (Kim 2005 1084) enrolling 27 adult participants with vasovagal syncope, with results favoring the use of lower body PCM (Leg crossing) when compared with upper limb PCM (Handgrip). The overall quality of evidence was rated as very low due to inconsistency, indirectness and imprecision.

#### V. Lower body PCM (Squatting) compared with Abdominal PCM (Abdominal Contraction/Compression) Blood Pressure

For the important outcome of SBP, we identified one observational study (Bouvette 1996 847) enrolling 9 adult participants with neurogenic orthostatic hypotension, with results favoring the use of lower body PCM (Squatting), when compared with abdominal PCM. The overall quality of evidence was rated as very low due to indirectness and imprecision.

#### VI. Lower body PCM (Squatting) compared with Neck PCM (Neck Flexion) Blood Pressure

For the important outcome of SBP, we identified one observational study (Bouvette 1996 847) enrolling 9 adult participants with neurogenic orthostatic hypotension, with results favoring the use of lower body PCM (Squatting) when compared with neck PCM. The overall quality of evidence was rated as very low due to indirectness and imprecision.

#### Body Positioning and Hydration

No evidence was identified for the interventions of body positioning or hydration using the inclusion and exclusion criteria.

#### **Treatment Recommendations:**

We recommend the use of any type of physical counter-pressure maneuver by individuals with acute symptoms of presyncope due to vasovagal or orthostatic causes in the first aid setting (strong recommendation, low and very low-certainty evidence).

We suggest that lower body physical counter-pressure maneuvers are preferable to upper body and abdominal physical counter-pressure maneuvers (weak recommendation, very low-certainty evidence).

**2010/2015 Search Strategy:** NA

**2019 Search Strategy:** see appendix 1 + table of results

**Database searched:** Medline, OVID, Cochrane, ClinicalTrials.gov

**Date Search Completed:** 2021-12-07

**Search Results (Number of articles identified / number identified as relevant):** 1000

**Inclusion/Exclusion Criteria:**

- **Exclusion:** No English abstract, animal studies, interventional studies in certain diseases such as Parkinson.

**Dates searched** 2018-01-01 to 2021-12-07

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

**Summary of Evidence Update:** No new studies found.

**Evidence Update Process for topics not covered by ILCOR Task Forces**

1. 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**

Jan L Jensen, Shinichiro Ohshimo, Pascal Cassan, Daniel Meyran, Jennifer Greene, Kee Chong Ng, Eunice Singletary, David Zideman, First Aid and Pediatric Task Forces of the International Liaison Committee on Resuscitation. Immediate Interventions for Presyncope of Vasovagal or Orthostatic Origin: A Systematic Review. PMID: 30957664 Prehosp Emerg Care. Jan-Feb 2020;24(1):64-76. doi: 10.1080/10903127.2019.1605431. Epub 2019 May 9.

Dockx K, Avau B, De Buck E, Vranckx P, Vandekerckhove P. Physical manoeuvres as a preventive intervention to manage vasovagal syncope: A systematic review. PLoS One. 2019 Feb 28;14(2):e0212012. doi: 10.1371/journal.pone.0212012. PMID: 30818337; PMCID: PMC6395036.

Charlton NP, Pellegrino JL, Kule A, Slater TM, Epstein JL, Flores GE, Goolsby CA, Orkin AM, Singletary EM, Swain JM. 2019 American Heart Association and American Red Cross Focused Update for First Aid: Presyncope: An Update to the American Heart Association and American Red Cross Guidelines for First Aid. Circulation. 2019 Dec 10;140(24):e931-e938. doi: 10.1161/CIR.0000000000000730. Epub 2019 Nov 14. PMID: 31722559.

Drago F. 2019 American Heart Association and American Red Cross presyncope update. J Pediatr. 2020 May;220:264-267. doi: 10.1016/j.jpeds.2020.02.066. PMID: 32334665.  
<https://www.jpeds.com/action/showPdf?pii=S0022-3476%2820%2930280-8>

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

**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 found	<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)
None found	<u>Study Type:</u>	<u>Inclusion Criteria:</u>	<u>1° endpoint:</u>	

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

No new research studies found. Relevant ILCOR systematic review was identified:

Jan L Jensen, Shinichiro Ohshimo, Pascal Cassan, Daniel Meyran, Jennifer Greene, Kee Chong Ng, Eunice Singletary, David Zideman, First Aid and Pediatric Task Forces of the International Liaison Committee on Resuscitation. Immediate Interventions for Presyncope of Vasovagal or Orthostatic Origin: A Systematic Review. PMID: 30957664 Prehosp Emerg Care. Jan-Feb 2020;24(1):64-76. doi: 10.1080/10903127.2019.1605431. Epub 2019 May 9.

No relevant protocols were identified, we assume that many might come up soon on POTS post-covid.

Since no new observational studies or trials were found, an update of the 2019 ILCOR CoS and systematic review is not indicated. Therefore, the 2019 treatment recommendations remain unchanged.

	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



**Search Strategy:**

Set	Search	Results
01	syncope/ or syncope, vasovagal/	205
02	(Syncope or syncopal or syncope or syncopes or pre-syncope or presyncope).ab,kf,ti.	1231
03	(vasovagal adj1 (syncope* or episode* or symptom* or recurrent repeat or attack* or collapse* or shock*)).ab,kf,ti.	120
04	Tilt-Table Test/	44
05	(Tilt-Table Test or tilt test* or Tilt-induced).ab,kf,ti.	147
06	orthostatic intolerance/ or hypotension, orthostatic/ or Lower Body Negative Pressure/	106
07	(orthostatic or orthostasis or drop attack* or lipothymia*).ab,kf,ti.	731
008	VVS.ab,kf,ti.	63
009	((feeling or blood donor*) adj2 (faint* or Dizzy* or Dizzi* or Lighthead* or Light-Head* or Disequilibrium or dis-equilibrium or Vertigo or Discomfort)).ab,kf,ti.	27
010	(Lower body adj2 pressure).ab,kf,ti.	49
011	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10	2024
012	Valsalva Maneuver/	36
13	(Valsalva or maneuver or maneuvers or manoeuvres or manoeuvre).ab,kf,ti.	2403
14	counterman*.ab,kf,ti.	12
15	exp hypertonic solutions/ or isotonic solutions/ or rehydration solutions/	73
016	water/ or drinking water/	3584
017	fluid therapy/ or hypodermoclysis/	309
018	Drinking/	105
019	((isotonic or isometric or hypertonic) adj1 solution*).ab,kf,ti.	100
20	(water or waters).ab,kf,ti.	52099
21	(rehydration or re-hydration or hydration or drink or drinks or drinking).ab,kf,ti.	11559
22	exp Beverages/	3209
23	(fluid therap* or oral fluid replacement* or beverage* or milk or tea or coffee).ab,kf,ti.	13347
024	exp Exercise Therapy/	1806
025	Salts/	140
026	Pressure/	551
027	Hemodynamics/	1201
028	Baroreflex/	74
029	(Hemodynamic or Hemodynamics).ab,kf,ti.	7321
030	(salts or pressure or posture or supine or postural change or trendelenburg or Squatting or standing or handgrip or counterpressure* or grip or gripping).ab,kf,ti.	60924
031	(leg adj2 cross*).ab,kf,ti.	36
032	exp Posture/	911
033	Patient Positioning/	244
034	((Patient or dorsal or body) adj1 (position or positioning)).ab,kf,ti.	526
35	((arm* or leg* or limb* or chest) adj2 (low* or elevated* or rais* or position*)).ab,kf,ti.	6235
36	Non?pharmacological*.ab,kf,ti.	549
37	((arm or muscle or leg) adj1 (tensing or tension or counterpressure or exercise* or counterpressure*)).ab,kf,ti.	367

38 (Abdominal adj1 (Compression or bandage*)).ab,kf,ti.	37
39 (Inspiratory adj1 (sniffing or pursed lips breathing or obstruction)).ab,kf,ti.	1
40 Breathing Exercises/ or Respiratory Therapy/ or Compression Bandages/ or *Isometric Contraction/	229
041 or/12-40	143820
042 treatment outcome/ or treatment failure/ or disease management/	28676
043 pc.fs.	23671
044 tu.fs.	35316
045 th.fs.	38466
046 (prevent or preventing or prevention).ab,kf,ti.	91174
047 (improve or improved or improvement or improves).ab,kf,ti.	215259
048 (reduce or reduced or reduces or reducing or reduction).ab,kf,ti.	241601
49 (treat or treatment or therapy or therapies).ab,kf,ti.	416145
50 (ameliorate or effect* or benefit* or impact or efficacy).ab,ti.	609167
051 (intervention or interventions).ab,ti.	106704
052 "standard of care".ab,kf,ti.	6385
053 or/42-52	988456
054 Animals/ not (Animals/ and Humans/)	53665
055 (letter or comment or editorial).pt.	79106
056 case reports/	54852
057 55 or 56	131943
058 11 and 41 and 53	406
059 58 not 54	404
060 59 not 57	355
061 limit 60 to updaterange="medl(20210930223436-20211027171152] 171,medp(20210930223436-20211029202548],mesx(20210930223436-20211029200326],pmnm(20210930223436-20211029202347],prem(20210930223436-20211029202325]"	

**\*\*CONFIDENTIAL DO NOT DISTRIBUTE\*\*****2022 Evidence Update Worksheet**

**Worksheet author(s):** David C. Berry, David Zideman

**Task Force:** First Aid

**Date Submitted:** August 1, 2021; Final submitted December 14, 2021

**Worksheet ID:** FA799, First Aid Concussion Scoring System

**PICO / Research Question (FA 799):** Adults and children with suspected head injury without loss of consciousness (P) does use of a simple single-stage concussion scoring system (I) compared with standard first aid assessment without a scoring system (C) improve outcomes (O)?

**Outcomes:** Likelihood of differentiating between minor head contusion and more serious concussion and time to recognition of the deteriorating patient were ranked as critical outcomes. Survival to 30 days with good neurological outcomes, the likelihood of poor neurological outcomes, and the need for advanced medical care were ranked as important outcomes.

**Type (intervention, diagnosis, prognosis):** Diagnosis

**Additional Evidence Reviewer(s):** NA

**Conflicts of Interest (financial/intellectual, specific to this question):** None

**Year of last full review:** First and most recent CoSTR, 2015; Scoping Review, 2020

**Last ILCOR Consensus on Science and Treatment Recommendation:** 2015

## **Concussion (FA 799)**

### ***Introduction***

This is a new topic for the 2015 consensus on science. First aid providers are commonly faced with the need to identify concussion. The identification of concussion can be complex, and if concussion is missed, this can lead to a delay in receiving proper postconcussion advice and a delay in formal assessment and definitive treatment that can result in lifechanging or even life-threatening consequences. The task force sought to evaluate the effectiveness of early clinical recognition of concussion by first aid providers using a simple scoring system.

### ***Consensus on Science***

For the critical outcome of likelihood of differentiating between minor head contusion and more serious concussion (brain injury), we identified very-low-quality evidence (downgraded for risk of bias and indirectness) from 1 nonrandomized observational study (Thompson 2011, 417) with 19 408 patients in a trauma registry using a secondary analysis of rescoring prehospital Glasgow Coma Scale (GCS) scores showing

no significant difference between a simple derived motor score when compared with the GCS score to determine brain injury.

For the important outcome of need for advanced medical care (neurosurgical intervention and emergency tracheal intubation), we identified very-low-quality evidence (downgraded for imprecision) from 1 nonrandomized observational study (Thompson 2011, 417) with 19 408 patients in a trauma registry using a secondary analysis of rescoring the prehospital GCS scores showing no significant difference between a simple derived motor score when compared with the GCS score for neurosurgical intervention (MD, 0.04; 95% CI, 0.01–0.09) and the need for emergency tracheal intubation (MD, 0.05; 95% CI, 0.01–0.11).

For the critical outcome of change in time to recognition of the deteriorating patient, for the important outcomes of survival to 30 days with good neurologic outcome, and for the likelihood of a poor neurologic outcome, we did not identify any evidence.

### ***Treatment Recommendations***

No recommendation. We acknowledge the role that a simple, validated, single-stage concussion scoring system could play in the first aid provider's recognition and referral of victims of suspected head injury. However, review of the available literature shows no evidence regarding the application of such scoring systems by the first aid provider.

### ***Values, Preferences, and Task Force Insights***

Failure to properly recognize concussion can result in delay or absence of referral for definitive evaluation and care or inappropriate release to activity, which has the potential to worsen outcomes. We did identify concussion assessment tools currently recommended for use in sports medicine, but these require a 2-stage assessment, before competition and after concussion, and were thought to be inappropriate for use in the standard first aid setting. Our extensive search strategy yielded 1837 publications, but subsequent review resulted in the selection of only 1 published manuscript. Despite the finding of 1 prehospital scientific publication supporting a simplified motor score, it was decided that this single article, a retrospective observational study where prehospital GCS scoring extracted from an urban Level 1 trauma registry was rescored by using a 3-point simplified motor score and compared with 4 hospital-based outcomes, did not formally address the PICO question and was in itself a very weak level of scientific evidence. Many of the studies identified in our literature search used the adult and pediatric GCS to grade concussion. The GCS was designed as a tool for use by advanced prehospital and hospital care providers, and it is not commonly used by first aid providers. The task force thought that this was not an appropriate tool to be used by first aid providers to assess concussion.

Our search and analysis did not identify any evidence to support or refute the use of a simplified scoring system, such as Sport Concussion Assessment Tool (SCAT); the GCS; or Alert, responds to Voice, responds to Pain, Unresponsive Scale (AVPU), versus standard first aid without a scoring system. It was thought that the serious consequences of not recognizing concussion in the first aid environment warranted an approach whereby any individual with a head injury and any alteration of level of consciousness requires immediate evaluation by an advanced healthcare provider or at a hospital.

### ***Knowledge Gaps***

- There is a need for a clearer definition of concussion supported by clinical data that can be used to support assessment made in the first aid environment.
- There is a need for RCTs to assess the efficacy of scoring systems as used by non–healthcare professional in prehospital environments.
- There is a need for RCTs to assess the efficacy of SCAT in the clinical environment and whether it can be applied to nonsport environments.

### **2010/2015/2019 (utilized 2019 for 2021 EvUP) Search Strategy:** Last search update 12-2019

**Pubmed:** (((((((((((((((brain injuries) OR (TBI OR traumatic brain injury )) AND (mild OR sport OR athletic OR minor)) NOT "loss of consciousness")) AND (((physical examination) AND (((((((Trauma Severity Indices[MeSH Terms]) OR (index or indices[Title])) OR assessment tool[TIAB]) OR diagnostic tool[ TIAB])))) OR injury severity score[TIAB] ) OR SCAT[TIAB]) OR Sport concussion assessment tool[TIAB] ) OR Glasgow coma scale[MeSH Terms]))))))) AND (((((((outcomes) OR recovery of function[MeSH Terms]) OR return to work) OR activities of daily living[MeSH Terms]) OR length of stay[MeSH Terms]) AND (((((((("randomized controlled trial"[PT] OR "controlled clinical trial"[PT] OR "clinical trial"[PT] OR "comparative study"[PT] OR random\*[TIAB] OR controll\*[TIAB] OR "intervention study"[TIAB] OR "experimental study"[TIAB] OR "comparative study"[TIAB] OR trial[TIAB] OR evaluat\*[TIAB] OR "Before and after"[TIAB] OR "interrupted time series"[TIAB])) OR ("Epidemiologic Studies"[Mesh] OR "case control"[TIAB] OR "case-control"[TIAB] OR ((case[TIAB] OR cases[TIAB]) AND (control[TIAB] OR controls[TIAB])) OR "cohort study"[TIAB] OR "cohort analysis"[TIAB] OR "follow up study"[TIAB] OR "follow-up study"[TIAB] OR "observational study"[TIAB] OR "longitudinal"[TIAB] OR "retrospective"[TIAB] OR "cross sectional"[TIAB] OR "cross-sectional"[TIAB] OR questionnaire[TIAB] OR questionnaires[TIAB] OR survey[TIAB])))) NOT (("animals"[MH] NOT (animals[MH] AND "humans"[MH])))) NOT (("letter"[pt] OR "comment"[pt] OR "editorial"[pt] OR "case reports"[pt])))))))

**Embase:** 'brain injuries'/exp OR 'brain injuries':ab,ti OR 'traumatic brain injuries':ab,ti OR 'tbi':ab,ti AND ('physical examination'/exp OR examination:ab,ti OR 'first aid'/exp) AND ('trauma severity indices'/exp OR index:ab,ti OR indices:ab,ti OR 'assessment tool':ab,ti OR 'sport concussion assessment tool':ab,ti OR 'scat':ab,ti OR 'glasgow coma scale'/exp OR 'glasgow coma scale':ab,ti) AND [embase]/lim

**Cochrane Central Register of Controlled Trials:** ([mh "brain injuries"] or "brain injuries" OR "traumatic brain injuries") AND ([mh "physical examination"] OR examination OR [mh "first aid"]) AND ([mh "trauma severity indices"] or index OR indices or "assessment tool" OR "Sport concussion assessment tool" OR "SCAT" OR [mh "Glasgow coma scale"] OR "Glasgow coma scale")

A second structured literature search was conducted using Medline, keywords: (1) SCAT 5, (2) CRT 5, (3) concussion recognition tool, (4) sport\* concussion assessment tool, and (5) concussion assessment tool.

A third literature search, Google Chrome, keywords: (1) “single-stage concussion scoring”, (2) “single-stage concussion assessment” AND lay, and (3) “single-stage concussion assessment” AND prehospital.

### **Databases searched:**

1. Pubmed
2. Cochrane Central Register of Controlled Trials

3. Medline

4. Google Chrome

### Date Search Completed:

1. Pubmed.gov, 07/20/2021

2. Cochrane Central Register of Controlled Trials, 07/20/2021

3. Medline, 07/20/2021

- a. (1) SCAT 5, (2) CRT 5, (3) concussion recognition tool, (4) sport\* concussion assessment tool, and (5) concussion assessment tool.

4. Goggle Chrome, 07/20/2021

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

Databases	Identified Records (11.19 to 09.21)	Excluded on Title, Abstract	Reviewed for Inclusion	Included
Pubmed.gov	261	255	6	0
Cochrane Library (Reviews)	8	8	0	0
Cochrane Library (Trial)	3	3	0	0
Cochrane Library (Protocol)	1	1	0	0
Medline	138 hits (1 SCAT 5, 39 CRT 5, 98 concussion recognition tool or sport* concussion assessment tool or concussion assessment tool)	126	12	0
Google Chrome "single-stage concussion scoring"	5 hits	2 (ads)	3 (all ILCOR documents)	0
Google Chrome "single-stage concussion assessment" AND lay	2 hits	2 (ads)	0	0
Google Chrome "single-stage concussion assessment" AND prehospital	0	0	0	0

**Date Search Completed:** December 14, 2021

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

Databases	Identified Records (09.27.21 to 12.14.2021)	Excluded on Title, Abstract	Reviewed for Possible Inclusion	Included
<i>Pubmed.gov</i>	26	26	0	0

**Inclusion/Exclusion Criteria:**

Inclusion Criteria	Exclusion Criteria
<ul style="list-style-type: none"> <li>Randomized controlled trials (RCTs), controlled clinical trial, clinical trial, comparative study, non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies, case-control, cross-sectional, epidemiologic), case series (n&gt;5), survey and retrospective</li> <li>Adults and children (&gt; 1-year-old) with suspected head injury without loss of consciousness</li> <li>Simple single-stage concussion scoring system</li> <li>Assessments in the prehospital (first aid) environment</li> <li>Assessments by non-healthcare providers</li> <li>Available abstract</li> </ul>	<ul style="list-style-type: none"> <li>Unpublished studies (e.g., conference abstracts, trial protocols), editorials, commentary, case reports, and animals are excluded in only search strategy one</li> <li>Concussion scoring system administered in the emergency department</li> <li>Assessments by healthcare providers</li> </ul>

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

No new records regarding simple single stage scoring systems for concussion by the first aid provider was identified.

**Summary of Evidence Update:**

No new evidence regarding the application of a single stage scoring systems for concussion by the first aid provider was identified.

The 2015 review resulted in a 'no treatment recommendation' due to lack of evidence, and there continues to be no single stage concussion scoring systems applicable to first aid. All scoring systems are two-stage systems and require a baseline evaluation score, such as used in sport. A systematic review is not indicated at this time.

**Relevant Guidelines or Systematic Reviews**

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

**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 (including whether meet criteria for formal review):**

This evidence update did not identify any studies describing a simple, single-stage scoring system for use by a first aid provider in the assessment of someone with a possible concussion. The task force discussed the previous lack of a recommendation stemming from the 2015 CoSTR and subsequently upheld with a 2020 scoping review. In task force discussion, it was noted that despite a lack of evidence for a single-stage concussion scoring system, the PICOST comparator (“standard first aid assessment”) would remain the “gold standard” for first aid assessment of a person with a suspected head injury without loss of consciousness. It was the task force consensus that a Best Practice statement be made reflecting this discussion.

**2021 Task Force Best Practice Statement**

It is critically important that concussion is recognised and managed appropriately. In the absence of a validated simple single stage concussion scoring system, the first aid assessment for a person with a possible concussion should be based upon the typical signs and symptoms of concussion.

	<b>Approval Date</b>
<b>Evidence Update coordinator</b>	



ILCOR board	
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**\*Once approval has been made by Evidence Update coordinator, worksheet will go to ILCOR Board for acknowledgement.**

#### **Reference list**

Thompson DO, Hurtado TR, Liao MM, Byyny RL, Gravitz C, Haukoos JS. Validation of the Simplified Motor Score in the out-of-hospital setting for the prediction of outcomes after traumatic brain injury. *Ann Emerg Med*. 2011;58:417–425. doi: 10.1016/j.annemergmed.2011.05.033.

**\*\*CONFIDENTIAL DO NOT DISTRIBUTE\*\*****2022 Evidence Update Worksheet****Worksheet author(s):** Richard N. Bradley**Task Force:** First Aid**Date Submitted:** October 13, 2021; Update December 15, 2021**Worksheet ID:** FA 1545, Heat Stroke Cooling**PICO / Research Question:**

PICOST	Description (with recommended text)
<b>Population</b>	Adults and children in any setting (in-hospital or out-of-hospital) with heat stroke or exertional hyperthermia.
<b>Intervention</b>	Any cooling technique (or combination of techniques) appropriate for first aid (conduction, evaporation, convection, or radiation).
<b>Comparison</b>	Another cooling technique (or combination of techniques) appropriate for first aid. For case series, there will be no comparator or control group. Studies without a comparison group will be described narratively.
<b>Outcomes</b>	Mortality and rate of body temperature reduction (°C/min or °C/hour) are critical outcomes. Clinically important organ dysfunction, adverse effects (e.g. overcooling, hypothermia, injury) and hospital length are important outcomes.
<b>Study Design</b>	Randomized controlled trials (RCTs) and non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies), case series of 5 or more are eligible for inclusion. Case series are limited in providing high level evidence, particularly without a comparator group; however, they provide direct evidence in hyperthermic patients compared to indirect evidence when using healthy volunteers. Unpublished studies (e.g., conference abstracts, trial protocols) will be excluded.
<b>Timeframe</b>	All languages since July 11, 2019 if there is an English abstract; unpublished studies (e.g., conference abstracts, trial protocols) to be excluded.

**Outcomes:** Mortality and rate of body temperature reduction (°C/min or °C/hour) are critical outcomes. Clinically important organ dysfunction, adverse effects (e.g. overcooling, hypothermia, injury) and hospital length are important outcomes.

**Type (intervention, diagnosis, prognosis):** cold water immersion (14 - 17° C); colder water immersion (9 - 12° C); ice water immersion (1 - 5° C); evaporative cooling (misting and fanning); commercial ice packs; cooling vests and jackets; cold shower; ice sheets, fan, hand cooling devices, reflective blankets

**Additional Evidence Reviewer(s):** none

**Conflicts of Interest (financial/intellectual, specific to this question):** member of the American Red Cross Scientific Advisory Council

**Year of last full review:** 2019 **New question:** 2019-20

## Last ILCOR Consensus on Science and Treatment Recommendation: 2020

### 2020 Consensus on Science:

#### **Cold Water Immersion (14-15°C; 57.2-59°F)**

For the critical outcome of rate of core body temperature reduction, we identified low certainty evidence (downgraded for risk of inconsistency and indirectness) from seven controlled trials (Clements 2002 146, DeMartini 2011 2065; Peiffer 2009 987, Peiffer 2010 461, Taylor 2008 1962, Walker 2014 1159, Weiner 1980 507) recruiting 143 adult subjects with exertional hyperthermia which showed a faster rate of body temperature reduction with cold water immersion (14-15°C; 57.2-59°F) of the torso compared with passive cooling (mean difference range from 0.01 to 0.10°C/min). Due to high heterogeneity between studies, a pooled estimate of the mean difference in rate of body temperature reduction was not performed.

For the critical outcome of rate of core body temperature reduction, we identified very low certainty evidence (downgraded for risk of inconsistency, indirectness and imprecision) from three controlled trials (Caldwell 2018 512, Proulx 2003 1317, Taylor 2008 1962) recruiting 23 adult subjects with exertional hyperthermia which showed no significant mean difference in the rate of core body temperature reduction with cold water immersion (14°C; 57.2°F) of the torso compared with temperate water immersion (20-26°C; 68-78.8°F) of the torso (mean difference range from -0.04 to 0.21°C/min). Due to high heterogeneity between studies, a pooled estimate of the mean difference in rate of body temperature reduction was not performed.

For the critical outcome of rate of core body temperature reduction, we identified low certainty evidence (downgraded for risk of indirectness and imprecision) from one controlled trial (Proulx 2003 1317) recruiting 7 adult subjects with exertional hyperthermia which showed no significant mean difference in the rate of body temperature reduction with the use of cold water immersion (14°C; 57.2°F) of the torso compared with the use of “colder” water immersion (8°C; 46.4°F) (mean difference -0.04°C/min; 95% CI -0.11-0.03).

For the critical outcome of rate of core body temperature reduction, we identified very low certainty evidence (downgraded for risk of inconsistency, indirectness and imprecision) from two controlled trials (Clements 2002 146, Proulx 2003 1317) recruiting 24 adult subjects with exertional hyperthermia which showed no significant mean difference in the rate of core body temperature reduction with the use of cold water immersion (14°C; 57.2°F) of the torso compared with ice water immersion (2-5°C; 35.6-41°F) of the torso (mean difference range from -0.20 to 0.00°C/min). Due to high heterogeneity between studies, pooled estimate of the mean difference in rate of core body temperature reduction was not performed.

#### **Cold Water Immersion (10-17°C; 50.0-62.6°F) of Hands and Feet**

For the critical outcome of rate of core body temperature reduction, we identified moderate certainty evidence (downgraded for risk of indirectness) from six controlled trials (Barwood 2009 385, Carter 2007 109, Clapp 2001 160, DeMartini 2011 2065, Selkirk 2004 521, Zhang 2014 17) recruiting 62 adult subjects with exertional hyperthermia which showed a faster rate of core body temperature reduction with the use of cold water immersion (10-17°C; 50.0-62.6°F) of the hands and/or feet compared with passive cooling (mean difference 0.01°C/min; 95% CI 0.01-0.01).

#### **Colder Water Immersion (9-12°C; 48.2-52.6°F)**

For the critical outcome of rate of core body temperature reduction, we identified moderate certainty evidence (downgraded for risk of indirectness) from three controlled trials (Clapp 2001 160, Halson 2008 331, Hosokawa 2016 347) recruiting 30 adult subjects with exertional hyperthermia which showed a faster rate of core body temperature reduction with the use of “colder” water immersion (9-12°C; 48.2-52.6°F) of the torso compared with passive cooling (mean difference 0.11°C/min; 95% CI 0.07-0.15).

For the critical outcome of rate of core body temperature reduction, we identified low certainty evidence (downgraded for risk of indirectness and imprecision) from one controlled trial (Pointon 2012 2483) recruiting 10 adult subjects with exertional hyperthermia which showed no significant mean difference in the rate of core body temperature reduction with the use of colder water immersion (9°C; 48.2°F) up to the iliac crest compared with passive cooling (mean difference 0.02°C/min; 95% CI -0.00-0.04).

For the critical outcome of rate of core body temperature reduction, we identified moderate certainty evidence (downgraded for risk of indirectness) from one controlled trial (Lee 2012 655) recruiting 4 adult subjects with exertional hyperthermia which showed a faster rate of core body temperature reduction with the use of colder water immersion (11.7°C; 53.0°F) of the torso compared with temperate water (23.5°C; 74.3°F) immersion (MD 0.08°C/min; 95% CI 0.02-0.14).

For the critical outcome of rate of core body temperature reduction, we identified low certainty evidence (downgraded for risk of indirectness and imprecision) from one controlled trial (Clapp 2001 160) recruiting 5 adult subjects with exertional hyperthermia which showed no significant mean difference in the rate of core body temperature reduction with the use of colder water immersion (10-12°C; 50.0-52.6°F) of the hands/feet compared with the use of colder water immersion of the torso (mean difference -0.09°C/min; 95% CI -0.19-0.01).

### **Ice Water Immersion (1-5°C; 33.8-41.0°F)**

For the critical outcome of mortality, we identified very low certainty evidence (downgraded for risk of imprecision) from one small observational cohort study (Hostler 2013 456) of 23 adult exertional heat stroke patients evaluating the use of ice water immersion (5-10°C; 33.8-41.0°F) of the torso and the administration of intravenous (IV) 0.9% normal saline at ambient temperature together compared with the use of ice bags applied to the axilla which showed no deaths in either group.

For the critical outcome of rate of core body temperature reduction, we identified low certainty evidence (downgraded for risk of inconsistency and indirectness) from four controlled trials (Clements 2002 146, Flouris 2014 2551, Gagnon 2010 157, Lühring 2016 946) recruiting 54 adult subjects with exertional hyperthermia and low certainty evidence from one observational cohort study (Armstrong 1996 355) enrolling 21 exertional heat stroke patients, which showed a faster rate of core body temperature reduction with the use of ice water immersion (1-5°C; 33.8-41.0°F) of the torso compared with passive cooling (MD range from 0.06 to 0.23°C/min). Due to high heterogeneity between studies, a pooled estimate of the difference in mean rates of body temperature reduction was not performed.

For the critical outcome of rate of core body temperature reduction, we identified moderate certainty evidence (downgraded for risk of indirectness) from two controlled trials (Friesen 2014 1727, Proulx 2003 1317) recruiting 27 adult subjects with exertional hyperthermia which showed a faster rate of core body temperature reduction with the use of ice water immersion (2°C; 35.6°F) of the torso compared with temperate water immersion (20-26°C; 68.0-78.8°F) of the torso (MD 0.14°C/min; 95% CI 0.09-0.18).

For the critical outcome of rate of core body temperature reduction, we identified low certainty evidence from one small observational cohort study (Hostler 2013 456) of 23 adult patients with exertional heat stroke which showed a faster rate of core body temperature reduction with the use of ice water immersion (5-10°C; 33.8-41.0°F) of the torso combined with the administration of IV 0.9% normal saline compared with the use of ice packs to the axilla (mean difference 0.06°C/min; 95% CI 0.01-0.11).

### **Evaporative Cooling (Mist and fan)**

For the critical outcome of rate of core body temperature reduction, we identified low certainty evidence (downgraded for risk of indirectness) from two controlled trials (Kielblock 1986 378, Sefton 2016 936) recruiting 23 adult subjects with exertional hyperthermia which showed no significant mean difference in the rate of core body temperature reduction with evaporative cooling compared with passive cooling (mean difference 0.01°C/min; 95% CI 0.00-0.01).

For the critical outcome of rate of core body temperature reduction, we identified low certainty evidence (downgraded for risk of indirectness and imprecision) from one controlled trial (Sinclair 2009 1984) recruiting 11 adult subjects with exertional hyperthermia which showed no significant mean difference in the rate of body temperature reduction with evaporative cooling compared with use of ice packs applied to the neck, axilla and groin (mean difference 0.00°C/min; 95% CI -0.01-0.01).

For the critical outcome of rate of core body temperature reduction, we identified low certainty evidence (downgraded for risk of indirectness and imprecision) from one controlled trial (Kielblock 1986 378) recruiting 5 adult subjects with exertional hyperthermia which showed no significant mean difference in the rate of body temperature reduction with evaporative cooling compared with the use of commercial ice packs applied to the neck, axilla and groin (MD 0.00°C/min; 95% CI -0.00-0.00).

For the critical outcome of rate of core body temperature reduction, we identified low certainty evidence (downgraded for risk of indirectness and imprecision) from one controlled trial (Kielblock 1986 378) recruiting 5 adult subjects with exertional hyperthermia which showed no significant mean difference in the rate of core body temperature reduction with evaporative cooling compared with the use of commercial ice packs applied to the whole body (mean difference 0.00°C/min; 95% CI -0.00-0.00).

For the critical outcome of rate of core body temperature reduction, we identified low certainty evidence (downgraded for risk of indirectness and imprecision) from one controlled trial (Kielblock 1986 378) recruiting 5 adult subjects with exertional hyperthermia which showed no significant mean difference in the rate of core body temperature reduction with evaporative cooling combined with the use of commercial ice packs to the neck, axilla and groin compared with passive cooling (mean difference 0.00°C/min; 95% CI -0.00-0.00).

For the critical outcome of rate of core body temperature reduction, we identified low certainty evidence (downgraded for risk of indirectness and imprecision) from one controlled trial (Kielblock 1986 378) recruiting 5 adult subjects with exertional hyperthermia which showed no significant mean difference in the rate of core body temperature reduction with the use of evaporative cooling and commercial ice packs to the neck, axilla compared with evaporative cooling alone (mean difference 0.00°C/min; 95% CI -0.00-0.00).

For the critical outcome of rate of core body temperature reduction, we identified low certainty evidence (downgraded for risk of indirectness and imprecision) from one controlled trial (Sinclair 2009 1984) recruiting 11 adult subjects with exertional hyperthermia showed no significant mean difference in the rate of core body temperature reduction using evaporative cooling compared with the administration of IV 0.9% normal saline at 20°C (68.0°F) (MD 0.00°C/min; 95% CI -0.01-0.01).

### Ice Sheets

For the critical outcome of rate of core body temperature reduction, we identified low certainty evidence (downgraded for risk of indirectness and imprecision) from two controlled trials (Butts 2017 e1951, DeMartini 2011 2065) recruiting 29 adult subjects with exertional hyperthermia which showed no significant mean difference in the rate of core body temperature reduction with the use of ice sheet application (bed sheets soaked in ice water kept at 3°C(37.4°F) and towels soaked in ice water kept at 14°C(57.2.0°F), respectively, to the body compared with passive cooling (mean difference 0.01°C/min; 95% CI -0.00-0.02).

For the critical outcome of rate of core body temperature reduction, we identified low certainty evidence (downgraded for risk of indirectness and imprecision) from one controlled trial (Nye 2017 294) recruiting 18 adult subjects with exertional hyperthermia which showed no significant mean difference in the rate of core body temperature reduction with the use of ice sheet application (sheets soaked in ice and water at 5-10°C; 33.8-41.0°F) to the body compared with colder water (5-10°C; 33.8-41.0°F) immersion (mean difference 0.02°C/min; 95% CI -0.01-0.05).

### Commercial Ice Packs

For the critical outcome of rate of core body temperature reduction, we identified low certainty evidence (downgraded for risk of indirectness and imprecision) from two controlled trials (Kielblock 1986 378, Lissoway 2015 173) recruiting 15 adult subjects with exertional hyperthermia which showed no significant mean difference in the rate of core body temperature reduction with the use of commercial ice packs to the neck, groin and axilla compared with passive cooling (mean difference 0.02°C/min; 95% CI -0.03-0.07).

For the critical outcome of rate of core body temperature reduction, we identified low certainty evidence (downgraded for risk of indirectness and imprecision) from one controlled trial (Kielblock 1986 378) recruiting 5 adult subjects with exertional hyperthermia which showed no significant mean difference in the rate of core body temperature reduction with the use of commercial ice packs to the whole body compared with passive cooling (mean difference 0.00°C/min; 95% CI -0.00-0.00).

For the critical outcome of rate of core body temperature reduction, we identified moderate certainty evidence (downgraded for risk of indirectness) from one controlled trial (Lissoway 2015 173) recruiting 10 adult subjects with exertional hyperthermia which showed a faster rate of core body temperature reduction with the use of commercial ice packs to the facial cheeks, palms and soles compared with passive cooling (mean difference 0.18°C/min; 95% CI 0.12-0.24).

For the critical outcome of rate of core body temperature reduction, we identified moderate certainty evidence (downgraded for risk of indirectness) from one controlled trial (Lissoway 2015 173) recruiting 10 adult subjects with exertional hyperthermia which showed a faster rate of core body temperature reduction with the use of commercial ice packs to the facial cheeks, palms and soles compared with the use of commercial ice packs applied to the neck, groin and axilla (mean difference 0.13 °C/min; 95% CI 0.09-0.17).

### **Fan Alone**

For the critical outcome of rate of core body temperature reduction, we identified low certainty evidence (downgraded for risk of indirectness and imprecision) from two controlled trials (Barwood 2009 385, DeMartini 2011 2065) recruiting 25 adult subjects with exertional hyperthermia which showed no significant mean difference in the rate of core body temperature reduction with the use of fanning alone compared with passive cooling (mean difference 0.02°C/min; 95% CI 0.00-0.04).

### **Cold Shower**

For the critical outcome of rate of core body temperature reduction, we identified moderate certainty evidence (downgraded for risk of indirectness) from one controlled trial (Butts 2016 252) recruiting 17 adult subjects with exertional hyperthermia which showed a faster rate of core body temperature reduction with the use of cold showers (20.8°C; 69.4°F) compared with passive cooling (mean difference 0.03 °C/min; 95% CI 0.01-0.05).

### **Hand Cooling Devices**

For the critical outcome of rate of core body temperature reduction, we identified low certainty evidence (downgraded for risk of indirectness and imprecision) from three controlled trials (Adams 2016 936, Maroni 2018 441, Zhang 2009 283) recruiting 29 adult subjects with exertional hyperthermia which showed no significant mean difference in the rate of core body temperature reduction with the use of hand cooling devices compared with passive cooling (mean difference 0.02°C/min; 95% CI -0.00-0.04).

### **Cooling Vests and Jackets**

For the critical outcome of rate of core body temperature reduction, we identified low certainty evidence (downgraded for risk of indirectness and imprecision) from two controlled trials (Brade 2010 164, Maroni 2008 441) recruiting 24 adult subjects with exertional hyperthermia which showed no significant mean difference in the rate of core body temperature reduction with the use of the Arctic Heat cooling jacket (Arctic Heat Products Pty Ltd, Queensland, Australia) compared with passive cooling (MD 0.01°C/min; 95% CI -0.01-0.03).

For the critical outcome of rate of body temperature reduction, we identified very low certainty evidence (downgraded for risk of inconsistency, indirectness and imprecision) from five controlled trials (Barwood 2009 385, Brade 2010 164, DeMartini 2011 2065; Lopez 2008 55, Smith 2018 413) recruiting 73 adult subjects with exertional hyperthermia that compared the use of various cooling vests with passive cooling, of which none evaluated showed no significant mean difference in the rate of core body temperature reduction when compared with passive cooling. Due to the high heterogeneity of commercial vests used between studies, pooled estimates were not performed.

### **Reflective Blankets**

For the critical outcome of rate of body temperature reduction, we identified low certainty evidence (downgraded for risk of indirectness and imprecision) from one controlled trial (Reynolds 2015 97) recruiting 20 adult subjects with exertional hyperthermia which showed no significant mean difference in rate of core body temperature reduction with the use of reflective blankets compared with passive cooling (mean difference -0.01°C/min; 95% CI -0.02 to -0.00).

### **Intravenous Fluids**

For the critical outcome of rate of core body temperature reduction, we identified low certainty evidence (downgraded for risk of indirectness and imprecision) from one controlled trial (Sinclair 2009 1984) recruiting 11 adult subjects with exertional

hyperthermia which showed no significant mean difference in the rate of core body temperature reduction with administration of 2 liters of IV 0.9% normal saline at 20°C(68°F) over 20 minutes compared with the use of ice packs to the neck, axilla and groin (mean difference 0.00°C/min; 95% CI -0.01-0.01).

For the critical outcome of rate of core body temperature reduction, we identified low certainty evidence (downgraded for risk of indirectness and imprecision) from one controlled trial (Morrison 2018 493) recruiting 12 adult subjects with exertional hyperthermia which showed no significant mean difference in the rate of body temperature reduction with administration of 2 liters of cold (4°C;39.2°F) IV 0.9% normal saline over 30 minutes compared with 2 liters of IV NS at 22°C(71.6°F) (mean difference 0.01°C/min; 95% CI -0.00-0.02).

For the critical outcome of mortality (with the exception of ice water immersion) and the important outcomes of clinically important organ dysfunction, adverse events and hospital length of stay, there were no comparator studies evaluating any of the above cooling techniques.

## Treatment Recommendations

For adults with exertional hyperthermia or exertional heat stroke:

- We recommend immediate active cooling using whole body (neck down) water immersion techniques (1-26°C; 33.8-78.8°F) until a core body temperature of less than 39°C (102.2°F) is reached (weak recommendation, very low certainty evidence).
- We recommend that where water immersion is not available, any other active cooling technique be initiated (weak recommendation, very low certainty of evidence).
- We recommend immediate cooling using any active or passive technique available to care providers that provides the most rapid rate of cooling (weak recommendation, very low certainty of evidence)

For adults with classic heat stroke, we cannot make a recommendation for or against any specific cooling technique compared with an alternative cooling technique (no recommendation, very low certainty evidence)

For children with exertional or classic heat stroke, we cannot make a recommendation for or against any specific cooling technique compared with an alternative cooling technique (no recommendation, very low certainty evidence).

### Technical remarks

1. The most rapid cooling was achieved using whole-body (from the neck down) water immersion techniques between 1-26°C (33.8-78.8°F). While there was heterogeneity in cooling rates between different water temperatures, colder water temperatures were associated with faster cooling rates.
2. Cooling rates achieved with water immersion techniques were faster than other active cooling modalities such as commercial ice packs, cold showers, evaporative cooling, ice sheets and towels, fanning, evaporative cooling, cooling vests and jackets. However, because confidence intervals cross for most of the mean weighted cooling rates for cooling techniques studied, we are unable to provide a rank order list. Graphically displayed trends in mean weighted cooling rates for cooling techniques are available in Figure 1 of the accompanying Evidence to Decision document.
3. The evidence summary consistently reports core body temperature as measured rectally. The absence of core rectal temperature measurement availability should not preclude initiation of whole-body cold-water immersion if available.

## Justification and Evidence to Decision Framework Highlights

This PICO was prioritized for review by the First Aid Task Force based on a) the importance of the problem; b) increases in the number of extreme heat events (heatwaves); c) major sporting events being held in hot climates; and d) survival and morbidity associated with heat stroke could be improved with rapid cooling.

In making these recommendations, the First Aid Task Force considered the following:

- With the exception of case series, there were no studies that evaluated cooling techniques for exertional heat stroke. This is likely due to ethical restraints related to the morbidity associated with heat stroke. In addition, none of the included studies evaluated cooling techniques in children.
- We noted that there is a wide variation of cooling methods employed across different regions and in different settings.



- It was considered feasible to provide whole-body (from the neck down) cold water immersion using relatively inexpensive “fit for purpose” equipment or improvised materials in most settings.
- Passive cooling (e.g. moving to cooler environment) is an essential part of the initial management of exertional hyperthermia and heat stroke based on consensus expert opinion. However, it is a slower cooling method compared with most other studied cooling modalities.
- Given the clinical consequences of delayed cooling for heat stroke, the Task Force considered that core temperature measurement should be available in first aid settings where there is a high risk of encountering heat stroke, such as sports events, particularly when high ambient or wet bulb temperatures were anticipated.
- The Task Force recognizes that the optimal immersion time to reduce core temperature to below 39°C is unknown. We considered that even in the absence of core temperature measurement, the use of water immersion, if available, should be continued until there has been resolution of symptoms or for a reasonable amount of time, such as 15 minutes, as benefit is more plausible than harm. To arrive at this time the Task Force created scenarios with different initial temperatures and different rates of cooling in an attempt to strike a balance between benefits and harms. Included studies did not report significant hypothermia or thermal injuries during cold-water immersion across the recommended temperature ranges.
- Combinations of less effective techniques may result in an overall faster cooling rate than if any technique is used alone, although this has not been studied.
- The Task Force recognizes that times required to cool a person with heat stroke or exertional hyperthermia will vary with their body size, age and multiple additional factors. The Task Force does not feel that a treatment recommendation that included specific time limits for cooling could be made in the absence of further clinical evidence.

## Knowledge Gaps

Current knowledge gaps include but are not limited to:

- There are no prospective comparative studies of cooling techniques for individuals with exertional or classic (nonexertional) heat stroke, and only a few cohort studies were identified for cooling of exertional stroke. Recommendations in this review are based on indirect evidence from exertional hyperthermia.
- There is an urgent need for studies investigating the optimal duration of cooling by cold water immersion techniques when core temperature measurement is unavailable
- Specific pediatric intervention studies for heat-related illness are lacking.
- There are no comparative studies of combined active with passive cooling techniques on rate of cooling and on clinical outcomes, for example, the use of ice packs with evaporative and passive cooling.
- There are no studies of the optimal method of cooling for heat related illness in children or based on body mass index
- Research is lacking into the ability of a first aid provider to recognize heat stroke without a core temperature measurement and the educational requirement to bridge this gap
- Research is required into the optimal approach of the management of extreme heat events involving multiple victims with heat related illness, including evaluation of the health economic impact and the impact of active cooling techniques.

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Zhang Y, Nepocaty S, Katica CP, Collins AB, Casaru C, Balilionis G, Sjökvist J, Bishop PA. Effect of Half Time Cooling on Thermoregulatory Responses and Soccer-Specific Performance Tests. *Monten J Sports Sci Med* 3. 2014;1: 17–22.

## 2019/2021 Search Strategy:

**Database: Ovid MEDLINE: Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Ovid MEDLINE® Daily and Ovid MEDLINE® <1946-Present>. (Re-run July 10, 2019)**

Search Strategy:

- 
- 1 exp Heat Stroke/
  - 2 heat exhaustion/
  - 3 heat stroke\*.tw,kf.
  - 4 heatstroke\*.tw,kf.
  - 5 heat exhaustion.tw,kf.
  - 6 (sunstroke\* or sun stroke\*).tw,kf.
  - 7 ((exertion or exertional or exercis\* or sport or sports or athlete\* or running or runner\*) and hyperthermia\*).tw,kf.
  - 8 ((exertion or exertional or exercis\* or sport or sports or athlete\* or running or runner\*) and hyperthermic).tw,kf.
  - 9 ((exertion or exertional or exercis\* or sport or sports or athlete\* or running or runner\*) and heat illness).tw,kf.
  - 10 ((exertion or exertional or exercis\* or sport or sports or athlete\* or running or runner\*) and heat related illness).tw,kf.
  - 11 or/1-10
  - 12 exp Cryotherapy/
  - 13 Cold Temperature/
  - 14 Immersion/
  - 15 ice/
  - 16 First Aid/
  - 17 emergency treatment/
  - 18 cooling.tw,kf.
  - 19 cold.tw,kf.
  - 20 cool.tw,kf.
  - 21 cooled.tw,kf.
  - 22 conduction.tw,kf.
  - 23 conductive.tw,kf.
  - 24 evaporation.tw,kf.
  - 25 evaporative.tw,kf.
  - 26 convection.tw,kf.
  - 27 convective.tw,kf.
  - 28 first aid.tw,kf.
  - 29 ice.tw,kf.
  - 30 immersion.tw,kf.
  - 31 or/12-30

- 32 11 and 31  
 33 limit 32 to (comment or editorial or letter)  
 34 32 not 33  
 35 34 not (animals/ not humans/)  
 36 remove duplicates from 35

**Database searched:** Ovid MEDLINE; CINAHL Plus

**Date Search Completed:** 13 October 2021

**Search Results (Number of articles identified / number identified as relevant):** 295 / 2

**Inclusion/Exclusion Criteria:** Studies that addressed EHS, NEHS or induced exertional hyperthermia with an intervention that was appropriate to first aid.

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

**Summary of Evidence Update:** There is minimal additional evidence to add to the review published in 2020.

### 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
Filep EM. 2020	Exertional Heat Stroke, Modality Cooling Rate, and Survival Outcomes: A Systematic Review.	Case reports of EHS	32	Identified reports of 498 cases with survival and 23 with mortality. Cooling rates $> 0.15^{\circ}\text{C/min}$ was significantly associated with survival and reduced mortality.	First aid for EHS should include aggressive cooling $> 0.15^{\circ}\text{C/min}$ .
Parker KC. 2020	Do Alternative Cooling Methods Have Effective Cooling Rates for Hyperthermia Compared With Previously Established CWI Cooling Rates?	<ul style="list-style-type: none"> <li>•P: hyperthermic individuals</li> <li>•I: alternative cooling methods</li> <li>•C: cold-water immersion</li> <li>•O: cooling rate</li> </ul>	9	Tarp-assisted cooling with oscillation (TACO) is the only effective alternative to cold water immersion (CWI) that gives an acceptable cooling rate.	CWI is the preferred therapy. TACO is acceptable if CWI is not available.
Douma et al, 2020	First Aid Task Force of the International Liaison Committee on Resuscitation. First aid cooling			Water immersion	See CoSTR above

	techniques for heat stroke and exertional hyperthermia: A systematic review and meta-analysis. Resuscitation. 2020 Mar 1;148:173-190. doi: 10.1016/j.resuscitation.2020.01.007. Epub 2020 Jan 22. PMID: 31981710.			produces fastest rates of cooling – colder is better.	
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**RCT: None**

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

### Nonrandomized Trials, Observational Studies

<b>Study Acronym; Author; Year Published</b>	<b>Study Type/Design; Study Size (N)</b>	<b>Patient Population</b>	<b>Primary Endpoint and Results (include P value; OR or RR; &amp; 95% CI)</b>	<b>Summary/Conclusion Comment(s)</b>
Chemically Activated Cooling Vest's Effect on Cooling Rate Following Exercise-Induced Hyperthermia: a Randomized Counter-Balanced Crossover Study. Hosokawa Y. 2020.	<u><b>Study Type:</b></u> non-randomized controlled trial; cross-over study	<u><b>Inclusion Criteria:</b></u> 14 recreationally active adults	<u><b>1° endpoint:</b></u> rate of body temperature reduction. Cooling vest resulted in a 0.02° C/min faster than passive cooling. P=0.02. 95% CI 0.01 - 0.03.	Cooling vests were better than passive cooling for EHS.
Comparing Body Bag Cooling to Cold Water Immersion Following Exertional Hyperthermia. Cutler, B. 2021.	<u><b>Study Type:</b></u> non-randomized controlled trial; cross-over study	<u><b>Inclusion Criteria:</b></u> 8 adults	<u><b>1° endpoint:</b></u> rate of body temperature reduction. The rate of cooling in a body bag was not different in a body bag compared to cold water immersion.	Trial failed to show a difference between potential therapies.

**Reviewer Comments (including whether meet criteria for formal review):** The search only located two observational studies that have been added since the last evidence review, each evaluating different cooling techniques. The updated search from 12/2021 identified studies examining mortality for different severities of heat stroke with cooling vs rehydration; a study of EMS adherence with pre-transport cooling for heatstroke; and a case report of hypothermia following cold water immersion for exertional heat illness. The additional studies do not meet inclusion criteria.

This topic does not currently meet criteria for an updated systematic review and the 2020 Treatment Recommendations remain unchanged.

	<b>Approval Date</b>
<b>Evidence Update coordinator</b>	
<b>ILCOR board</b>	

**\*Once approval has been made by Evidence Update coordinator, worksheet will go to ILCOR Board for acknowledgement.**

## Reference list

Cutler, Breana, Richins, Jenessa, Barker, Bryce, Rigby, Brock, Butts, Cory. Comparing Body Bag Cooling To Cold Water Immersion Following Exertional Hyperthermia: 1065. *Med Sci Sports Exerc.* 2021;53(8S):346. doi:10.1249/01.mss.0000763252.41508.c9.

Douma MJ, Aves T, Allan KS, Bendall JC, Berry DC, Chang WT, Epstein J, Hood N, Singletary EM, Zideman D, Lin S; First Aid Task Force of the International Liaison Committee on Resuscitation. First aid cooling techniques for heat stroke and exertional hyperthermia: A systematic review and meta-analysis. *Resuscitation.* 2020 Mar 1;148:173-190. doi: 10.1016/j.resuscitation.2020.01.007. Epub 2020 Jan 22. PMID: 31981710.

Filep EM, Murata Y, Endres BD, Kim G, Stearns RL, Casa DJ. Exertional Heat Stroke, Modality Cooling Rate, and Survival Outcomes: A Systematic Review. *Medicina (Kaunas).* 2020 Nov 5;56(11):589. doi: 10.3390/medicina56110589. PMID: 33167534; PMCID: PMC7694459.

Hosokawa Y, Belval LN, Adams WM, Vandermark LW, Casa DJ. Chemically Activated Cooling Vest's Effect on Cooling Rate Following Exercise-Induced Hyperthermia: A Randomized Counter-Balanced Crossover Study. *Medicina (Kaunas).* 2020 Oct 14;56(10):539. doi: 10.3390/medicina56100539. PMID: 33066469; PMCID: PMC7602153.

Parker KC, Shelton RR, Lopez RM. Do Alternative Cooling Methods Have Effective Cooling Rates for Hyperthermia Compared With Previously Established CWI Cooling Rates? *J Sport Rehabil*. 2020 Mar 1;29(3):367-372. doi: 10.1123/jsr.2019-0098. PMID: 31628268.

December 2021:

Monseau AJ, Hurlburt GA, Balcik BJ, Oppenlander KE, Chill NM, Martin PS. Status of US Emergency Medical Service Protocols Regarding Pre-Transfer Cooling for Exertional Heat Stroke. *Cureus*. 2021 Nov 12;13(11):e19505. doi: 10.7759/cureus.19505. PMID: 34912642; PMCID: PMC8666133.

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Stone GL, Sanchez LD. Hypothermia following cold-water immersion treatment for exertional heat illness. *Res Sports Med*. 2021 Aug 12:1-5. doi: 10.1080/15438627.2021.1966007. Epub ahead of print. PMID: 34383570.

**\*\*CONFIDENTIAL DO NOT DISTRIBUTE\*\*****2022 Evidence Update Worksheet****FA 1549: Oxygen for Acute Stroke**

**Worksheet author(s):** Wei-Tien Chang, Tetsuya Sakamoto, David A. Zideman, Eunice M. Singletary

**Task Force:** First Aid Task Force

**Date Submitted to SAC rep for peer review and approval:** September 22, 2021; Updated December 16, 2021

**Worksheet ID:** FA 1549 O2 for acute stroke

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

Among adults with suspected acute stroke in the pre-hospital setting receiving care by first responders/first aid providers (P), does use of normobaric supplementary oxygen (I), compared with no use of normobaric supplementary oxygen (C), change outcomes (O)?

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

2020

**Current (2020) ILCOR Consensus on Science and Treatment Recommendation for this PICOST:**

**Consensus on Science**

For the critical outcome of **survival** at one week, we identified moderate certainty evidence (downgraded for indirectness) from one randomized controlled trial {Roffe 2017 1206} recruiting 8003 adults with acute stroke showing no difference between use of continuous supplementary oxygen at 2-3 L/min via nasal cannula for 72h and use of room air (oxygen only if clinically indicated) (risk ratio 1.00, 95% CI 0.99-1.01).

For the critical outcome of **survival** at 3 months, we identified moderate certainty evidence (downgraded for indirectness) from one randomized controlled trial {Roffe 2017 1206} recruiting 8003 adult patients with acute stroke showing no difference between use of continuous supplementary oxygen at 2-3 L/min via nasal cannula for 72h (n=2668) and use of room air (n=2668) (risk ratio 1.0, 95% CI 0.98-1.01).

For the critical outcome of **survival** at 6 months, we identified moderate certainty evidence (downgraded for indirectness) from one randomized controlled trial {Ali 2014 937} recruiting 289 adult patients with acute stroke showing no difference between use of supplementary oxygen at 2-3 L/min via nasal cannula for 72h and use of room air (risk ratio 1.0, 95% CI 0.91-1.10).

For the critical outcome of **survival** at one year, we identified low certainty evidence (downgraded for risk of bias and indirectness) from one randomized controlled trial {Ronning 1999 408} recruiting 550 adult patients with acute stroke showing no difference between use of supplementary oxygen via nasal cannula at 3 L/min for 24h and use of room air (risk ratio 0.95, 95% CI 0.85-1.05).

For the critical neurological outcome of **neurological outcome** of National Institute of Health Stroke Scale (**NIHSS**) at one week, we identified low certainty evidence (downgraded for indirectness) from 5 randomized controlled trials {Ali 2014 937; Padma 2010 840; Singhal 2005 1035; Roffe 2017 1206; Roffe 2011 1297} recruiting 5969 adult patients with acute stroke showing no difference between use of supplementary oxygen at 2-4 L/min via nasal cannula, the use of facemask for 8-72h and the use of room air (absolute difference 0 points, 95% CI, -0.01 to 0.01).



For the critical **neurological outcome** of National Institute of Health Stroke Scale (**NIHSS**) at 3 months, we identified very low certainty evidence (downgraded for risk of bias, indirectness and imprecision) from 2 randomized controlled trial {Padma 2010 840; Singhal 2005 1035} recruiting 54 adult patients with acute stroke showing no difference between use of supplementary oxygen at 10-45 L/min via facemask for 8-12h and use of room air (oxygen only if clinically indicated) (absolute difference 0.62 points lower, 95% CI, -2.79 to 1.56).

For the critical **neurological outcome** of National Institute of Health Stroke Scale (**NIHSS**) difference between baseline and one week, we identified moderate certainty evidence (downgraded for indirectness) from one randomized controlled trial {Roffe 2011 1297} recruiting 289 adult patients with acute stroke showing no difference between use of continuous supplementary oxygen via nasal cannula at 2-3 L/min for 72h and use of room air (absolute difference 1.00 point lower, 95% CI -2.83 to 0.83).

For the critical **neurological outcome** of improvement of National Institute of Health Stroke Scale (NIHSS) score of more than 4 at one week, we identified moderate certainty evidence (downgraded for indirectness) from one randomized controlled trial {Roffe 2011 1297} recruiting 289 adult patients with acute stroke showing that the patients receiving supplementary oxygen at 2-3 L/min via nasal cannula for 72h had higher chance of NIHSS improvement of more than 4 at one week as compared to those breathing room air (risk ratio 2.19, 95% CI 1.37 to 3.51).

For the critical **neurological outcome** of favorable modified Rankin score (**mRS**) at hospital discharge, we identified very low certainty of evidence (downgraded for risk of bias) from one retrospective observational study {Dylla 2019} recruiting 1352 patients with acute stroke showing no difference between the patients without hypoxia at baseline receiving prehospital supplementary oxygen and those breathing room air (relative risk 1.06, 95% CI 0.84-1.33). The dosage of supplementary oxygen was not provided in this study.

For the critical **neurological outcome** of modified Rankin sore (**mRS**) at 3 months, we identified moderate certainty evidence (downgraded for indirectness) from three RCTs {Roffe 2017 1206; Singhal 2015 1035; Padma 2010 284}. The large RCT by Roffe et al. {Roffe 2017 1206} recruiting 8003 individuals showed no difference in mRS score for the group receiving supplementary oxygen at 2-3 L/min via nasal cannula for 72h and the group receiving room air (odds ratio 0.97, 95% C.I. 0.89 to 1.05). The RCT by Singhal (Singhal 2015 1035) recruiting 16 patients with acute stroke, found no difference in mRS score in the group receiving supplementary oxygen at 45 L/min by facemask for 8h compared with the group receiving room air (absolute difference 0.90 points higher, 95% CI -2.84 to 1.04). Oxygen was delivered if clinically indicated in the study by Singhal et al.

For the critical **neurological outcome** of modified Rankin sore (**mRS**) at 6 months, we identified low certainty evidence (downgraded for risk of bias and indirectness) from 2 randomized controlled trials {Ali 2014 937; Mazdeh 2015 1069} recruiting 340 adult patients with acute stroke showing no difference in mRS score with use of supplementary oxygen via nasal cannula or Venturi mask for 12-72h and room air (oxygen only if clinically indicated) (absolute difference 0.22 points lower, 95% CI -0.01 to 0.45).

For the critical **neurological outcome** of modified Rankin sore (**mRS**) less than 3 at 6 months, we identified low certainty evidence (downgraded for risk of bias and indirectness) from 2 randomized controlled trials {Ali 2014 937; Mazdeh 2015 1069} recruiting 340 adult patients with acute stroke showing no difference between supplementary oxygen via nasal cannula at 2-3 L/min for 72 hours or Venturi mask for 12-72h compared with room air (oxygen only if clinically indicated) (risk ratio 1.06, 95% CI 0.84 to 1.34).

For the critical **neurological outcome** of Scandinavian stroke scale (**SSS**) at 3 months, we identified low certainty evidence (downgraded for indirectness and imprecision) from one randomized controlled trial {Singhal 2015 1035} recruiting 16 adult patients with acute stroke showing no difference with use of supplementary oxygen at 45 L/min via simple facemask for 8h compared with room air (oxygen used only if clinically indicated) (absolute difference 5.00 points higher, 95% CI 5.65 points lower to 15.65 points higher).

For the critical **neurological outcome** of Scandinavian stroke scale (**SSS**) at 7 months, we identified low certainty evidence (downgraded for risk of bias and indirectness) from one randomized controlled trial {Ronning 1999 408} recruiting 550 adult patients with acute stroke showing benefit with use of supplementary oxygen at 3 L/min via nasal cannula for 24h compared with room air (SSS at 7 months: absolute difference 0.50 points lower, 95% CI 0.98 lower to 0.02 points lower).

For the important **quality of life outcome** of **Barthel index** at 3 months, we identified moderate certainty evidence (downgraded for indirectness) from one randomized controlled trial {Roffe 2017 1206} recruiting 8003 patients with acute stroke showing no difference with use of supplementary oxygen at 2-3 L/min via nasal cannula for 72h compared with room air (absolute difference 0.70 points lower, 95% CI 1.49 points lower to 2.89 points higher).

For the important **quality of life outcome** of **Barthel index** at 6 months, we identified very low certainty evidence (downgraded for risk of bias, indirectness and imprecision) from one randomized controlled trial {Mazdeh 2015 1069} recruiting 51 adult patients with acute stroke showing no difference with use of supplementary oxygen via Venturi mask for 12h compared with room air (absolute difference 7.70 points higher, 95% CI 11.01 points lower to 26.41 points higher).

For the important **quality of life outcome** of **Barthel index** at 7 months, we identified low certainty evidence (downgraded for risk of bias and indirectness) from one randomized controlled trial {Ronning 1999 1069} recruiting 550 adult patients with acute stroke showing that the patients receiving supplementary oxygen 3 L/min via nasal cannula for 24h had a lower Barthel index as compared with those breathing room air (absolute difference 5.00 points lower, 95% CI 6.24 points lower to 3.76 points lower).

For the important **quality of life outcome** of **Nottingham Extended ADL score** at 3 months, we identified moderate certainty evidence (downgraded for indirectness) from one randomized controlled trial {Roffe 2017 1206} recruiting 8003 patients with acute stroke showing no difference with use of supplementary oxygen at 2-3 L/min via nasal cannula for 72h compared with room air (absolute difference 0.11 lower, 95% CI 0.28 points lower to 0.50 points higher).

For the important **quality of life outcome** of (**EuroQOL [EQ5D-3L]**) score at 3 months, we identified moderate certainty evidence (downgraded for indirectness) from one randomized controlled trial {Roffe 2017 1206} recruiting 8003 patients with acute stroke showing no difference with use of supplementary oxygen at 2-3 L/min via nasal cannula for 72h compared with room air (absolute difference 0.01 points higher, 95% C.I. 0.03 points lower to 0.01 points higher).

For the important **quality of life outcome** of **VAS** for at 3 months, we identified moderate certainty evidence (downgraded for indirectness) from one randomized controlled trial {Roffe 2017 1206} recruiting 8003 patients with acute stroke showing no difference with use of supplementary oxygen at 2-3 L/min via nasal cannula for 72h compared with room air (absolute difference 0.10 points lower, 95% C.I. 1.67 points lower to 1.57 points higher).

For the important **imaging outcome of lesion volume** change at 6 hours, we identified low certainty evidence (downgraded for indirectness and imprecision) from one randomized controlled trial {Wu 2012 894} recruiting 16 adult patients with acute stroke showing no difference with use of high-flow supplementary oxygen via facemask for 8 h compared with room air (absolute difference 63% higher, 95% CI 16% lower to 142% higher).

For the important **imaging outcome of lesion volume** change at 24 hours, we identified low certainty evidence (downgraded for indirectness and imprecision) from one randomized controlled trial {Wu 2012 894} recruiting 16 adult patients with acute stroke showing no difference with use of high-flow supplementary oxygen via facemask for 8 h compared with room air (absolute difference 57% higher, 95% CI 60% lower to 174% higher).

For the important **imaging outcome of lesion volume** change at hospital discharge, we identified low certainty evidence (downgraded for indirectness and imprecision) from one randomized controlled trial {Wu 2012 894} recruiting 16 adult patients with acute stroke showing no difference with use of high-flow supplementary oxygen via facemask for 8 h compared with room air (absolute difference 31% higher, 95% CI 58% lower to 120% higher).

For the important **adverse effects and complications outcome of hospital-acquired pneumonia**, we identified very low certainty evidence (downgraded for risk of bias) from one retrospective observational study {Dylla 2019 30742} recruiting 1352 adult patients with acute stroke showing that the patients without hypoxia at baseline who received prehospital supplementary oxygen had a lower rate of hospital-acquired pneumonia compared with those breathing room air (risk ratio 0.50, 95% CI 0.26-0.98).

For the important **adverse effects and complications outcome of any documentation of pneumonia** at hospital discharge, we identified very low certainty evidence (downgraded for risk of bias) from one retrospective observational study {Dylla 2019 30742} recruiting 1352 adult patients with acute stroke showing no difference between patients without hypoxia at baseline who received prehospital supplementary oxygen compared with those breathing room air (risk ratio 1.77, 95% CI 0.97-3.21).

For the important **adverse effects and complications outcome of pulmonary edema**, we identified very low certainty evidence (downgraded for risk of bias) from one retrospective observational study {Dylla 2019 30742} recruiting 1352 adult patients with acute stroke showing no difference between patients without hypoxia at baseline who received prehospital supplementary oxygen compared with those breathing room air (risk ratio 1.41, 95% CI 0.52-3.86).

For the important **adverse effects and complications outcome of use of non-invasive positive pressure ventilation**, we identified very low certainty evidence (downgraded for risk of bias) from one retrospective observational study {Dylla 2019 30742} recruiting 1352 adult patients with acute stroke showing no difference between the patients without hypoxia at baseline who received prehospital supplementary oxygen and those breathing room air (risk ratio 1.57, 95% CI 0.56-4.38).

For the important **adverse effects and complications outcome of intubation** with mechanical ventilation, we identified very low certainty evidence (downgraded for risk of bias) from one retrospective observational study {Dylla 2019 30742} recruiting 1352 adult patients with acute stroke showing that the patients without hypoxia at baseline who received prehospital supplementary oxygen had a higher rate of intubation with mechanical ventilation in comparison with those breathing room air (risk ratio 2.80, 95% CI 2.1-3.70).

For the **adverse effects and complications outcome** of any **respiratory complications** during hospitalization, we identified very low certainty evidence (downgraded for risk of bias) from one retrospective observational study {Dylla 2019 30742} recruiting 1352 adult patients with acute stroke showing that the patients without hypoxia at baseline who received prehospital supplementary oxygen had a higher rate of respiratory complications in comparison with those breathing room air (risk ratio 1.92, 95% CI 1.54-2.39).

### **Treatment Recommendation**

For adults with suspected acute stroke, we suggest against the routine use of supplementary oxygen in the first aid setting compared with no use of supplementary oxygen (weak recommendation, low to moderate certainty of evidence)

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

- #1 MeSH descriptor: [Stroke] explode all trees
- #2 MeSH descriptor: [] explode all trees
- #3 MeSH descriptor: [Intracranial Hemorrhages] explode all trees
- #4 ((Infarct\* or h?emorrhag\* or stroke\*) near/2 (isch?mic or brain or cerebral or cerebrovascular or intracerebral or Intracranial or Subarachnoid or Lacunar)):ti,ab,kw
- #5 (acute cerebrovascular accident\* or cerebral vascular accident):ti,ab,kw
- #6 ((h?emorrhag\* or acute) near/1 stroke\*):ti,ab,kw
- #7 (transient isch?mic attack\*):ti,ab,kw
- #8 #1 or #2 or #3 or #4 or #5 or #6 or #7
- #9 MeSH descriptor: [Oxygen Inhalation Therapy] explode all trees
- #10 MeSH descriptor: [Hyperoxia] explode all trees
- #11 MeSH descriptor: [Oxygenators] explode all trees
- #12 MeSH descriptor: [Hypoxia] explode all trees
- #13 (Oxygen\* near/1 (diffusion or supplement\* or mask\* or cannula or administration\* or therap\* or nocturnal or treatment or continuous)):ti,ab,kw
- #14 eubarc hyperoxia
- #15 (normobaric near/1 (oxygen or hyperoxia or therap\* or treatment))
- #16 #9 or #10 or #11 or #12 or #13 or #14 or #15
- #17 #8 and #16
- #18 Hyperbaric oxygen:ti
- #19 Hyperbaric Oxygenation:ti
- #20 #18 or #19
- #21 #17 not #20
- #22 MeSH descriptor: [Child] explode all trees
- #23 MeSH descriptor: [Infant] explode all trees
- #24 #22 or #23
- #25 #21 not #24

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

**Database searched:**

Medline, Embase, and Cochrane

**Time Frame: (existing PICOST) – updated from end of last search****2021.09.16 ~ 2021.12.15****Date Search Completed:**

2021.12.16.

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

Number of articles identified: 683 (Embase + Medline 391, Cochrane 291)

Number of articles finally evaluated: 2

Number of relevant articles: 0

**Summary of Evidence Update:**

No relevant studies are identified in this evidence update.

There are two trials ongoing, one targeting at acute ischemic stroke while the other targeting at acute intracranial hemorrhage. The results could be helpful after the studies are completed.

**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**

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

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

Since there are no new relevant studies identified, no further systemic review or scoping review are needed at this stage.

A comprehensive systemic review is suggested after the ongoing trials are completed and further studies available. The 2020 Treatment Recommendation remains unchanged.

**\*\*CONFIDENTIAL DO NOT DISTRIBUTE\*\*****2022 Evidence Update Worksheet****Worksheet author(s):** Vere Borra**Task Force:** First Aid**Date Submitted:** 20/9/2021; Updated 6 Dec 2021**Worksheet ID:** FA 1585 Hypoglycemia glucose administration**PICO / Research Question:**

Among adults and children in any setting (in-hospital or out-of-hospital) with (suspected) hypoglycemia (P), does administration of glucose by any route appropriate for use by first aid providers (I), compared with administration of glucose by another route appropriate for first aid providers (C), improve outcome (O)?

**Outcomes:** Resolution of symptoms (critical); Time to resolution of symptoms (critical); Blood or plasma glucose concentration at 20 minutes (critical); Resolution of hypoglycemia (Important); Time to resolution of hypoglycemia (Important); Any adverse event (Important); Administration delay (Important).

**Type (intervention, diagnosis, prognosis):** Intervention**Additional Evidence Reviewer(s):** /**Conflicts of Interest (financial/intellectual, specific to this question):** none**Year of last full review:** 2018**Last ILCOR Consensus on Science and Treatment Recommendation:**

2018 CONSENSUS ON SCIENCE:

Buccal compared with oral administration of glucose:

*For the critical outcome of plasma glucose concentration at 20 min (mg/dL), we found evidence with very low certainty (downgraded for risk of bias, indirectness and imprecision) from one non-randomized controlled trial enrolling 16 healthy volunteers that showed benefit from oral glucose administration compared with buccal glucose administration (mean difference [MD]; 95% confidence interval [CI]) (MD, -15; 95%CI, -24.20– -5.80 with an assumed within subjects correlation coefficient of 0.1; P < 0.01; MD, -15; 95%CI, -18.07– -11.93 with an assumed within subjects correlation coefficient of 0.9; P < 0.01) (Chlup 2009 205).*

*For the critical outcome of blood glucose concentration at 20 min (mg/dL), measured as a dichotomous outcome (number of subjects with increased blood glucose at 20 min), we found evidence with very low certainty (downgraded for risk of bias, indirectness and imprecision) from one non-randomized controlled trial enrolling 7 healthy adult volunteers that showed benefit from oral glucose administration compared with buccal glucose administration. None (0/7) of the participants in the buccal administration group showed an increased blood glucose concentration while all (7/7) participants in the oral glucose administration group showed an increased blood glucose concentration (risk ratio [RR]; 95% CI)(RR, 0.00; 95%CI, 0.00– 0.55; P = 0.02) (Gunning 1976 1611).*

We did not identify any evidence to address the critical outcomes of resolution of symptoms and time to resolution of symptoms, and the important outcomes of adverse events, resolution of hypoglycemia, time to resolution of hypoglycemia and administration delay.

#### Combined oral and buccal compared with oral administration of glucose

*For the critical outcome of resolution of symptoms*, we identified evidence with low certainty (downgraded for risk of bias and imprecision) from one randomized controlled trial enrolling 41 adult participants with insulin-dependent diabetes that failed to demonstrate a benefit from combined oral and buccal glucose administration compared with oral glucose administration at 20 minutes (RR, 0.36; 95%CI, 0.12–1.14; P = 0.08; 587 fewer per 1,000 treated) following glucose administration (Slama 1990 589).

*For the critical outcome of blood glucose concentration at 20 min (mg/dL)* we identified low-certainty evidence (downgraded for risk of bias and imprecision) from the same study that failed to demonstrate a benefit from combined oral and buccal glucose administration compared with oral glucose administration (MD, -16; 95%CI, -34.32– -2.32; P = 0.09) (Slama 1990 589).

We did not identify any evidence to address the critical outcome of time to resolution of symptoms, and the important outcomes of adverse events, resolution of hypoglycemia, time to resolution of hypoglycemia and administration delay.

#### Sublingual compared with oral administration of glucose

*For the critical outcome of blood glucose concentration at 20 min (mg/dL)*, we found evidence with very low certainty (downgraded for risk of bias, indirectness and imprecision) from one randomized trial enrolling 69 children between 1 to 15 years of age with moderate symptoms of hypoglycemia related to acute malaria or respiratory tract infections that showed a benefit favoring sublingual sugar administration (2.5 g of wet sugar under the tongue) compared with oral glucose administration (2.5 g of sugar on the tongue) (MD, 17; 95%CI, 4.38–29.62; P = 0.01) (Barennes 2005 648).

*For the important outcome of adverse events*, we identified evidence of the rate of adverse events with very low certainty (downgraded for risk of bias, indirectness and imprecision) from the same study, however the RR was not able to be estimated as there were no reported adverse events in either group (Barennes 2005 648).

*For the important outcome of resolution of hypoglycemia*, defined as “early treatment (administration) failure rate” (the proportion of children with no blood glucose rise at 20 minutes), we found evidence with very low certainty (downgraded for risk of bias, indirectness and imprecision) from the same randomized trial that failed to demonstrate a benefit for sublingual glucose administration compared with oral glucose administration (RR, 0.28; 95%CI, 0.06–1.34; P = 0.11; 192 fewer per 1,000 treated) (Barennes 2005 648).

*For the important outcome of resolution of hypoglycemia*, defined as “treatment (administration) failure rate” (the proportion of children who did not reach blood glucose concentrations of  $\geq 0.9$  g/L within the 80 minute study period), we found evidence with very low certainty (downgraded for risk of bias, indirectness and imprecision) from the same randomized trial that showed a benefit of sublingual sugar administration



compared with oral glucose administration (RR, 0.03; 95% CI, 0.00–0.55;  $P = 0.02$ ; 517 fewer per 1,000 treated) (Barennes 2005 648).

*For the important outcome of time to resolution of hypoglycemia (minutes), we found evidence with very low certainty (downgraded for risk of bias, indirectness and imprecision) from the same randomized trial that showed a benefit of sublingual glucose administration compared with oral glucose administration (MD, -51.50; 95%CI, -57.97– -45.03;  $P < 0.01$ ) (Barennes 2005 648).*

We did not identify any evidence to address the critical outcomes of resolution of symptoms and time to resolution of symptoms, and the important outcome of administration delay.

## TREATMENT RECOMMENDATIONS

We recommend the use of oral glucose (swallowed) for individuals with suspected hypoglycemia who are conscious and able to swallow (strong recommendation, very low certainty of evidence).

We suggest against buccal glucose administration compared with oral glucose administration for individuals with suspected hypoglycemia who are conscious and able to swallow (weak recommendation, very low certainty of evidence).

If oral glucose (e.g. tablet) is not immediately available, we suggest a combined oral + buccal glucose (e.g. glucose gel) administration for individuals with suspected hypoglycemia who are conscious and able to swallow (weak recommendation, very low certainty of evidence).

We suggest the use of sublingual glucose administration for suspected hypoglycaemia for children who may be uncooperative with the oral (swallowed) glucose administration route (weak recommendation, very low certainty of evidence).

## Current Search Strategy:

- 1 Hypoglycemia/ OR (Hypoglycemi\* or hypoglycaemi\*).tw,kf. OR Healthy Volunteers/ OR (healthy participant or healthy participants or healthy subject or healthy subjects or healthy volunteer or healthy volunteers or human volunteer or human volunteers or normal volunteer or normal volunteers).tw,kf. OR healthy people.tw,kf. OR healthy persons.tw,kf.
- 2 Glucose/ OR (glucose or sugar).tw,kf.
- 3 drug administration routes/ or administration, inhalation/ or exp administration, oral/ or Administration, Rectal/ OR administ\*.tw,kf.
- 4 (buccal\* or sublingual\* or oral\* or by mouth or rectal\* or tablet\* or liquid\* or gel or gels or sachet\* or spray or sprays or tongue or cheek or swallow\* or administration route\*).tw,kf. OR Solutions/ OR Tablets/ OR Cheek/ OR Gels/
- 5 1 and 2 and 3 and 4
- 6 limit 5 to (case reports or comment or congresses or editorial or letter)
- 7 5 not 6
- 8 7 not (animals/ not humans/)
- 9 Limit 8 to yr="2018-Current"

**Database searched:** Medline Ovid

**Date Search Completed:** 13 September 2021; Search dates: 1/1/2018 – 13/9/2021. Search updated on 06/12/2021

**Search Results (Number of articles identified / number identified as relevant):** 259 original articles screened by title and abstract / 0 articles included

### **Inclusion/Exclusion Criteria:**

*Population:* Adults and children in any setting (in-hospital or out-of-hospital) with (suspected) hypoglycaemia. We will not include neonates, as we believe the identification of hypoglycemia in this age group is a specialized diagnostic and treatment process well beyond First Aid.

*Intervention:* administration of glucose by any route appropriate for use by first aid providers

*Comparison:* administration of glucose by another route appropriate for first aid providers

*Outcomes:*

- Resolution of symptoms (critical) – defined as the reversal of the initial symptoms (dichotomous outcome; yes/no);
- Time to resolution of symptoms (critical) - defined as the time from the administration of the sugar containing solution until the symptoms resolved (continuous outcome);
- Blood or plasma glucose concentration at 20 minutes (critical) – defined as the glucose level as measured 20 minutes after the administration of the sugar substrate (continuous outcome) or as evidence of blood or plasma glucose elevation at 20 minutes (dichotomous outcome; yes/no);
- Resolution of hypoglycemia (Important) – defined as elevation of the blood glucose level to rise above the authors' threshold for determining hypoglycemia (dichotomous outcome; yes/no);
- Time to resolution of hypoglycemia (Important) - defined as the time from the administration of the sugar containing solution until the blood glucose concentration rose above the threshold for the authors' definition of hypoglycemia (continuous outcome);
- Any adverse event (Important) – any event resulting from the administration as defined by the study authors (e.g. aspiration);
- Administration delay (Important) – defined as the delay in administering the sugar containing solution as a result of the administration arm (dichotomous outcome; yes/no).

*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.

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

N/A

### **Summary of Evidence Update:**

No new relevant studies were included.

### **Relevant guidelines or Systematic Reviews:** None

**RCT:** None

**Nonrandomized Trials, Observational Studies:** None

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

No new studies were identified with this search; the current treatment recommendations remain valid.

	<b>Approval Date</b>
<b>Evidence Update coordinator</b>	
<b>ILCOR board</b>	

**\*Once approval has been made by Evidence Update coordinator, worksheet will go to ILCOR Board for acknowledgement.**

**Updated references:** None

**Prior references:**

Barenes H, Valea I, Nagot N, Van de Perre P, Pussard E. Sublingual Sugar Administration as an Alternative to Intravenous Dextrose Administration to Correct Hypoglycemia Among Children in the Tropics. *Pediatrics* 2005, 116(5):e648-e653

Chlup R, Zapletalova J, Peterson K, Poljakova I, Lenhartova E, Tancred A, Perera R, Smital J. Impact of buccal glucose spray, liquid sugars and dextrose tablets on the evolution of plasma glucose concentration in healthy persons. *Biomed Pap Med Fac Univ Palacky Olomouc Czech Repub* 2009, 153(3):205-209

Gunning RR, Garber AJ. Bioactivity of Instant Glucose. Failure of Absorption through Oral Mucosa. *JAMA* 1978, 240:1611-1612

Slama G, Traynard P, Desplanque N, Pudar H, Dhunpath I, Letanoux M, Bornet FRJ, Tchobroutsky G. The Search for an Optimized Treatment of Hypoglycemia. Carbohydrates in Tablets, Solution, or Gel for the Correction of Insulin Reactions. *Arch Intern Med* 1990, 150:589-593

**\*\*CONFIDENTIAL DO NOT DISTRIBUTE\*\*****2022 Evidence Update Worksheet****Worksheet author(s):** Craig Goolsby**Council:** First Aid**Date Submitted:** 9/23/21**Worksheet ID:** New-Peds Tourniquet**PICO / Research Question:**

PICOST	Description
<b>Population</b>	Children (<19 years of age) with severe, life-threatening bleeding from an extremity wound
<b>Intervention</b>	commercial elastic wrap tourniquet or commercial ratcheting tourniquet
<b>Comparison</b>	commercial windlass-type tourniquet
<b>Outcomes</b>	Any clinical outcome.
<b>Study Design</b>	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) modelling studies, studies of tourniquets applied solely to maintain a bloodless surgical field, or those relating only to education are excluded.
<b>Timeframe</b>	All languages are included as long as there is an English abstract. Previous search run September 2020. Search updated from Jan 1, 2020 forward.

**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:**

2021

Two cohort studies including 73 patients ages 2 to 16 years met our eligibility criteria. Evidence from both studies was of very low certainty. Additional experimental studies using models and manikins were considered by the task force within the context of the GRADE evidence-to-decision process.

For the critical outcome of **control of bleeding**, no studies were identified that compared the use of one tourniquet type with another tourniquet type. Two cohort studies enrolling a total of 73 children between 2 and 16 years of age and utilizing a manufactured windlass rod tourniquet were identified.<sup>396,397</sup> The first study was conducted on 60 uninjured volunteers in an orthopedic office (ages 6–16 years)<sup>396</sup> using a windlass rod tourniquet applied by researchers to an uninjured extremity. The second study was conducted on 13 volunteers (2–7 years old) using the same manufactured windlass rod tourniquet on an uninjured extremity while under anesthesia in an operating room.<sup>397</sup> Pooled data showed cessation of pulses in 71/71 (100%) of

the upper extremities and in 69/73 (94.5%) of the lower extremities. Tourniquet failures in the unanesthetized group were due to an inability to continue secondary to pain (n=1) and in the anesthetized group because of an inability to occlude the distal pulse after a prespecified maximum of 3 windlass turns (n=3).<sup>396</sup>

No evidence was identified for the outcomes of mortality, blood loss, and shock/hypotension.

### Treatment Recommendations

- We suggest the use of a manufactured windlass tourniquet for the management of life-threatening extremity bleeding in children (weak recommendation, very low-certainty evidence).
- We are unable to recommend for or against the use of other tourniquet types in children because of lack of evidence.
- For infants and children with extremities that are too small to allow the snug application of a tourniquet before activating the circumferential tightening mechanism, we recommend the use of direct manual pressure with or without the application of a hemostatic trauma dressing (good practice statement).

### Justification and Evidence-to-Decision Framework Highlights

This topic was prioritized by the First Aid Task Force after a ScopRev<sup>393,394</sup> identified emerging evidence from human studies of tourniquet use in children. Previous reviews of adult and pediatric literature identified experimental studies of tourniquet use in pediatric models such as polyvinyl chloride pipes that demonstrated failure of adult tourniquets on smaller pipe sizes.<sup>398</sup>

In making this recommendation, the First Aid Task Force weighed the lack of direct evidence to show that tourniquets are a lifesaving intervention for life-threatening extremity bleeding in children against the previously established role of a manufactured windlass tourniquet in reducing mortality in adults with life-threatening extremity bleeding.<sup>392</sup> The Combat Application Tourniquet Generation 7 was the specific brand of windlass rod tourniquet used in both included studies, and the minimum limb circumference of the children included was 13 cm. Other windlass rod tourniquets may vary in their ability to tighten successfully on limbs with small circumferences. While some data are available from studies using manikins or models such as polyvinyl chloride pipes and stair rails, these studies were felt to be too indirect to be included.<sup>398,399</sup> Review of these studies in the evidence-to-decision process suggests that the rigid mechanism of some tourniquets can preclude successful application on limbs with small circumferences.

It is the consensus of the task force that for children less than 2 years of age, body size and a lower relative pressure would likely make direct manual pressure more effective for control of life-threatening extremity bleeding. While it may be difficult for providers to determine whether a child is 2 years or older, the task force discussed that the typical habitus of a toddler, rather than an infant, could be used to help make this determination.

### Task Force Knowledge Gaps

- Urgent need for RCTs in the prehospital setting to determine which tourniquet designs produce beneficial outcomes in children
- Younger age and size limits for manufactured tourniquets, and which can be applied to both upper and lower extremities to control hemorrhage
- Data on complications of tourniquet use in children
- Data on efficacy and speed of application of tourniquets on children by first aid providers

### References

395. Charlton NP, Goolsby CA, Singletary EM, Zideman D, Maconochie I, on behalf of the International Liaison Committee on Resuscitation First Aid and Pediatric Life Support Task Forces. Pediatric tourniquet types: first aid new TF SR. <https://costr.ilcor.org/document/pediatric-tourniquet-types-first-aid-new-tf-sr>. Accessed March 10, 2021.
396. Harcke HT, Lawrence LL, Gripp EW, Kecskemethy HH, Kruse RW, Murphy SG. Adult tourniquet for use in school-age emergencies. *Pediatrics*. 2019;143 doi: 10.1542/peds.2018-3447
397. Kelly JR, Levy MJ, Reyes J, Anders J. Effectiveness of the combat application tourniquet for arterial occlusion in young children. *J Trauma Acute Care Surg*. 2020;88:644-647. doi: 10.1097/ta.0000000000002594
398. El-Sherif N, Lowndes B, Franz W, Hallbeck MS, Belau S, Sztajnkrzyer MD. Sweating the little things: tourniquet application efficacy in two models of pediatric limb circumference. *Mil Med*. 2019;184:361-366. doi: 10.1093/milmed/usy283
399. Kragh JF Jr, Wright-Aldossari B, Aden JK 3rd, Dubick MA. Ease of use of emergency tourniquets on simulated limbs of infants: deliberate practice. *J Spec Oper Med*. 2019;19:41-47.

## 2020 Search Strategy:

- #1 'tourniquet'/exp OR tourniquet\$:ti,ab,kw,de OR windlass:ti,ab,kw,de OR ((elastic NEAR/3 (ring OR band OR wrap OR strap)):ti,ab,kw,de) 11,243
- #2 #1 NOT ('snakebite'/de OR 'spider bite'/de OR 'venom'/de OR 'hypospadias'/de OR 'arthroscopy'/exp OR snake:kw,de OR spider:kw,de OR hypospadias:kw,de OR arthroscop\*:kw,de) 10,619
- #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) 7,652
- #4 'bleeding'/de OR 'wound hemorrhage' OR haemorrhag\*:ti,ab OR hemorrhag\*:ti,ab OR exsanguinat\*:ti,ab OR bleed\*:ti,ab OR 'blood loss':ti,ab,kw,de 791,116
- #5 'traumatic amputation'/de OR trauma\*:ti,ab OR amputat\*:ti,ab 530,698
- #6 'arm injury'/de OR 'leg injury'/de OR 'limb injury'/de 18,791
- #7 'battle injury'/de OR 'blast injury'/de 9,003
- #8 #3 AND #4 1,652
- #9 #3 AND #5 754
- #10 #3 AND #6 128
- #11 #3 AND #7 134
- #12 #8 OR #9 OR #10 OR #11 2,099
- #13 'newborn'/exp OR 'infant'/exp OR 'child'/exp OR 'adolescent'/exp OR 'pediatrics'/exp OR infant\*:de,kw,ab,ti OR baby:de,kw,ab,ti OR babies:de,kw,ab,ti OR paediatric\*:de,kw,ab,ti OR pediatric\*:de,kw,ab,ti OR kid\*:de,kw,ab,ti OR child\*:de,kw,ab,ti OR 'pre-adolescen\*':de,kw,ab,ti OR 'preadolescen\*':de,kw,ab,ti OR "adolescen\*":de,kw,ab,ti OR teenager:de,kw,ab,ti OR juvenile:de,kw,ab,ti OR youth:de,kw,ab,ti OR ((young NEAR/3 (person OR people)):de,kw,ab,ti) 4,632,610
- #14 #12 AND #13 250
- #15 tourniquet:ti OR tourniquet\$:ti OR windlass:ti OR ((elastic NEAR/3 (ring OR band OR wrap OR strap)):ti) 3,117
- #16 #15 NOT ('snakebite'/de OR 'spider bite'/de OR 'venom'/de OR 'hypospadias'/de OR 'arthroscopy'/exp OR snake:kw,de OR spider:kw,de OR hypospadias:kw,de OR arthroscop\*:kw,de) 3,020
- #17 #16 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) 2,275
- #18 #13 AND #17 171

#19 #14 OR #18

Rewritten 9 Sept 2021: OVID running Embase and Medline: 225 results to 9<sup>th</sup> Sept 2021

1. "exsanguinat\*".mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy]
2. "bleed\*".mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy]
3. "blood loss".mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy]
4. "haemorrhag\*".mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy]
5. "hemorrhag\*".mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy]
6. 1 or 2 or 3 or 4 or 5
7. "trauma\*".mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy]
8. "amputat\*".mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy]
9. "arm injury".mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy]
10. "leg injury".mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy]
11. "limb injury".mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy]
12. "battle injury".mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy]
13. "blast injury".mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy]
14. 7 or 8 or 9 or 10 or 11 or 12
15. ((elastic NEAR/3 (ring OR band OR wrap OR strap)))
16. "infant\*".mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy]
17. "baby".mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy]
18. "paediatric\*".mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy]
19. "pediatric\*".mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy]
20. "kid\*".mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy]
21. "child\*".mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy]
22. "pre-adolescen\*".mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy]
23. "preadolescen\*".mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy]
24. "teenager".mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy]
25. "juvenile".mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy]
26. "youth".mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy]
27. "newborn".mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy]
28. child.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy]
29. babies.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy]
30. adolescen\*.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy]
31. young.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy]
32. 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31
33. 6 and 14
34. ((tourniquet\* or windlass or elastic\* ring or elastic\* band or elastic\* wrap or elastic\* strap) not (venom or hypospadias or arthroscopic\* or spider\* or snake\*)).mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy]
35. 33 and 34
36. 32 and 35

**Database searched:** Embase, Medline

**Date Search Completed:** 10/1/2020, 9/9/21

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

**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) are eligible for inclusion. Unpublished studies (e.g., conference abstracts, trial protocols) are excluded.

**Link to Article Titles and Abstracts (if available on PubMed):** N/A

**Summary of Evidence Update:** 225 abstracts screened, 0 full text review.

**Evidence Update Process for topics not covered by ILCOR Task Forces**

1. N/A

**Relevant Guidelines or Systematic Reviews:**

1. Charlton NP, Goolsby CA, Zideman DA, Maconochie IK, Morley PT, Singletary EM. Appropriate Tourniquet Types in the Pediatric Population: A Systematic Review. Cureus. 2021 Apr 13;13(4):e14474. doi: 10.7759/cureus.14474. PMID: 33996333; PMCID: PMC8118807.

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

No new studies have been identified since the previous search was performed for the 2020 CoSTR. There is no indication of a need to update the existing systematic review, and the previous 2020 treatment recommendation remains valid.

	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. Charlton NP, Goolsby CA, Zideman DA, Maconochie IK, Morley PT, Singletary EM. Appropriate Tourniquet Types in the Pediatric Population: A Systematic Review. Cureus. 2021 Apr 13;13(4):e14474. doi: 10.7759/cureus.14474. PMID: 33996333; PMCID: PMC8118807.