QUESTION

Should different pad orientation (i.e. AP) vs. standard position (AL) be used for children with cardiac arrest and a shockable rhythm at any time during cardiopulmonary resuscitation (CPR)?	
POPULATION:	children with cardiac arrest and a shockable rhythm at any time during cardiopulmonary resuscitation (CPR)
INTERVENTION:	different pad orientation (i.e. AP)
COMPARISON:	standard position (AL)
MAIN OUTCOMES:	Survival to hospital discharge with good neurological outcome; Return of spontaneous circulation; Return of spontaneous circulation; Survival to hospital discharge with good neurological outcome; Survival to hospital discharge; Survival to hospital discharge; VF termination;
SETTING:	
PERSPECTIVE:	
BACKGROUND:	
CONFLICT OF INTERESTS:	

ASSESSMENT

Problem
Is the problem a priority?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ No ○ Probably no ○ Probably yes ● Yes ○ Varies ○ Don't know	Survival from sudden cardiac arrest is low. Patients who present in an shockable rhythm have a higher rate of good outcome. Approximately 20% of VF adult patients, however, will remain in VF despite standard resuscitation interventions. In addition, transthoracic impedance (TTI) may vary based on pad size and orientation and this may have an impact on shock success. Different pad orientations may also result in a higher voltage gradient in different area of the myocardium from where fibrillation may start/restart.	

Desirable Effects
How substantial are the desirable anticipated effects?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS

○ Trivial ○ Small ● Moderate ○ Large ○ Varies ○ Don't know	Improvement in ROSC, long term survival, and neurologic outcome are desirable. However, there are no studies in patients at early-stage VF/pulseless VT directly comparing the effects of different pad positions on defibrillation success, ROSC and long term survival. Indeed, the recent trial from Cheskes, 2022, compared vector change vs. standard pad position, i.e. AP vs. AL position, only in refractory VF patients. Most studies evaluates cardioversion (eg, AF) or secondary endpoints (eg, TTI). There are no studies in children that compare pads different orientation and placement.	In 2022 the topic related to the pads position has been challenged by a cluster-randomized trial with crossover (Cheskes, 2022, 1947) evaluating, among new defibrillation strategies, the vector-change (VC) defibrillation to the anterior-posterior (AP) position, compared with the standard (anterior-lateral (AL)) defibrillation in adult patients with refractory ventricular fibrillation (VF) during out-of-hospital cardiac arrest (OHCA). Refractory VF was defined as an initial presenting rhythm of VF or pulseless ventricular tachycardia (VT) that was still present after three consecutive standard defibrillations. A total of 136 patients were assigned to receive standard defibrillation while 144 received VC defibrillation. Survival to hospital discharge was more common in the VC group than in the standard group (21.7% vs. 13.3%; RR, 1.71; 95% CI, 1.01 to 2.88). No difference in good neurological outcome (RR 1.48 [95% CI, 0.81 to 2.71]) nor in ROSC (RR 1.39 [95% CI, 0.97–1.99]) was reported between VC vs. standard defibrillation. Termination of VF occurred 79.9% of VC defibrillations compared to 67.6% of standard ones (RR 1.18 [95% CI, 1.03 to 1.36]).

Undesirable Effects
How substantial are the undesirable anticipated effects?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ Trivial ○ Small ○ Moderate ○ Large ○ Varies ● Don't know	Available evidence is inconclusive.	

Certainty of evidence
What is the overall certainty of the evidence of effects?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS

● Very low ○ Low ○ Moderate ○ High ○ No included studies	The randomized trial from Cheskes, 2022, compared vector change vs. standard pad position only in refractory VF patients. This is the first showing a benefit from VC compared with SD for VF termination and survival to discharge and only a possible benefit for ROSC and survival with favorable neurologic outcome (not statistically significant). There are no other studies in patients on early-stage VF/pulseless VT directly comparing the effects of various pad positions on patient outcome. There are no studies in pediatric populations.	

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

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ Important uncertainty or variability ○ Possibly important uncertainty or variability ○ Probably no important uncertainty or variability ● No important uncertainty or variability		

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

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ Favors the comparison ○ Probably favors the comparison ○ Does not favor either the intervention or the comparison ● Probably favors the intervention ○ Favors the intervention ○ Varies ○ Don't know	There is no evidence in favour the intervention or the comparison for the initial treatment of shockable cardiac arrest. However, if we consider the condition of refractory VF, although the certainty of evidence is very low, the existing evidence suggests a beneficial effect with VC compared with standard AL pad position in VF termination and survival with good neurological outcome.	AP positioning in easier to stablish in children.

Acceptability
Is the intervention acceptable to key stakeholders?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ No ○ Probably no ● Probably yes ○ Yes ○ Varies ○ Don't know	If beneficial, stakeholders will likely accept the intervention.	

Feasibility
Is the intervention feasible to implement?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ No ○ Probably no ○ Probably yes ● Yes ○ Varies ○ Don't know		

SUMMARY OF JUDGEMENTS

	JUDGEMENT						
PROBLEM	No	Probably no	Probably yes	**Yes**		Varies	Don't know
DESIRABLE EFFECTS	Trivial	Small	**Moderate**	Large		Varies	Don't know
UNDESIRABLE EFFECTS	Trivial	Small	Moderate	Large		Varies	**Don't know**
CERTAINTY OF EVIDENCE	**Very low**	Low	Moderate	High			No included studies
VALUES	Important uncertainty or variability	Possibly important uncertainty or variability	Probably no important uncertainty or variability	**No important uncertainty or variability**			
BALANCE OF EFFECTS	Favors the comparison	Probably favors the comparison	Does not favor either the intervention or the comparison	**Probably favors the intervention**	Favors the intervention	Varies	Don't know
ACCEPTABILITY	No	Probably no	**Probably yes**	Yes		Varies	Don't know
FEASIBILITY	No	Probably no	Probably yes	**Yes**		Varies	Don't know

TYPE OF RECOMMENDATION

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

CONCLUSIONS

Recommendation

For manufacturers:
There is insufficient evidence to recommend a specific pad placement for optimal external defibrillation in children (Good Practice Statement).
We suggest that manufacturers of AEDs standardize pad placement in an anterior-posterior position for infants and young children (with one pad anteriorly, over the left precordium, and the other pad posteriorly to the heart just inferior to the left scapula) (Good Practice Statement).
For BLS providers:
We recommend that BLS providers follow the AED's specific guidance and instructions for pads placement in children (Good practice statement).
For ALS providers:
We suggest that ALS providers follow manufacturer's specific guidance and instructions for pad placement in children (weak recommendation, very low certainty of evidence).
We suggest that initially ALS providers place pads in an anterior-posterior position as described above (weak recommendation, very low certainty of evidence).

Justification

In making these recommendations, the PLS Task Force considered the following:
- Pulseless shockable rhythms are more common in adults than in children and vary according to the age. The low frequency of these rhythms contributes to the lack of information on pediatric defibrillation. We do not know the incidence of refractory shockable rhythms in children.
- Transthoracic impedance varies based on pad size and position, and this may impact shock success. Different pad orientations/positions may also result in a higher voltage gradient in different areas of the myocardium from where fibrillation may start/restart.
- The four studies included were all adults studies and at serious risk of bias, and only one was a RCT (Cheskes, 2022, 1947).
- No studies directly compare the effects of different pad placement on patient outcomes outside of refractory shockable rhythms in adults.
- A secondary analysis of the DOSE VF trial (Cheskes, 2024, 110186), which explored the relationship between alternative defibrillation strategies employed and the type of VF, i.e. shock-refractory VF or recurrent VF, on patient outcomes, showed that vector-change defibrillation compared to standard pads placement, was not superior for VF termination, ROSC, or survival for shock-refractory VF; for recurrent VF, vector-change defibrillation was superior to standard pads placement only for VF termination, but not for ROSC or survival.
- There are no studies examining defibrillation pad orientation for IHCA. However, this evidence could be applied to the IHCA, with additional downgrading for indirectness.
- Paddles may still be in use in some low-resource settings. However, the Task Force acknowledges that the anterior-posteriorposition is not feasible with paddles and that paddle sizes are those standard as provided by the manufacturer. The Task Force did not foresee future development in the use of paddles.
- In pediatric resuscitation, pads are also used as real-time feedback devices for quality assessment of chest compressions. For chest compression metric measurement pads are generally needed to be positioned in AP.
- Anterio-posterior positioning of pads is easier in children than in adults.
- AEDs have pictoral representation to guide providers in correct pad positioning. Most AEDs for pediatric patients depict AP positioning. However, there is a wide variation in this recommendations and evidence suggests that correct anatomical pad placement is poor, such that a clearer, more effective diagram is urgently needed. In a recent study in adults, untrained bystanders failed to achieve accurate defibrillation pad placement, when guided by current defibrillation pad diagrams (Deakin 2019 282).
- In most cases, bias was assessed per comparison rather than per outcome, since there were no meaningful differences in bias across outcomes. In cases where differences in risk of bias existed between outcomes this was noted.

Subgroup considerations

None.

Implementation considerations

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

Monitoring and evaluation

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

Research priorities

- No studies examined the paediatric/in-hospital setting.
- No RCTs have compared different pad positions with standard positions in any patient population, in the first 3 shocks.
- No studies have evaluated pad placement in unique populations.
- No studies evaluated the interaction between pad size and orientation.

REFERENCES SUMMARY

Author(s):
Question: Different pad orientation (i.e. AP) compared to standard position (AL) for children with cardiac arrest and a shockable rhythm at any time during cardiopulmonary resuscitation (CPR)
Setting:
Bibliography:

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	different pad orientation (i.e. AP)	standard position (AL)	Relative (95% CI)	Absolute (95% CI)		
Survival to hospital discharge with good neurological outcome												
1	randomised trials	serious[a]	not serious	very serious[b,c]	very serious[d]		51/144 (35.4%)	36/136 (26.5%)	**RR 1.39** (0.97 to 1.99)	**103 more per 1000** (from 8 fewer to 262 more)	⨁◯◯◯ [a,b,c,d]	IMPORTANTE
Return of spontaneous circulation												
1	non-randomised studies	very serious[e,f,g,h]	not serious	very serious[c,i]	not serious		117/158 (74.1%)	49/97 (50.5%)	**OR 2.64** (1.50 to 4.65)	**224 more per 1000** (from 100 more to 321 more)	⨁◯◯◯ [c,e,f,g,h,i]	IMPORTANTE
Return of spontaneous circulation												
1	randomised trials	serious[a]	not serious	very serious[b,c]	very serious[d]		51/144 (35.4%)	36/136 (26.5%)	**RR 1.39** (0.97 to 1.99)	**103 more per 1000** (from 8 fewer to 262 more)	⨁◯◯◯ [a,b,c,d]	IMPORTANTE
Survival to hospital discharge with good neurological outcome												
1	non-randomised studies	very serious[e,f,g,h]	not serious	very serious[c,i]	not serious		54/158 (34.2%)	22/97 (22.7%)	**OR 1.86** (0.98 to 3.51)	**126 more per 1000** (from 4 fewer to 280 more)	⨁◯◯◯ [c,e,f,g,h,i]	CRÍTICO
Survival to hospital discharge												
1	randomised trials	serious[a]	not serious	very serious[b,c]	serious[d]		31/143 (21.7%)	18/135 (13.3%)	**RR 1.71** (1.01 to 2.88)	**95 more per 1000** (from 1 more to 251 more)	⨁◯◯◯ [a,b,c,d]	CRÍTICO
Survival to hospital discharge												
1	non-randomised studies	very serious[e,f,g,h]	not serious	very serious[c,i]	not serious		54/158 (34.2%)	25/97 (25.8%)	**OR 1.55** (0.83 to 2.90)	**92 more per 1000** (from 34 fewer to 244 more)	⨁◯◯◯ [c,e,f,g,h,i]	CRÍTICO
VF termination												
1	randomised trials	serious[a]	not serious	very serious[b,c]	serious[d]		115/144 (79.9%)	92/136 (67.6%)	**RR 1.18** (1.03 to 1.36)	**122 more per 1000** (from 20 more to 244 more)	⨁◯◯◯ [a,b,c,d]	IMPORTANTE

CI: confidence interval; **OR:** odds ratio; **RR:** risk ratio

Explanations

a. . The cluster randomization led to lack of blinding to treatments, rescuers knowing already what group a patient would be in at the time of enrollment. Rescuers also determined some outcomes (VF termination, ROSC)
b. The AP position was tested vs. the standard one only in the instance of refractory VF (thus from the 4th shock)
c. The population studied included no children
d. In the original trial design, the calculated sample size was 310 patients per group; the actual number of patients enrolled was 136 in the standard position and 144 in the vector change group. Thus, due to the smaller sample size, the study was likely underpowered
e. No sample size calculation. Study likely underpowered.
f. Selection bias as pad placement was left to the discretion of individual EMS crews
g. Limits in generalizability as the study involved cases treated by a single fire-based EMS agency
h. ROSC definition by EMS might have been complicated by difficulty in pulse palpation in cardiac arrest
i. Results account for a change in pad position (vector change) midway through the resuscitation.

QUESTION

Should The use of large pad size vs. small pad size be used for children in any setting (in-hospital or out-of-hospital) with cardiac arrest and a shockable rhythm at any time during cardiopulmonary resuscitation (CPR)?	
POPULATION:	children in any setting (in-hospital or out-of-hospital) with cardiac arrest and a shockable rhythm at any time during cardiopulmonary resuscitation (CPR)
INTERVENTION:	The use of large pad size
COMPARISON:	small pad size
MAIN OUTCOMES:	Nuevo desenlace ;
SETTING:	
PERSPECTIVE:	
BACKGROUND:	
CONFLICT OF INTERESTS:	

ASSESSMENT

Problem
Is the problem a priority?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ No ○ Probably no ○ Probably yes ● Yes ○ Varies ○ Don't know	Survival from sudden cardiac arrest is low. Patients who present in an shockable rhythm have a higher rate of good outcome. Approximately 20% of VF adult patients, however, will remain in VF despite standard resuscitation interventions. In addition, transthoracic impedance (TTI) may vary based on pad size and this may have an impact on shock success.	

Desirable Effects
How substantial are the desirable anticipated effects?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ Trivial ○ Small ● Moderate ○ Large ○ Varies ○ Don't know	Improvement in ROSC, long term survival, and neurologic outcome are desirable. However, there are few studies in patients at early-stage VF/pulseless VT directly comparing the effects of different pad size on defibrillation success, ROSC and long term survival.	

Undesirable Effects
How substantial are the undesirable anticipated effects?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS

○ Trivial ○ Small ○ Moderate ○ Large ○ Varies ● Don't know	Available evidence is inconclusive.	

Certainty of evidence
What is the overall certainty of the evidence of effects?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
● Very low ○ Low ○ Moderate ○ High ○ No included studies	Available evidence is inconclusive.	Several old studies have evaluated the role of pad and paddle size in children relationship to thransthoracic impedance (TTI). One prospective before and after observational study in adults found no differences in the first shock defibrillation success between small pads (89%) and large pads (86%), TTI was significantly higher with small pads.

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

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ Important uncertainty or variability ○ Possibly important uncertainty or variability ○ Probably no important uncertainty or variability ● No important uncertainty or variability		

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

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS

○ Favors the comparison ○ Probably favors the comparison ○ Does not favor either the intervention or the comparison ● Probably favors the intervention ○ Favors the intervention ○ Varies ○ Don't know	There is no evidence in favour of higher or lower size for the treatment of shockable cardiac arrest.	For pad size there are old studies mainly focusing on TTI, showing that smaller pads or paddles are associated with higher TTI. A recent obervational study from 2023, investigating large vs. small pad sizes showed no difference in defibrillation success after a BTE shock.

Acceptability
Is the intervention acceptable to key stakeholders?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ No ○ Probably no ● Probably yes ○ Yes ○ Varies ○ Don't know	If beneficial, stakeholders will likely accept the intervention.	

Feasibility
Is the intervention feasible to implement?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ No ○ Probably no ● Probably yes ○ Yes ○ Varies ○ Don't know		

SUMMARY OF JUDGEMENTS

	JUDGEMENT						
PROBLEM	No	Probably no	Probably yes	**Yes**		Varies	Don't know
DESIRABLE EFFECTS	Trivial	Small	**Moderate**	Large		Varies	Don't know
UNDESIRABLE EFFECTS	Trivial	Small	Moderate	Large		Varies	**Don't know**
CERTAINTY OF EVIDENCE	**Very low**	Low	Moderate	High			No included studies
VALUES	Important uncertainty or variability	Possibly important uncertainty or variability	Probably no important uncertainty or variability	**No important uncertainty or variability**			
BALANCE OF EFFECTS	Favors the comparison	Probably favors the comparison	Does not favor either the intervention or the comparison	**Probably favors the intervention**	Favors the intervention	Varies	Don't know

ACCEPTABILITY	No	Probably no	**Probably yes**	Yes		Varies	Don't know
FEASIBILITY	No	Probably no	**Probably yes**	Yes		Varies	Don't know

TYPE OF RECOMMENDATION

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

CONCLUSIONS

Recommendation

For manufacturers:
There is insufficient evidence to recommend a specific pad size for optimal external defibrillation in children (Good Practice Statement).
Manufacters could consider the standardization of pads size for children and adults. (Good Practice Statement).

For BLS providers:
We recommend that BLS providers follow the AED's specific guidance and instructions for pads placement in children (Good practice statement).

For ALS providers:
We suggest that ALS providers follow manufacturer's specific guidance and instructions for pad placement in children (weak recommendation, very low certainty of evidence).

Justification

In making these recommendations, the PLS Task Force considered the following:

- Pulseless shockable rhythms are more common in adults than in children and vary according to the age. The low frequency of these rhythms contributes to the lack of information on pediatric defibrillation. We do not know the incidence of refractory shockable rhythms in children.
- Transthoracic impedance varies based on pad size and position, and this may impact shock success. Different pad orientations/positions may also result in a higher voltage gradient in different areas of the myocardium from where fibrillation may start/restart.
- In Yin (2023), transthoracic impedance was higher for smaller electrodes than the larger electrodes, but defibrillation success was equivalent. The study, however, has important biases in its design. It included no data on ROSC or survival and focused only on the biphasic truncated exponential defibrillation waveform. Based on the above assumptions, there is no evidence that any specific pad size/orientation and position differing from the standard anterior-lateral improves any critical or important outcome. However, it is likely that defibrillator manufacturers have proprietary data that are not available in the public sphere.
- Two observational studies in adults (Kerber 1981 676; Yin 2023 109754) and three in children (Atkins 1994 90; Atkins 1988 914; Samson 1995 544) showed that transthoracic impedance was significantly higher with small-sized pads/paddles than large-sizedpads/paddles. Lower transthoracic impedance results in higher current flow, possibly allowing for higher defibrillation success. Another observational study (Kastreva 2006 1009) evaluated transthoracic impedance in volunteers measured according to the interelectrode voltage drop obtained by passage of a low amplitude high-frequency current between the two self-adhesive electrodes in anterior-posterior and anterior-lateral positions without delivering a shock. Lower transthoracic impedance was measured in the anterior-posterior compared to the anterior-lateral position.
- An observational study included 123 cardiac arrests (Dalzell 1989 741). Pad diameters were small (8/8 cm) in 26 cardiac arrests, intermediate (8/12 cm) in 63 arrests and large (12/12 cm) in 34 cardiac arrests. Transthoracic impedance significantly decreased with increasing pad size. A single shock of 200 J (delivered energy) was successful in 8 of 26 (31%) arrests using small pads, in 40 of 63 (63%) with intermediate pads and in 28 of 34 (82%) with large pads (p=0.0003).
- There are no studies examining defibrillation pad size or orientation for IHCA. However, this evidence could be applied to the IHCA, with additional downgrading for indirectness.
- If the same pads size could be used for adult, children and infants, costs would be reduced and training could be improved.
- In most cases, bias was assessed per comparison rather than per outcome, since there were no meaningful differences in bias across outcomes. In cases where differences in risk of bias existed between outcomes this was noted.

Subgroup considerations

Implementation considerations

Implementation of a different size pad did not require training. Instructions for BLS providers should be clear and easy to be followed.

Monitoring and evaluation

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

Research priorities

- No studies examined the paediatric/in-hospital setting.
- No RCTs compared different pad sizes in any patient population.
- No studies evaluated the interaction between pad size and orientation.
- Only surrogate outcomes were evaluated for pads size (i.e. transthoracic impedance).

REFERENCES SUMMARY

Author(s):
Question: The use of large pad size compared to small pad size in children in any setting (in-hospital or out-of-hospital) with cardiac arrest and a shockable rhythm at any time during cardiopulmonary resuscitation (CPR)
Setting:
Bibliography: Yin RT, Taylor TG, de Graaf C, Ekkel MM, Chapman FW, Koster RW. Automated external defibrillator electrode size and termination of ventricular fibrillation in out-of-hospital cardiac arrest. Resuscitation. 2023 Apr;185:109754. doi: 10.1016/j.resuscitation.2023.109754. Epub 2023 Feb 25. PMID: 36842678.

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	The use of large pad size	small pad size	Relative (95% CI)	Absolute (95% CI)		
Nuevo desenlace												
1	non-randomised studies	extremely serious[a,b,c]	not serious	serious[d]	not serious		135/157 (86.0%)	158/178 (88.8%)	**OR 0.82** (0.42 to 1.60)	**21 fewer per 1000** (from 119 fewer to 39 more)	_[a,b,c,d]	IMPORTANTE

CI: confidence interval; **OR:** odds ratio

Explanations

a. Before and after study design with patients cases collected over several years between outcomes. Many factos have changed over time and there are other differences between groups to be accounted for.
b. Only defibrillations with BTE waveforms were investigated
c. Strong involvement of the manufacturer of AEDs used in the study's authorship
d. VF termination was evaluated based on ECG rhythm annotations, i.e. whether the VF was extinguished, which was necessary but not sufficient condition for ROSC and survival