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| Question | |
| **Should the use of large pad size vs. small pad be used for adults and children with cardiac arrest and a shockable rhythm at any time during cardiopulmonary resuscitation?** | |
| **Population:** | Adults and children with cardiac arrest and a shockable rhythm at any time during cardiopulmonary resuscitation (CPR) |
| **Intervention:** | The use of any specific pad size/orientation and position |
| **Comparison:** | Reference standard pad size/orientation and position |
| **Main outcomes:** | **Critical:**  Survival with favourable neurological outcome at hospital discharge or 30-days  Survival at hospital discharge or 30 days  **Important:**  Return of spontaneous circulation (ROSC)  Termination of VF  Rates of refibrillation. |
| **Setting:** | in- and out-of-hospital cardiac arrest |
| **Perspective:** | **patient** |
| **Background:** | A SR on this topic was pefomed in 2010. In 2019, the topic was re-evaluated by the BLS task force with a scoping review, followed by evidence updates in 2021 and 2022. At the end of 2022 the topic related to the pads position has been challenged by a cluster-randomized trial with crossover (Cheskes, 2022, 1947) evaluating, among new defibrillation strategies, the vector-change (VC) defibrillation to the anterior-posterior (AP) position, compared with the standard (anterior-lateral) defibrillation in adult patients with refractory ventricular fibrillation (VF) during out-of-hospital cardiac arrest (OHCA). Another recent retrospective before-after study (Steinberg; 2022; 16) on electronic defibrillator data, included shocks from OHCA with initial VF or pulseless VT. In the pre- dataset, 207 patients received 1023 shocks with AP pad placement, compared with 277 patients from the post- dataset who received 1020 shocks with AL pad placement. |
| **Conflict of interests:** | None |

# Assessment

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| Problem Is the problem a priority? | | |
| Judgement | Research evidence | Additional considerations |
| ○ No ○ Probably no ○ Probably yes ● Yes ○ Varies ○ Don't know | Survival from sudden cardiac arrest is low. Patients who present in an shockable rhythm have a higher rate of good outcome. Approximately 20% of VF patients, however, will remain in VF despite standard resuscitation interventions. In addition, transthoracic impedance (TTI) may vary based on pad size and orientation and this may have an impact on shock success. Different pad orientations may also result in a higher voltage gradient in different area of the myocardium from where fibrillation may start/restart. |  |
| Desirable Effects How substantial are the desirable anticipated effects? | | |
| Judgement | Research evidence | Additional considerations |
| ○ Trivial ○ Small ● Moderate ○ Large ○ Varies ○ 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). | 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.  A recent observational pre-post implementation study evaluated effects of large vs. small pad size on defibrillation success evaluated on ECG recorded by AEDs; again no data on patient outcome are available. | Several old studies have evaluated the role of pad and paddle size in relationship to TTI |
| Values Is there important uncertainty about or variability in how much people value the main outcomes? | | |
| Judgement | Research evidence | Additional considerations |
| ○ Important uncertainty or variability ○ Possibly important uncertainty or variability ○ Probably no important uncertainty or variability ● No important uncertainty or variability |  |  |
| Balance of effects Does the balance between desirable and undesirable effects favor the intervention or the comparison? | | |
| Judgement | Research evidence | Additional considerations |
| ○ Favors the comparison ○ Probably favors the comparison ○ Does not favor either the intervention or the comparison ● Probably favors the intervention ○ Favors the intervention ○ Varies ○ Don't know | There is no evidence in favour the intervention or the comparison for the initial treatment of shockable cardiac arrest. However, if we consider the condition of refractory VF, although the certainty of evidence is very low, the existing evidence suggests a beneficial effect with VC compared with standard AL pad position in VF termination and survival with good neurological outcome. | For pad size there are old studies mainly focusing on TTI, showing that smaller pads or paddles are ssociated with higher TTI. A recent obervational study from 2022, investigating large vs. small pad sizes showed no difference in defibrillation success after a BTE shock. |
| Resources required How large are the resource requirements (costs)?" | | |
| Judgement | Research evidence | Additional considerations |
| ○ Large costs ○ Moderate costs ○ Negligible costs and savings ○ Moderate savings ○ Large savings ○ Varies ● Don't know | No data are available. Nevertheless, modifing the pad position on the chest is costless. Manufactors may bare some cost in aligning instructions with correct pad placement. | Additional costs may be expected in the case of VC for refracorty VF, in which a second pair of pads are applied. |
| Certainty of evidence of required resources What is the certainty of the evidence of resource requirements (costs)? | | |
| Judgement | Research evidence | Additional considerations |
| ○ Very low ○ Low ○ Moderate ○ High ● No included studies |  | Changing pad orientation could require some cost for training. |
| Cost effectiveness Does the cost-effectiveness of the intervention favor the intervention or the comparison? | | |
| Judgement | Research evidence | Additional considerations |
| ○ Favors the comparison ○ Probably favors the comparison ○ Does not favor either the intervention or the comparison ○ Probably favors the intervention ○ Favors the intervention ○ Varies ● No included studies |  |  |
| Equity What would be the impact on health equity? | | |
| Judgement | Research evidence | Additional considerations |
| ○ Reduced ○ Probably reduced ● Probably no impact ○ Probably increased ○ Increased ○ Varies ○ Don't know | No data are available. Nevertheless, modifing the pad position on the chest is costless | Additional costs may be expected in the case of VC for refracorty VF, in which a second pair of pads are applied. |
| Acceptability Is the intervention acceptable to key stakeholders? | | |
| Judgement | Research evidence | Additional considerations |
| ○ No ○ Probably no ● Probably yes ○ Yes ○ Varies ○ Don't know | If beneficial, stakeholders will likely accept the intervention |  |
| Feasibility Is the intervention feasible to implement? | | |
| Judgement | Research evidence | Additional considerations |
| ○ No ○ Probably no ● Probably yes ○ Yes ○ Varies ○ Don't know |  |  |

# Summary of judgements

|  | **Judgement** | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Problem** | No | Probably no | Probably yes | **Yes** |  | Varies | Don't know |
| **Desirable Effects** | Trivial | Small | **Moderate** | Large |  | Varies | Don't know |
| **Undesirable Effects** | Trivial | Small | Moderate | Large |  | Varies | **Don't know** |
| **Certainty of evidence** | **Very low** | Low | Moderate | High |  |  | No included studies |
| **Values** | Important uncertainty or variability | Possibly important uncertainty or variability | Probably no important uncertainty or variability | **No important uncertainty or variability** |  |  |  |
| **Balance of effects** | Favors the comparison | Probably favors the comparison | Does not favor either the intervention or the comparison | **Probably favors the intervention** | Favors the intervention | Varies | Don't know |
| **Resources required** | Large costs | Moderate costs | Negligible costs and savings | Moderate savings | Large savings | Varies | **Don't know** |
| **Certainty of evidence of required resources** | Very low | Low | Moderate | High |  |  | **No included studies** |
| **Cost effectiveness** | Favors the comparison | Probably favors the comparison | Does not favor either the intervention or the comparison | Probably favors the intervention | Favors the intervention | Varies | **No included studies** |
| **Equity** | Reduced | Probably reduced | **Probably no impact** | Probably increased | Increased | Varies | Don't know |
| **Acceptability** | No | Probably no | **Probably yes** | Yes |  | Varies | Don't know |
| **Feasibility** | No | Probably no | **Probably yes** | Yes |  | Varies | Don't know |

# Type of recommendation

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| 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

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| Recommendation |
| **For defibrillator manufacturers:**  There is insufficient evidence to recommend a specific pad or paddle size for optimal external defibrillation in adults (Good Practice Statement).  Manufacturers should standardize adult pad or paddle placement in the anterior-lateral position (Good Practice Statement). One pad or paddle should be placed below the right clavicle, just to the right of the upper sternal border, and the other with its center in the left mid-axillary line, below the armpit.  Manufacturers should provide clear instructions to ensure proper contact between the pad or paddle and the skin, along with diagrams that accurately show the ILCOR-recommended pad and paddle positions (Good Practice Statement).  **For CPR providers using an AED:**  Follow the manufacturer’s AED guidance and instructions for adult pad placement (Good Practice Statement).  **For CPR providers trained in manual defibrillation:**  In adults, place defibrillator pads or paddles in the anterior-lateral position to optimize placement speed and minimize interruptions to chest compressions (Good Practice Statement). One pad/paddle should be positioned below the patient’s right clavicle, just to the right of the upper sternal border. The other pad/paddle should be placed on the patient’s left mid-axillary line, below the armpit.  In adults, if the initial anterior-lateral position is not feasible, consider using the anterior-posterior pad position if trained (Good Practice Statement). Place the anterior pad on the left side of the chest, between the midline and the nipple. For female patients, place the anterior pad to the left of the lower sternum, ensuring it avoids breast tissue as much as possible. The posterior pad should be placed on the left side of the patient's spine, just below the scapula.  Pad or paddle placement should avoid breast tissue (Good Practice Statement).  **For healthcare professionals trained in vector change:**  For adults in refractory ventricular fibrillation (persistent VF after three defibrillations), consider changing pads to the anterior-posterior pad position (Good Practice Statement). Place the anterior pad on the left side of the chest, between the midline of the chest and the nipple. For female patients, place the anterior pad to the left of the lower sternum, ensuring it avoids breast tissue as much as possible. The posterior pad should be placed on the left side of the patient's spine, just below the scapula. This treatment recommendation does not replace the existing treatment recommendation on vector change and double sequential defibrillation for advanced life support providers (Berg 2023, e187; Berg 2023, 109992). |
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| Justification |

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

* Approximately 20% of patients remain in a shockable rhythm despite standard resuscitation interventions. Transthoracic impedance varies based on pad size and position, and this may impact shock success. Different pad orientations/positions may also result in a higher current density in different areas of the myocardium from where fibrillation may start/restart.
* No studies directly compare the effects of different pad placements on patient outcomes outside of refractory shockable rhythms.
* In clinical practice, BLS and ALS providers are unable to select pads sizes beyond what is provided by their healthcare organization. Therefore the Task Force realized that recommending the use of a specific pad size does not apply to providers.
* The four studies included were at serious risk of bias, and only one was a RCT (Cheskes, 2022, 1947).
* A secondary analysis of the DOSE VF trial (Cheskes, 2024, 110186), which explored the relationship between alternative defibrillation strategies employed and the type of VF, defined as shock-refractory VF or recurrent VF (e.g. persistent VF after each shock) or recurrent VF (e.g. absence of VF for at-least 5 sec after the shock, followed by spontaneous refibrillation), on patient outcomes, showed that vector-change defibrillation compared to standard pads placement, was not superior for VF termination, ROSC, or survival for shock-refractory VF; for recurrent VF, vector-change defibrillation was superior to standard pads placement only for VF termination, but not for ROSC or survival.
* In Yin (2023), transthoracic impedance was higher for smaller electrodes than the larger electrodes, but defibrillation success was equivalent. The study, however, has important biases in its design. It included no data on ROSC or survival and focused only on the biphasic truncated exponential defibrillation waveform. Based on the above assumptions, no evidence exists that any specific pad size/orientation and position differing from the standard anterior-lateral improves any critical or important outcome. However, defibrillator manufacturers likely have proprietary data unavailable in the public sphere.
* Two observational studies in adults (Kerber 1981 676; Yin 2023 109754) and three in children (Atkins 1994 90; Atkins 1988 914; Samson 1995 544) showed that transthoracic impedance was significantly higher with small-sized pads/paddles than large-sized pads/paddles. Lower transthoracic impedance results in higher current flow, possibly allowing for higher defibrillation success. Another observational study (Kastreva 2006 1009) evaluated transthoracic impedance in volunteers measured according to the interelectrode voltage drop obtained by passage of a low amplitude high-frequency current between the two self-adhesive electrodes in anterior-posterior and anterior-lateral positions without delivering a shock. Lower transthoracic impedance was measured in the anterior-posterior compared to the anterior-lateral position.
* An observational study included 123 cardiac arrests (Dalzell 1989 741). Pad diameters were small (8/8 cm) in 26 cardiac arrests, intermediate (8/12 cm) in 63 arrests and large (12/12 cm) in 34 cardiac arrests. Transthoracic impedance significantly decreased with increasing pad size. A single monophasic shock of 200 J (delivered energy) was successful in 8 of 26 (31%) arrests using small pads, in 40 of 63 (63%) with intermediate pads and in 28 of 34 (82%) with large pads (p=0.0003). Whether these results can be transferred to biphasic, impedance-compensated defibrillation waveforms remains unclear.
* There are no studies examining defibrillation pad size or orientation for IHCA. However, the evidence reported in this document could be applied to the IHCA, with additional downgrading for indirectness.
* Paddles may still be in use in some low-resource ALS settings. However, the Task Force acknowledges that the anterior-posterior position is not feasible with paddles and that paddle sizes are those standard as provided by the manufacturer. The Task Force did not foresee future development in the use of paddles.
* In atrial fibrillation, although some studies have shown that antero-posterior electrode placement is more effective than the traditional antero-apical position in elective cardioversion, the majority have failed to demonstrate any clear advantage of any specific electrode position. Moreover, transmyocardial current during defibrillation is likely to be maximal when the electrodes are placed so that the area of the heart that is fibrillating lies directly between them (i.e. ventricles in ventricular fibrillation/tachycardia, atria in atrial fibrillation). Therefore, the optimal electrode position may not be the same for ventricular and atrial arrhythmias and conclusions for one condition cannot be directly translated/applied to the other.
* AEDs have pictoral representation to guide providers in correct pad positioning. However, there is a wide variation in this pictoral guidance and evidence suggests that correct anatomical pad placement is poor, such that a clearer, more effective diagram is urgently needed. In a recent study, untrained bystanders failed to achieve accurate defibrillation pad placement, when guided by current defibrillation pad diagrams (Deakin 2019 282). Manufacturers of defibrillators should follow best practice, and align pad placement with ILCOR recommendations.
* In most cases, bias was assessed per comparison rather than per outcome, since there were no meaningful differences in bias across outcomes. In cases where differences in risk of bias existed between outcomes this was noted.

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| Subgroup considerations |
| none |

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| 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. |

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| 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. |

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

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