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| Question |
| **Should any other location for chest compressions vs. delivery of chest compressions on the lower half of the sternum be used for [health problem and/or population]?** |
| **Population:** | Adults and children in any setting (in-hospital or out-of-hospital) with cardiac arrest |
| **Intervention:** | any other location for chest compressions |
| **Comparison:** | delivery of chest compressions on the lower half of the sternum |
| **Main outcomes:** | Any clinical outcome. Survival to hospital discharge with good neurological outcome and survival to hospital discharge were ranked as critical outcomes. Return of spontaneous circulation (ROSC) was ranked as an important outcome. Physiological outcomes including blood pressure, coronary perfusion pressure or EtCO2 were also considered important outcomes. |
| **Setting:** | Cardiac arrest |
| **Perspective:** | Health care provider |
| **Background:** | The previous ILCOR recommendations are from the 2010 CoSTR.{Sayre 2010 S298; Koster 2010 e48} The BLS task force performed a TF based systematic review to update this recommendation. |
| **Conflict of interests:** | The following Task Force members and other authors declared an intellectual conflict of interest and this was acknowledged and managed by the Task Force Chairs and Conflict of Interest committees: Olasveengen: author on one of the included papers |

# Assessment

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| ProblemIs the problem a priority? |
| Judgement | Research evidence | Additional considerations |
| ○ No● Probably no○ Probably yes○ Yes○ Varies○ Don't know | None | There is broad consensus that optimizing chest compressions during cardiac arrest is vital to improve patient survival. There is limited focus on hand placement within the resuscitation research community, but concerns of injury and emphasis on correct hand placement are important topics during CPR training courses - and evidence to support current recommendations are lacking.  |
| Desirable EffectsHow substantial are the desirable anticipated effects? |
| Judgement | Research evidence | Additional considerations |
| ○ Trivial○ Small○ Moderate○ Large○ Varies● Don't know | There were no studies reporting the critical outcomes of favorable neurologic outcome, survival, or ROSC. For the important outcome of physiological end points, we identified 3 very low certainty studies (downgraded for bias, indirectness, and imprecision).{Orlowski 1986 667; Cha 2013 691; Qvigstad 2013 1203} One crossover study in 17 adults with prolonged resuscitation from non-traumatic cardiac arrest observed improved peak arterial pressure during compression systole (114 ± 51 mm Hg versus 95 ± 42 mm Hg) and end-tidal carbon dioxide (ETCO2; 11.0 ± 6.7 mm Hg versus 9.6 ± 6.9 mm Hg) when compressions were performed in the lower third of the sternum compared with the center of the chest, whereas arterial pressure during compression recoil peak right atrial pressure and coronary perfusion pressure did not differ.{Cha 2013 691} A second crossover study in 30 adults observed no difference between ETCO2 values and hand placement.{Qvigstad 2013 1203} A further crossover study in 10 children observed higher peak systolic pressure and higher mean arterial blood pressure when compressions were performed on the lower third of the sternum compared with the middle of the sternum.{Orlowski 1986 667}  | There is no evidence evaluating effects or even associations between hand position and patient outcomes. Studies looking at various hand positions and physiological parameters such as blood pressure or EtCO2 indicate finding optimal hand position might impact patient outcomes.  |
| Undesirable EffectsHow substantial are the undesirable anticipated effects? |
| Judgement | Research evidence | Additional considerations |
| ○ Large○ Moderate○ Small○ Trivial○ Varies● Don't know | The studies identified did not report any harm from varying hand placement, but their numbers were very small. | Potential undesirable effects could be harm related to compressing too far caudally or to any of the side which would have the potential for organ damage. Additionally, any strategy that complicated the resuscitation risks negatively affecting quality of CPR.  |
| Certainty of evidenceWhat is the overall certainty of the evidence of effects? |
| Judgement | Research evidence | Additional considerations |
| ● Very low○ Low○ Moderate○ High○ No included studies | Only evidence of surrogate outcomes and indirect evidence - very low certainty.  |  |
| ValuesIs there important uncertainty about or variability in how much people value the main outcomes? |
| Judgement | Research evidence | Additional considerations |
| ○ Important uncertainty or variability○ Possibly important uncertainty or variability○ Probably no important uncertainty or variability● No important uncertainty or variability | There is no uncertainty about the value of the critical outcomes of favorable neurologic outcome, survival, or ROSC. There is less certainty about the important outcome of physiological end points. | Cardiac arrest mortality remains very high, and there is no important uncertainty or variability in how much people value improved survival from cardiac arrest, or how much resuscitation experts value high quality CPR. |
| Balance of effectsDoes the balance between desirable and undesirable effects favor the intervention or the comparison? |
| Judgement | Research evidence | Additional considerations |
| ○ Favors the comparison● Probably favors the comparison○ Does not favor either the intervention or the comparison○ Probably favors the intervention○ Favors the intervention○ Varies○ Don't know | Very low certainty evidence suggests optimizing hand placement could add to the effectiveness of chest compressions during CPR, but there is currently no proven strategy for how to identify the optimal compression point. The studies identified did not report any harm from varying hand placement, but their numbers were very small. As there is little evidence evaluating potential harmful effects, experimentation to find optimal compression point should only be done in a research setting.  |  |
| Resources requiredHow large are the resource requirements (costs)? |
| Judgement | Research evidence | Additional considerations |
| ○ Large costs○ Moderate costs○ Negligible costs and savings○ Moderate savings○ Large savings● Varies○ Don't know | No evidence | Depending on the technology used to identify optimal hand placement, implementing new strategies could come at substantial cost. If strategies use monitoring already in common practice, the costs are limited to education and training. These are always hard to estimate because re-training CPR at set intervals is already recommended, and additional costs are therefore mostly related to changing educational content.  |
| Certainty of evidence of required resourcesWhat is the certainty of the evidence of resource requirements (costs)? |
| Judgement | Research evidence | Additional considerations |
| ○ Very low○ Low○ Moderate○ High● No included studies | No specific evidence was identified. |  |
| Cost effectivenessDoes the cost-effectiveness of the intervention favor the intervention or the comparison? |
| Judgement | Research evidence | Additional considerations |
| ○ Favors the comparison○ Probably favors the comparison○ Does not favor either the intervention or the comparison○ Probably favors the intervention○ Favors the intervention○ Varies● No included studies | No specific evidence was identified. |  |
| EquityWhat would be the impact on health equity? |
| Judgement | Research evidence | Additional considerations |
| ○ Reduced○ Probably reduced○ Probably no impact○ Probably increased○ Increased● Varies○ Don't know | No reason to expect any specific impacts on health equity. No specific evidence was identified. | Depending on the technology that might be used to guide hand placement, need for expensive equipment could potentially negatively impact health equity.  |
| AcceptabilityIs the intervention acceptable to key stakeholders? |
| Judgement | Research evidence | Additional considerations |
| ○ No● Probably no○ Probably yes○ Yes○ Varies○ Don't know | No specific evidence related to stakeholder acceptability was identified.  | As the certainty of current evidence is very low, and there is a potential for harm and potential for added cost – a change to hand position for chest compressions is likely to NOT be acceptable to stakeholders before more evidence has been evaluated.  |
| FeasibilityIs the intervention feasible to implement? |
| Judgement | Research evidence | Additional considerations |
| ○ No○ Probably no● Probably yes○ Yes○ Varies○ Don't know | The few studies identified would indicate it could be feasibly to develop strategies to assess alternative hand placement recommendations or strategies to identify individual hand placement during CPR.  |  |

# Summary of judgements

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

# Type of recommendation

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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 |
| We suggest performing chest compressions on the lower half of the sternum on adults in cardiac arrest (weak recommendation, very low certainty evidence).  |
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| Justification |
| The existing ILCOR treatment recommendation was published in 2010{Sayre 2010 S298; Koster 2010 e48}: “For adults receiving chest compressions, it is reasonable for rescuers to place their hands on the lower half of the sternum.” This topic was not reviewed in detail for the 2015 CoSTR.Imaging studies were excluded from the current systematic review as they do not report clinical outcomes for patients in cardiac arrest, but they do provide some supportive background information. Imaging studies examining hand position for chest compressions describe the optimal position for compressions based on the anatomical structures underlying the recommended and alternative hand positions. Evidence from recent imaging studies indicates that, in most adult and pediatric patients, the maximal ventricular cross-sectional area underlies the lower third of the sternum/xiphisternal junction, and the ascending aorta and left ventricular outflow tract underlie the center of the chest.{Park 2018 e576; Lee 2018 1; Nestaas 2016 54; Cha 2013 615; Papadimitriou 2013 549; Holmes 2015 401}. Imaging studies also suggest there might be important differences in anatomy between individuals depending on factors including age, Body Mass Index, congenital cardiac disease and pregnancy, and as such one specific hand placement strategy might not provide optimal compressions across a range of persons.{Park 2016 303; Lee 2018 1; Holmes 2015 401}. However, there is an absence of robust clinical evidence reporting survival outcomes or harm from any alternate hand position for chest compressions. In reconfirming the recommendation to perform chest compressions on the lower half of the sternum, with rewording to be consistent with the GRADE process, we placed a high value on consistency with previous recommendations, in the absence of compelling clinical data suggesting the need to change the recommended approach. The BLS Task Force acknowledges that every change in guidelines comes with a significant risk and cost as CPR educators and providers are asked to change current practice and implement new treatment strategies. Important gaps remain in evaluating how to identify optimal hand placement and/or compression point for individuals in cardiac arrest using physiologic feedback or incorporating previous imaging. |

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| Subgroup considerations |
| None |

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| Implementation considerations |
| None |

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| Monitoring and evaluation |
| None |

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| Research priorities |
| Current knowledge gaps include but are not limited to:• Associations between different hands-positions during CPR and patient outcomes• Should strategies to identify optimal individual hand placement during CPR be developed?• Which physiological parameter is most useful in evaluating optimal hand placement during CPR? |

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