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| Question |
| **Should analysis of cardiac rhythm during chest compressions vs. standard care (analysis of cardiac rhythm during pauses in chest compressions) be used for Adults and children with cardiac arrest?** |
| **Population:** | Adults in any setting (out of hospital or in hospital) with cardiac arrest |
| **Intervention:** | Analysis of cardiac rhythm during chest compressions  |
| **Comparison:** | Standard care - analysis of cardiac rhythm during pauses in chest compressions |
| **Main outcomes:** | Survival to hospital discharge with good neurological outcome and survival to hospital discharge / 30 days were ranked as critical outcomesReturn of spontaneous circulation (ROSC) was ranked as an important outcomeCPR quality metrics such as chest compression fraction, pauses in compressions, compressions per minute etc. were included as important outcomes |
| **Setting:** | Any setting (in-hospital or out-of-hospital)  |
| **Perspective:** | 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 Unpublished studies (e.g., conference abstracts, trial protocols) are excluded. All years and all languages were included as long as there was an English abstract; unpublished studies (e.g., conference abstracts, trial protocols) were excluded.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 Sept 23, 2019 to October 10th 2024 |
| **Background:** | High quality CPR with few pauses in chest compressions is emphasized in current Guidelines and CPR teaching practices. Rhythm analysis and pulse checks cause pauses in chest compressions, and artifact-filtering algorithms for analysis of electrocardiographic rhythm during CPR has been proposed as a measure to reduce pauses in chest compressions. |
| **Conflict of interests:** | Nil |

# 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 | High quality CPR with few pauses in chest compressions is emphasized in current Guidelines and CPR teaching practices. Rhythm analysis and pulse checks cause pauses in chest compressions, and artefact-filtering algorithms for analysis of electrocardiographic rhythm during CPR has been proposed as a measure to reduce pauses in chest compressions. Chest compressions are the sole source of forward blood flow during cardiac arrest in the BLS setting and there is general consensus that measures to decrease pauses are important. | Excessive pauses in chest compressions are commonly reported, and are regarded as a high priority problem. |
| Desirable EffectsHow substantial are the desirable anticipated effects? |
| Judgement | Research evidence | Additional considerations |
| ○ Trivial○ Small○ Moderate○ Large○ Varies● Don't know | Critical outcome of Survival to hospital discharge with good neurological outcome* no human studies

Critical outcome of Survival to hospital discharge / 30 days* one paper looked at this (Clement Derkenne)
* Survival at hospital discharge did not differ between 2017 and 2022, even after adjusting for age, gender, location, bystander status, and time from call to AED switch on

Survival at hospital discharge, n (%) 72 (25.3) vs 79 (28.0) , p = 0.49 (adjusted hazard-ratio 0.96 [95% CI, 0.78–1.18]) * however, survival improved within a subgroup of patients who had OOCA in public places and within a short time between call to AED connection (< 12.5 mins), (Adjusted hazard ratio 0.83 (95% CI 0.73-0.93))

Important outcomes criteria of ROSC* no human studies

Important outcome of CPR quality metrics* two human studies

de Graaf paper:Intervention had a higher median Chest Compression Fraction (86% (IQR 79, 92) vs 80% (IQR 73, 86), P < 0.001). Intervention cases had a shorter median pre-shock pause compared to control cases (8 s (IQR 7, 11) vs 22 s (IQR 20, 24), p < 0.001) and shorter peri shock pause 12 (10,16) vs 25 (22,29), p < 0.001Derkenne paper:The following metrics were significantly better with Intervention: a. Chest compressions and pauses  - prompt chest compression fraction (CCF during the cardiopulmonary phases)  - hands off max time, peri shock hands off time, pre shock hands off time, post shock hands off time- chest compression count between two analysis b. Cycle description  - analysis phase duration, cardiopulmonary phase duration, cycle duration c. Ventricular fibrillation storm  - shocks per minute between first and last shock  - median number of shocks  - time between shock and the next refibrillation - time between refibrillation and the next shock  - time between refibrillation and the next efficient shock d. Resuscitation quality  - no significant difference in chest compression rate between both groups e .Rhythms- time spent in shockable rhythm, organised rhythm, asystole  |   |
| Undesirable EffectsHow substantial are the undesirable anticipated effects? |
| Judgement | Research evidence | Additional considerations |
| ○ Large○ Moderate○ Small○ Trivial○ Varies● Don't know | Both the de Graaf paper and the Clement Derkenne paper did not seem to show any undesirable effects of the Intervention.They both confirmed that their algorithms performed at high Sensitivity and Specificity.  | Direct undesirable effects are unlikely, but adding any new technology to the resuscitation setting always has the unintended potential to further increase the complexity, thereby potentially reducing CPR quality. |
| 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 | Both the de Graaf paper and the Derkenne papers are Observational studies downgraded from Low Certainty to Very Low Certainty of Evidence because of serious risk of bias. (Using the ROBINS-I tool) |  |
| 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 | Chest compressions are the sole source of forward blood flow during cardiac arrest in the BLS setting – and there is general consensus that measures to decrease pauses are important. Excessive pauses in chest compressions are commonly reported, and are regarded as a high priority problem.  |  |
| 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 | Data for critical outcomes is lackingData for CPR quality metrics looks promisingBut we do not have trials giving us high certainty of evidenceNo obvious undesirable effects of the Intervention identified However not enough data about this topic available to be able to make an opinion. |  |
| 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 | Artefact-filtering algorithms for analysis of electrocardiographic rhythm during CPR are new technology that needs to be integrated in defibrillator software, the exact cost of this software upgrade is not known. While some defibrillator manufacturers already provide this technology in their products as a supplement to rhythm analysis during pauses, upgrading defibrillators that currently do not have this technology is likely to need significant investment in equipment as well as training resources.  |  |
| 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 | General requirements for education and training when implementing new elements in CPR algorithms is well recognized, but as EMS systems have pre-existing programs for regular training and re-training, the additional cost of each element or change is rarely studied. As development of new defibrillators might include several upgrades, the exact costs of the addition of filtering algorithms are not known.  |  |
| 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 | As the science evaluating artefact-filtering algorithms for analysis of electrocardiographic rhythm during CPR is limited, any benefit to patient outcomes remains to be determined.  |  |
| 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 | As this is new technology to be integrated into expensive medical equipment, it is likely that access to this technology would be dependent on available resources within health care systems. Health equity would likely decrease.  |  |
| AcceptabilityIs the intervention acceptable to key stakeholders? |
| Judgement | Research evidence | Additional considerations |
| ○ No○ Probably no● Probably yes ○Yes○ Varies○ Don't know | There is broad agreement that minimizing pauses in chest compressions is a priority in CPR monitoring and training. If the technology was actually shown to reduce compression pauses it is likely to be acceptable to stakeholders. |  |
| FeasibilityIs the intervention feasible to implement? |
| Judgement | Research evidence | Additional considerations |
| ○ No○ Probably no● Probably yes○ Yes○ Varies○ Don't know | The de Graaf and Derkenne papers would collectively suggest artefact-filtering algorithms for analysis of electrocardiographic rhythm during CPR is feasible to implement. |  |

# 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 the usefulness of artifact-filtering algorithms for analysis of electrocardiographic rhythm during CPR be assessed in clinical trials or research initiatives (Good Practice Statement) |
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| Justification |
| In making a recommendation against routine use, we placed priority on avoiding the costs of introducing a new technology where the effectiveness or harm on patient outcomes remains to be determined. This being highlighted by the absence of randomised controlled trials or observational studies with adequate comparisons. Furthermore, consideration was given on avoiding the costs of introducing a new technology where the effectiveness or harm on patient outcomes remained to be determined. It was however noted that no signal of harm was evident.Therefore it was felt that artifact filtering algorithms could not be recommended for routine analysis or inferring of electrocardiographic rhythm during CPR. As a result the Treatment Recommendations have been replaced with a Good Practice Statement suggesting that the usefulness of artifact-filtering algorithms for analysis of electrocardiographic rhythm during CPR be assessed in clinical trials or research initiatives. In making a recommendation for further research; the task force is acknowledging a) there is thus far insufficient evidence to support a decision for or against routine use, b) further research has potential for reducing uncertainty about the effects and c) further research is thought to be of good value for the anticipated costs.The task force also acknowledges that some EMS systems may already have implemented artifact-filtering algorithms for analysis of electrocardiographic rhythm during CPR, and as such wish to strongly encourage such systems to report on their experiences to build the evidence base regarding the use of these technologies in clinical practice.  |

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| Subgroup considerations |
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| Implementation considerations |
| Artefact-filtering algorithms for analysis of electrocardiographic rhythm during CPR is new technology that needs to be integrated in defibrillator software, the exact cost of this software upgrade is not known. While some defibrillator manufacturers already provide this technology in their products as a supplement to rhythm analysis during pauses, upgrading defibrillators that currently do not have this technology is likely to need significant investment in equipment as well as training resources. Furthermore, as development of new defibrillators might include several upgrades, the exact cost of the addition of filtering algorithms is not known.  |

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| Monitoring and evaluation |
| In addition to demonstrating benefit for this new technology related to patient outcomes, studies should also monitor and report quality of CPR.  |
| Research priorities |
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