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| Question |
| **Question: In adults and children with cardiac arrest does continuous chest compressions with or without ventilations compared with standard CPR delivered by in-hospital providers improve patient outcomes?** |
| **Population:** | Adults and children in any setting (in-hospital or out-of-hospital) with cardiac arrest |
| **Intervention:** | Continuous chest compressions with or without ventilations delivered by in-hospital providers |
| **Comparison:** | Standard CPR, defined as any compression-to-ventilation ratio, delivered by in-hospital providers. Comparator groups that received no CPR or compared manual CPR with mechanical CPR were excluded from the review. Studies including automated CPR or any use of mechanical devices were included if administered to all treatment arms. |
| **Main outcomes:** | Favourable neurological survival (as measured by cerebral performance category or modified Rankin Score) at discharge or 30-days and at any time interval after 30-days; Survival to discharge or 30 days survival; Survival to any time interval after discharge or 30 days survival; Return of spontaneous circulation (ROSC); Quality of life as measured by any indicator or score. |
| **Setting:** | In-hospital setting (including emergency departments) |
| **Perspective:** |  |
| **Background:** | This topic was prioritized for review due to the time since the previous systematic review.(Ashoor 2017 112) |
| **Conflict of interests:** | None  |

# Assessment

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| ProblemIs the problem a priority? |
| Judgement | Research evidence | Additional considerations |
| ○ No○ Probably no○ Probably yes**X** Yes○ Varies○ Don't know | Conventional cardiopulmonary resuscitation (CPR) consists of manual chest compressions and positive-pressure ventilation to maintain oxygenation until return of spontaneous circulation is achieved. Ventilations result in frequent interruptions in chest compressions, however, which can reduce coronary and aortic blood flow during cardiac arrest and has been associated with poorer survival in animal models (Kern 2002 645). Similarly, higher chest compression fraction (total resuscitation time spent performing chest compressions) has been associated with improved outcomes in observational studies (Christenson 2009 1241). One strategy to improve chest compression fraction and reduce interruptions in chest compression is to perform continuous chest compression with 1) asynchronous ventilations or 2) passive oxygenation via face mask. However, there is also concern that continuous chest compression may be harmful for patients who require more effective ventilations, such as asphyxial arrests or drowning (Berg 2000 1743).  | In resource-limited environments, there is value in limiting resuscitation logistics wherever possible. Some EMS systems have achieved this by performing continuous chest compression with passive oxygenation which may help prioritise other treatments. There has also been widespread adoption of high-performance CPR among EMS systems which focus on providing minimally interrupted chest compressions.  |
| Desirable EffectsHow substantial are the desirable anticipated effects? |
| Judgement | Research evidence | Additional considerations |
| ○ Trivial**X** Small○ Moderate○ Large○ Varies○ Don't know | Interruptions in chest compressions have been associated with poorer clinical outcomes in observational studies (Christenson 2009 1241). Pauses for ventilations are a significant source of interruptions in chest compressions and may have negative impacts on coronary and aortic blood flow (Berg 2001 2465). Asynchronous positive pressure ventilation may achieve similar oxygenation without compromising chest compression quality.**For the critical outcome of survival,** we identified very-low quality evidence (downgraded for risk of bias and very serious imprecision) from one cohort study in adults.(Lee 2013 158) In adjusted analysis from this study patients who received mechanical chest compressions and tracheal intubation with positive pressure ventilations without pausing chest compressions had increased adjusted survival to hospital discharge (adjusted odds ratio [aOR] = 2.43, 95%CI: 1.15 to 5.12) when compared to those who received mechanical chest compressions interrupted for ventilations at a ratio of 5 compressions to 1 ventilation. **For the critical outcome of return of spontaneous circulation,** we identified very-low quality evidence (downgraded for risk of bias and very serious imprecision) from one cohort study in adults.(Lee 2013 158) In the adjusted analysis, patients who received mechanical chest compressions and tracheal intubation with positive pressure ventilations without pausing chest compressions had increased return of spontaneous circulation (adjusted odds ratio [aOR] = 1.62, 95%CI: 1.07 to 2.43) when compared to those who received mechanical chest compressions interrupted for ventilations at a ratio of 5 compressions to 1 ventilation. |  A strategy of CCC has been shown to significantly improve chest compression fraction in a large cluster RCT in EMS (Nichol 2015 2203).  |
| Undesirable EffectsHow substantial are the undesirable anticipated effects? |
| Judgement | Research evidence | Additional considerations |
| ○ Large○ Moderate**X** Small○ Trivial○ Varies○ Don't know |  |   |
| Certainty of evidenceWhat is the overall certainty of the evidence of effects? |
| Judgement | Research evidence | Additional considerations |
| **X**  Very low○ Low○ Moderate○ High○ No included studies | The certainty of evidence for all outcomes was very low. Downgraded for risk of bias, imprecision and indirectness. The mechanical CPR devices are not in widespread use, particularly the models use in the single study. The CPR provided in the control arm was not at a ratio recommended by international guidelines or ILCOR.The only study that directly examined this PICOST was conducted with a before-and-after design that, although adjusted for demographic and cardiac arrest characteristics, did not account for potential temporal differences in resuscitation efficiencies between study periods. |  |
| 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**X** No important uncertainty or variability | There was only one study included that considered the impact of CCC and standard CPR on neurologically favourable survival.(Lee 2013 158) No studies examined quality of life outcomes or longer-term patient outcomes. |  |
| 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**X** Probably favors the intervention○ Favors the intervention○ Varies○ Don't know | Despite the theoretical risk of suboptimal ventilations in patients receiving CCC, there is limited data suggesting a negative impact on survival. Conversely, there is some observational data to indicate potential patient harm from interruptions in chest compressions. Furthermore, standard CPR involving a compression-to-ventilation ratio is hard to achieve, and in practice may result in asynchronous ventilations.(Schmicker 2021 31) | One large high-quality RCT in EMS reported no difference in patient outcomes with ventilations at a rate of 10/min without pausing compressions compared with a 30:2 ratio before intubation.(Nichol 2015 2203) |
| Resources requiredHow large are the resource requirements (costs)? |
| Judgement | Research evidence | Additional considerations |
| ○ Large costs○ Moderate costs**X** Negligible costs and savings○ Moderate savings○ Large savings○ Varies○ Don't know | Negligible impact on resources as both treatment strategies require similar investment in staff and resources. | It is possible the CCC is easier to teach and may be more practical in resource-limited environments. Data from one RCT (Nichol 2015 2203) and observation studies suggest that CCC is associated with more adherence to protocol compared to standard CPR.(Schmicker 2021 31) |
| 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**X** No included studies | There were no economic evaluations of the two treatment strategies. |  |
| 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**X** Does not favor either the intervention or the comparison○ Probably favors the intervention○ Favors the intervention○ Varies○ No included studies | CCC is likely to be as cost-effective as standard CPR. |  |
| EquityWhat would be the impact on health equity? |
| Judgement | Research evidence | Additional considerations |
| ○ Reduced○ Probably reduced**X** Probably no impact○ Probably increased○ Increased○ Varies○ Don't know | In the in-hospital setting, it is unlikely that CCC would improve treatment equity compared to standard CPR.  |  |
| AcceptabilityIs the intervention acceptable to key stakeholders? |
| Judgement | Research evidence | Additional considerations |
| ○ No○ Probably no○ Probably yes○ Yes○ Varies**X** Don't know | Unknown.  |  |
| FeasibilityIs the intervention feasible to implement? |
| Judgement | Research evidence | Additional considerations |
| ○ No○ Probably no○ Probably yes**X** Yes○ Varies○ Don't know | The task force placed high value on the importance of providing high-quality chest compressions and simplifying resuscitation logistics for providers and noted the support for the clinical benefit of bundles of care involving minimally interrupted cardiac resuscitation.  |  |

# 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 | 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 |
| ○  | ○  | **X** | ○  | ○  |

# Conclusions

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| Recommendation |
| In-hospital providers should perform CPR with 30 compressions to 2 ventilations or continuous chest compressions with positive pressure ventilations delivered without pausing chest compressions in adults in cardiac arrest (Good Practice Statement). |
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| Justification |
| Evidence from one study and studies in EMS do not indicate harm with continuous compressions with ventilations. The good practice statement for practice before an advanced airway is placed was added to fill the treatment gap and provide guidance for immediate CPR.Data on the same question in EMS found no high-quality evidence to support the superiority of either CCC or standard CPR for patient outcomes in OHCA. The task force also placed high-value on providing consistent recommendations for EMS and in-hospital providers, noting that the evidence in EMS is supported by one large RCT.(Nichol 2015 2203)The task force also placed a relatively high value on the importance of providing high-quality chest compressions and simplifying resuscitation logistics for providers and noted support for the clinical benefit of bundles of care involving minimally interrupted cardiac resuscitation. Evidence suggests that a CV ratio of 30:2 may be much harder to achieve in practice and would ultimately result in asynchronous ventilations.(Schmicker 2021 31) |

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| Subgroup considerations |
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| Implementation considerations |
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| Monitoring and evaluation |
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| Research priorities |

Several knowledge gaps were identified in the review of this topic, including:

1. What is the effect of delayed positive pressure ventilation versus 30:2 high-quality CPR?

2. Which elements of minimally interrupted cardiac resuscitation (compressions, ventilations, delayed defibrillation) are most important for patient outcomes?

3. How effective is passive oxygenation during resuscitation?

4. How does adherence to CCC or a CV ratio of 30:2 influence patient outcomes?

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