# QUESTION

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| **TITLE** |
| **POPULATION:** | Among adults and children who are in cardiac arrest in any setting |
| **INTERVENTION:** | Real-time feedback and prompt devices regarding the mechanics of CPR quality (e.g. rate and depth of compressions and/or ventilations) |
| **COMPARISON:** | No feedback |
| **MAIN OUTCOMES:** | Survival to hospital discharge with good neurological outcome and survival to hospital discharge were ranked as critical outcomes. Return of spontaneous circulation (ROSC), bystander CPR rates, time to first compressions, time to first shock, and CPR quality was ranked as important outcomes.  |
| **SETTING:** | In-hospital or out-of-hospital cardiac arrest |
| **PERSPECTIVE:** | Patient perspective |
| **BACKGROUND:** | The use of CPR feedback or prompt devices during CPR in clinical practice or CPR training is intended to improve CPR quality as a means to improving ROSC and survival. The forms of CPR feedback or prompt devices include audio and visual components such as voice prompts, metronomes, visual dials, numerical displays, wave-forms, verbal prompts, and visual alarms. Visual displays enable the rescuer to see compression-to-compression quality parameters, including compression depth and rate, in real time. All audio prompts may guide CPR rate (e.g., metronome) and may offer verbal prompts to rescuers (e.g., “push harder,” “good compressions”). |
| **CONFLICT OF INTERESTS:** | None to declare |

**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
 | CPR performance is highly variable with over ventilation, poor quality chest compressions, frequent interruptions to chest compressions and delays to defibrillation are ongoing problems.Through the use of direct observation of actual cardiac arrests, recordings from automated external defibrillators (AEDs) and accelerometers, several studies have shown that chest compressions performed by trained professionals do not meet recommendations for compression rate, depth and continuity (Abella 2005; Abella 2005; Ko 2005; Wik 2005). For example, Wik and colleagues observed that chest compressions were halted for an average of 48%of the time during OHCAs (Wik 2005). While observing 67 IHCAs, Abella and colleagues observed that the chest compression rate was less than 90/min for 27% of the duration of the cardiac arrest, and compression depth was too shallow 37% of the time (Abella 2005).Devices that provide real time feedback during CPR are an available technology, however their effect on patient outcomes is note clear.  | These devices are in common, but not universal use across hospital and EMS systems around the globe.  |
| **Desirable Effects**How substantial are the desirable anticipated effects? |
| **JUDGEMENT** | **RESEARCH EVIDENCE** | **ADDITIONAL CONSIDERATIONS** |
| * Trivial
* Small
* Moderate

 Large **X Varies*** Don't know
 | Most studies identified in our search did not demonstrate statistically or clinically significant improvements in outcomes associated with the use of real-time feedback devices. However, no studies identified significant harm and some demonstrated clinically important improvements in outcomes. Most notable was the addition of the Goharani study [Goharani 2019 p5] to the evidence base considered in 2020, which was an RCT of 900 in-patient cardiac arrests from Iran. This study demosntrated a +25.6% absolute increase in survival to hospital discharge with audio feedback on compression depth and recoil (54% vs 28.4%, p<0.001). Several observational studies demonstrated improvements in favorable neurologic outcome which were not statistically significant, and statistically significant improvements in various aspects of CPR quality including CPR and CPR fraction. | Several of the identified studies included settings where the baseline CPR quality was already good before the use of CPR feedback devices. The task force considered that the relative increase in CPR quality with the use of a feedback device is likely dependent on the baseline CPR quality in the provider population, with larger opportunities for improvement in poor performing contexts. There may be a ceiling effect where the CPR quality is high before implementation of CPR feedback devices. We also considered the potential use of CPR Feedback devices for indications outside of the narrow scope of our PICO. We considered that high quality CPR as measured by rate, depth, recoil, and fraction has been recommended by ILCOR and this may be difficult to implement without use of a device to measure and sustain these metrics in a system.  |

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| **Undesirable Effects**How substantial are the undesirable anticipated effects? |
| **JUDGEMENT** | **RESEARCH EVIDENCE** | **ADDITIONAL CONSIDERATIONS** |
| * Large
* Moderate

**X Small** Trivial* Varies

Don't know | We did not identify any evidence of significant harm to patients with the use of CPR feedback devices in the published literature.  | We considered the potential costs of feedback devices for systems choosing to implement this technology. We considered the potential for CPR Feedback devices to increase cognitive load and noise for providers during resuscitation. |
| **Certainty of evidence**What is the overall certainty of the evidence of effects? |
| **JUDGEMENT** | **RESEARCH EVIDENCE** | **ADDITIONAL CONSIDERATIONS** |
| Very low **X Low*** Moderate
* High
* No included studies
 | Most data comes from observational studies with significant risk of bias. The randomized controlled trials included also have methodological concerns. The generalizability of the Hostler cluster randomized trial is in question because it was conducted in a very high performing group of EMS systems involved in a multi-center collaborative conducting RCTs in cardiac arrest. Paramedic training in this collaborative was intensive and focused on high quality CPR. The Goharani study was an outlier with respect to a significant improvement in survival, but CPR metrics were not reported in the study. It is unclear whether the large effect size was due to the fact that baseline CPR quality was very poor.  |  |
| **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
 | Patients, clinicians and decision-makers value neurologically intact survival and survival. The value of CPR metrics to patients and decision-makers is less clear. |   |

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| uncertainty or variability* **No important uncertainty or variability**
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| **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
 | Despite many studies showing no significant effect, we did identify several studies demonstrating clinically important effects on critical and important outcomes. There was no strong signal of harm associated with CPR Feedback devices for real-time feedback.We did not identify any cost-effectiveness studies.  |  |
| **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
 | We did not review any research evidence on costs of CPR feedback devices.  | Real time feedback functionality can be provided with stand-alone devices or through technology integrated into defibrillators. Costs for some electronic stand-alone devices can be significant, while costs for some mechanical feedback devices (example clicker devices that provide haptic and audio feedback when the device is compressed with sufficient force) can be much less. Real time feedback capability on defibrillators can add significant costs per unit. CPR feedback devices will also require additional training and data review resources.  |
| **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**
 | We did not review any research evidence related to the costs for CPR Feedback devices.  |  |
| **Cost effectiveness**Does the cost-effectiveness of the intervention favor the intervention or the comparison? |

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| **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**
 | We did not review cost-effectiveness studies.  |  |
| **Equity**What would be the impact on health equity? |
| **JUDGEMENT** | **RESEARCH EVIDENCE** | **ADDITIONAL CONSIDERATIONS** |
| * Reduced

**X Probably reduced*** Probably no impact

Probably increased* Increased
* Varies
* Don't know
 | No studies examined health equity for CPR Feedback devices | Systems with increased resources are probably more likely to invest in CPR Feedback devices. |
| **Acceptability**Is the intervention acceptable to key stakeholders? |
| **JUDGEMENT** | **RESEARCH EVIDENCE** | **ADDITIONAL CONSIDERATIONS** |
| * No
* Probably no

 Probably yes* Yes
* Varies

**X Don't know** | No evidence on acceptability was reviewed.  | Anecdotes of paramedics muting the feedback during resuscitations due to a perception that family members or witnesses might be distressed by feedback suggesting CPR was less than optimal.  |
| **Feasibility**Is the intervention feasible to implement? |
| **JUDGEMENT** | **RESEARCH EVIDENCE** | **ADDITIONAL CONSIDERATIONS** |
| * No
* Probably no

 Probably yes **X Yes**Varies* Don't know
 | Although we did not review evidence from studies specifically designed to evaluated feasibility, we have identified many studies documenting the implementation of CPR Feedback in both the hospital and prehospital settings.  | Various technologies are in widespread use in services around the world.  |

# SUMMARY OF JUDGEMENTS

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|  | **JUDGEMENT** |
| **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**

## Recommendation

We suggest against routine implementation of real-time CPR feedback devices as a stand-alone measure to improve resuscitation outcome, or in isolation from more comprehensive quality improvement initiatives (weak recommendation, very low quality of evidence).

In systems currently using real-time CPR feedback devices, we suggest the devices may continue to be used given that there is no evidence suggesting significant harm (weak recommendation, very low quality of evidence).

## Justification

The focused scope of this question was on the use of CPR feedback devices alone and excluded studies where the technology was used with system wide quality improvement initiatives or post event debriefing. High quality CPR is important to patient outcomes and the task force recognizes the importance of monitoring CPR quality. Monitoring CPR quality may take many forms: this systematic review focused solely on real-time CPR feedback devices so does not negate the importance of a CPR quality improvement program. In making this recommendation, we place a higher value on resource allocation and cost effectiveness than widespread implementation of a technology with uncertain effectiveness.

The task force recognized that most devices which provide real-time feedback during real cardiac arrests can also be used support CPR training with manikins, debriefing after cardiac arrest events with CPR quality data and longitudinal programmatic CPR quality assurance. There was significant debate amongst task force members on whether to recommend for or against the use of these devices for real-time feedback on the basis of available data. The task force acknowledged that most studies identified did not demonstrate a clinically or statistically significant association between real-time feedback and improved patient outcomes. However, no studies identified significant harm and some demonstrated clinically important improvements in outcomes. Most notable was the addition of the Goharani study [Goharani 2019 5] to the evidence base considered in 2020, which was an RCT of 900 in-patient cardiac arrests from Iran. This study demonstrated a +25.6% absolute increase in survival to hospital discharge with audio feedback on compression depth and recoil (54% vs 28.4%, p<0.001). Several observational studies demonstrated improvements in favorable neurologic outcome which were not statistically significant, and statistically significant improvements in various aspects of CPR quality including CPR rate and CPR fraction.

The 2020 task force placed value on the fact that ILCOR has made recommendations for optimal CPR on the basis of chest compression metrics which can be measured with CPR feedback devices. The task force acknowledged that implementing high quality CPR in hospital and EMS systems would be difficult a reliable way to measure CPR quality in those systems. Measuring and monitoring the quality of health care provided is regarded essential for any high quality health care system. Most CPR quality measurement devices also have real-time feedback capability.

So, in the context of some very low certainty evidence suggesting benefit of real-time feedback identified by our literature review, supportive recommendations for the delivery of CPR with particular metrics, supportive treatment recommendations for the use of devices for quality assurance and education from the EIT task force, and a lack of evidence suggesting harm, we made a weak recommendation in support of these devices for real-time feedback.

## Implementation considerations

* We recognized that there are significant cost implications associated with implementation of some CPR Feedback devices and therefore may not be feasible in all settings.
* There will be different implementation consideration with respect to resource use, training and quality assurance depending on the type of feedback system implemented
* We recognize that this weak recommendation supports systems in systems with adequate resources where this technology is already in use. This low certainty evidence does not necessitate the implementation of CPR Feedback in all systems, especially where it is not already in use and resources are scarce

# Monitoring and evaluation

# Registries should track the use of CPR Feedback devices in systems that have this implemented.

# Research Priorities

Current knowledge gaps include but are not limited to:

* What is the effect of feedback devices on patient outcomes when used by lay people with AEDs?
* What is the effect of real-time feedback devices in “low performing services” with baseline CPR metrics which are below recommended values, as an alternative to conventional training strategies?
* What are the most effective parameters to feedback to users (i.e. measures of brain or other tissue perfusion, ECG characteristics, other physiologic measurements?
* What are the most effective modalities for feedback to be provided to users?