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| Question |
| **“Use of Cognitive Aids in Resuscitation”** |
| **Population:** | Adults, children and neonates in any setting (in-hospital or out-of-hospital) requiring resuscitation or laypersons and health care providers providing resuscitation or learning to provide resuscitation. |
| **Intervention:** | The use of cognitive aids or checklists during resuscitation or resuscitation training |
| **Comparison:** | Compared to no use of a cognitive aid or checklist |
| **Main outcomes:** | Survival to hospital discharge with good neurological outcome and survival to hospital discharge were ranked as critical outcomes. Quality of performance in actual resuscitations, skill performance 1 year after course conclusion, skill performance between course conclusion and 1 year, skill performance at course conclusion, knowledge at course conclusion were included as important outcomes. Measures of effect outcomes included adherence to resuscitation guidelines, CPR quality and test scores were also included as important outcomes. |
| **Background:** | Cognitive aids have been widely adopted in non-critical clinical situations. These aids, often in the form of checklists, flowcharts, or digital applications, provide a structured framework to provide guidance through complex and dynamic processes. The 2020 CoSTR from ILCOR recommended:* We recommend against the use of cognitive aids for the purposes of lay providers initiating CPR (weak recommendation, low certainty of evidence).
* We suggest the use of cognitive aids for health care providers during trauma resuscitation (weak recommendation, very low certainty of evidence). In the absence of studies on cardiopulmonary resuscitation no evidence-based recommendation can be issued.

There is insufficient data to suggest for or against the use of cognitive aids in lay provider training.* We suggest the use of cognitive aids for training of health care providers in resuscitation (weak recommendation, very low certainty of evidence).

The 2021 EvUp published in the CoSTR 2021 revealed a number of new studies published in last 2 years to trigger this Systematic Review |
| **Conflict of interests:** | Kevin Nation is the Chief Executive of the New Zealand and Australian Resuscitation Councils – both Councils produce resuscitation guidelines that may include algorithms, flowcharts and infographics. |

# 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 | The management of cardiac arrest and other medical emergencies can be complex. Cognitive aids have been widely adopted in non-critical situations to guide adherence to guidelines, improve performance and reduce errors. Improvement in the design and use of published algorithms and other cognitive aids and their use in education and resuscitation events may improve performance and patient outcomes.  | Resuscitation councils worldwide are using cognitive aids during training and clinical practice in form of algorithms, flow charts, posters, interactive apps and other formats. Evidence on the effect of such cognitive aids might strengthen its use and enhance development of more used tailored approaches |
| Desirable EffectsHow substantial are the desirable anticipated effects? |
| Judgement | Research evidence | Additional considerations |
| ○ Trivial○ Small● Moderate○ Large○ Varies○ Don't know | **Health Care Providers Managing Resuscitation in Neonates**We found 5 studies (30, 31, 1, 14, 22) investigating the effects of cognitive aids used during simulated neonatal resuscitation. Non interactive aids were used in 3 studies (30, 22, 1), a poster (22), an instruction card with images and captions (30) or a tablet with auditory and visual prompts (1). Interactive aids were used in 2 studies (14, 31), an audio voice guidance App (14), or an augmented reality decision support tool (31).For the important outcome of **errors in preparing medication**, we identified moderate certainty evidence (downgraded for serios indirectness) from one randomised trial (30) with 50 participants and investigating a printed cognitive aid to assist dose preparation. The use of the cognitive aid significantly reduced errors, 50% without aid versus 24% with aid RR 0.48 (0.27 to 0.83). For the important outcome of **errors in choosing correct medication concentration**, the same study found moderate certainty evidence that the printed cognitive aid decreased errors in selection of the correct medication concentration, 44% without aid versus 12% with aid RR 0.27 (0.12 to 0.59).For the important outcome of **adherence to a protocol or process,** we identified very low certainty evidence (downgraded for serious indirectness and serious impression) from 4 studies (14, 1, 22, 31) with a total of 89 participants in the intervention groups and 84 participants in the control groups.* one study (31), investigating an electronic decision support tool, demonstrated improvement in performance score.
* one study (1) investigating an audio visual prompt device, demonstrated fewer deviations from a resuscitation algorithm.
* one study (14) investigating an audio visual guidance tool, demonstrated improved adherence to a resuscitation algorithm and performance to a guideline.
* one study (22) investigating a poster of an algorithm demonstrated no difference in performance.

**Healthcare Providers Managing Paediatric Resuscitation**We found 6 studies (24, 4, 3, 2, 25, 26) investigating the effects of cognitive aids used during simulated paediatric resuscitation. Non interactive aids were used in 2 studies (26, 25), a CPR checklist (26), or an electronic decision support tool (25). Interactive aids were used in 4 studies (24, 4, 3, 2), a Tablet App (24, 4), a Personal Digital Assistant App (3), or a Smartphone App (2).For the important outcome of **errors in medication dosage**, we identified very low quality evidence (downgraded for very serious risk of bias and serious indirectness) from 2 randomised trials (2, 3). * one study reported less medication errors using a mobile App compared with conventional method (2).
* in the another study all the participants (n=17) dosed epinephrine appropriately using computer-based resuscitation tool compared with only 1 participant in the control group (n=17) (3).

For the important outcome **time to medication preparation and administration**, we identified moderate quality evidence (downgraded for serious indirectness) from 1 randomised trial (2), demonstrating significant decrease in time to drug preparation and drug delivery with the use of the cognitive aids (mobile App).For the important outcome of **CPR quality** we found low quality evidence from 2 randomised trials (26, 4).* One study investigating the use of a checklist by 16 individuals in the intervention and control groups found no difference in CPR performance (26).
* One study investigating a decision support App with 32 teams in the intervention group and 75 teams in the two control arms also showed no difference in CPR quality metrics (4)

For the important outcome of **adherence to a protocol or process** we found very low quality evidence (downgraded for very serious risk of bias and serious indirectness) from 2 randomised trials (3, 4).* one study investigating a computer based resuscitation tool used by an individual with 19 participants in the intervention group examined the use of a computer based resuscitation tool by an individual, found improvement in the number of tasks completed with the tool compared to the19 participants in the control group. Other time relevant interventions showed no benefit (3).
* one study investigating a decision support App with 32 teams in the intervention group and 75 teams in the two control arms found significantly less deviations from guideline recommendations in the intervention groups (4).

For the important outcome of **non-technical team performance** (assessed using TEAM and BAR scores) we found very low quality evidence (downgrade for very serious risk of bias and serious indirectness) from one randomised trial (25). Negligible effect on non-technical performance were estimated in TEAM and BAR scores for all 35 teams used a non-interactive electronic decision support tool with non-technical skill prompts, 35 teams in the control group using memory alone and 35 teams using a combined technical and non-technical skills tool.For the less important outcome of **user workload** (assessed with NASA task load index score) we found very low quality evidence (downgraded for serious indirectness and very serious impression) from one observational study[(24).](#_References_Summary) 33 individual participants using a tablet App in the intervention arm had no significant difference in workload from the 15 participants in the control group.**Healthcare Providers Managing Adult Advanced Life Support**We found 8 studies (15, 16, 17, 6, 18, 5, 19, 20) investigating the effects of cognitive aids used during adult advanced life support simulated resuscitation. All the studies used interactive aids, a Smartphone App (15, 18, 19), a Tablet App (17, 6, 5), or a computer based clinical decision display system (16, 20).For the important outcome **adherence to a protocol or process**, we identified very low quality evidence (downgraded for very serious risk of bias and serious indirectness and very serious imprecision) from 8 randomised trials (15, 20, 19, 5, 18, 6, 17, 16).* Four studies (15, 17, 18, 19) investigated the use of interactive telephone Apps. Two studies reported improved performance scores (15, 19). Two studies (17, 18) demonstrated significantly improved adherence to correct sequences and reduce errors of commission.
* One study using an interactive computer prompt device demonstrated little difference in performance between the intervention group and control group in managing familiar algorithms but improved performance in the intervention group when managing less familiar protocols (20).
* Another study using an interactive large scree clinical decision display system seen by the team demonstrated a number of interventions performed closer to ACLS recommendations (16).
* Two studies (5, 6) with 40 teams participating in the intervention groups and 39 teams in the control groups investigated the use of interactive table Apps. One study (6) showed improved performance scores in the intervention group. One study (5) showed variable results between the intervention and control group.

For the less important outcome of **user workload** (assessed with NASA task load index score) we found very low quality evidence (downgraded for very serios risk of bias and serious indirectness) from one randomised trial (6). 32 teams using an interactive tablet App in the intervention group indicated significantly lower mental demand, physical demand and effort.**Healthcare Providers Managing Other Emergencies**We found 6 studies (7, 28, 29, 21, 23, 27) investigating the effects of cognitive aids used by healthcare providers managing other emergencies in simulated events. All of the studies used non interactive aids, checklists (29, 21, 28, 7, 23), or a Resuscitation Situation Display (27).For the important outcome **adherence to a protocol or process**, we identified very low quality evidence (downgraded for very serious risk of bias and serious imprecision) from 3 randomised trials (7, 28, 29). * two studies (29, 28) with a total of 79 participants in each of the intervention and control groups demonstrated highly significant increases in average performance scores (28) and reduced failure to adhere to critical steps (29).
* two studies with 607 participants in 85 teams in the intervention and 95 teams in control groups demonstrated that using a medical emergency checklist resulted in 9% absolute and 15% relative risk reduction of failure to adhere to guideline-adherent critical process steps. All teams had a lower failure rate for adherence to key processes with the intervention (7) . With a checklist the intervention groups had significantly shorter time to adequate administration of glucose in the hypoglycaemic coma scenario (median times 632s with checklist, 756s without checklist, p=0.03) but did not shorten time to performance of the other nine emergency interventions. Access to crisis checklists had no impact on whether emergency interventions were carried out or not (21)

For the important outcome **CPR performance and retention**, we identified very low quality evidence (downgraded for very serious risk of bias, serious indirectness and serious imprecision) from 1 randomised trial (23) indicating long check lists superior to short checklist or no checklist for overall performance on procedural variables but not for CPR quality. For the important outcome **Teamwork, simulation study (assessed with: Clinical Teamwork scale (CTS)**, we identified low quality evidence (downgraded for serious risk of bias and serious indirectness) from 1 observational trial (27) involving 3 teams in the intervention and control groups. The study found using a non-interactive situation display, resuscitation teamwork, as measured by the CTS, was overall better in the intervention group. For the less important outcome of **situational awareness** (assessed with Situational Awareness Global Assessment Technique, SAGAT) we found low quality evidence (downgraded for serious risk of bias and serious indirectness) from one observation study (27) involving 3 teams in the intervention and control group. The study found no difference with using a non-interactive situation display in either group.**Laypersons Delivering Resuscitation**We found 9 studies, 7 randomised trials (32, 9, 10, 33, 13, 12, 34) and 2 observational studies (8, 11), investigating the effects of cognitive aids used by lay rescuers during simulated resuscitation. Non interactive aids were used in 4 studies (32, 33, 13, 34), Smartphone Apps (32, 33), a flowchart (13), or an instruction card (34). Interactive aids were used in 5 studies (8, 9, 10, 11, 12), Smartphone Apps (9, 12), Personal Digital Assistant Apps (8, 10), or a Chatbot (11).For the important outcome of **adherence to a protocol or process assessed by a performance score,** we identified very low quality evidence (downgraded for very serious risk of bias, serious inconsistency and very serious impression) from 5 randomised trials (32, 9, 33, 12, 34) with a total of 171 participants in the intervention groups and 190 participants in the control groups.* three studies (32, 9, 33) investigating the use of mobile phone applications, demonstrated improved adherence to a process measured using a checklist or performance score. One study (12) investigating a mobile phone application using yes/no questions found no significant improvement.
* one study investigating the use of an instruction card by individuals found improved adherence to the sequence of AED use and improved time to shock (34).

For the important outcome of **adherence to a protocol or process assessed with an Objective Structured Clinical Examination (OSCE) score**, we found low quality evidence (downgraded for very serious indirectness) from one observational study (8). Investigating the use of speech recognition software on a personal digital assistant device, with 49 participants in the intervention group and 56 participants in the control group, the study demonstrated improved OSCE points scores.For the important outcome of **quality of CPR** we identified very low quality evidence (downgraded for very serious risk of bias, serious inconsistency and serious indirectness) from 2 randomised trials (10, 13) with 58 participants in intervention groups and 56 participants in the control groups.* one study (10) investigating the use of a voice activated visual and auditory assisted decision device, demonstrated improved adherence to a 30:2 CPR ratio.
* one study (13) investigating the use of a flowchart demonstrated reduced hands off time during CPR.

We also identified moderate quality evidence (downgraded for serious indirectness) from one observational study (11)with 21 participants investigating the feasibility of Chatbot guidance which demonstrated thirty-three percent of participants achieved high-quality CPR, 86% achieved quality chest release, 38% did so in depth of compressions and only 5% in compression rate. 24% achieved a mean depth between 50 and 60 mm and 62% achieved a mean rate between 100 and 120 c/min. | No critical outcomes regarding patient outcome or skill performance in real situations were investigated in any study. All studies involved an individual or teams using a cognitive aid in simulated clinical situations.There is significant heterogeneity in the types of cognitive aids studied.The most analysed outcome was "Adherence to a protocol or process". Cognitive aids may improve performance and patient outcome by providing real-time decision support and guidance and: ● decreasing cognitive load of individuals or team collectively (35). Limitations to working memory, systems 1 cognitive processes and the impact of stress and distraction in resuscitation may impair rapid, accurate decision-making (36) which can be improved by cognitive aids. ● standardizing communication among resuscitation team members (37).● allow for better situation awareness/ shared mental model among team members (38). |
| Undesirable EffectsHow substantial are the undesirable anticipated effects? |
| Judgement | Research evidence | Additional considerations |
| ○ Trivial○ Small● Moderate○ Large○ Varies○ Don't know | **Laypersons Delivering Resuscitation**We found very low quality evidence from 3 studies (10, 33, 13) with a total of 255 participants that demonstrated potentially undesirable effects. Two studies (10, 13) identified significant increase in time to commencing chest compressions. One study (33) found delays in calling emergency services and delays in commencing chest compressions.  | In laypersons, the use of cognitive aids may ● promote fixation errors and groupthink(39)● impair communication among team members(40) ● be distracting especially when not developed well (flow, colour, how easy to read, confusing to follow etc) and may worsen performance/patient outcome |
| 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 | **Health Care Providers Managing Resuscitation in Neonates*** The certainly of evidence was moderate for medication error outcomes and very low for adherence to protocol or process outcome
* Downgrades for serious indirectness and very serious imprecision

**Healthcare Providers Managing Paediatric Resuscitation*** The certainly of evidence was very low or low for most outcomes. For one outcome (medication timing) the certainty of evidence was moderate
* RCT downgrades for serious to very serious risk of bias and serious indirectness
* Non RCT downgrades for serious indirectness and very serious imprecision

**Healthcare Providers Managing Adult Advanced Life Support*** The certainty of evidence was very low
* Downgrades occurred for very serious risk of bias, serious indirectness and very serious imprecision

**Healthcare Providers Managing Other Emergencies*** The certainly of evidence was very low in two four outcomes and low in the other two
* RCT downgrades for very serious risk of bias serious indirectness and serious imprecision
* Non RCT downgrades for serious risk of bias and serious indirectness

**Laypersons Delivering or Learning to Deliver Resuscitation*** The certainty of evidence was low or very low for three of four outcomes. One outcome (quality of CPR) was moderate
* RCT downgrades for very serious risk of bias, serious inconsistency, serious indirectness and very serious imprecision
* Non RCT downgrades for serious and very serious indirectness
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| 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 | We found no evidence for the use of cognitive aids by trained health care providers during actual resuscitation events.Good neurological function is a valued patient outcome however we found no studies evaluating this. | Despite all outcomes being assessed in simulated resuscitation, the main outcomes may be valued as surrogate for actual resuscitation performance in patients with cardiac arrest. |
| 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 | See listed outcomes under desirable and undesirable effects.  | In contrast to the last systematic review in 2019 more randomized controlled trials in simulated resuscitation, indicate evidence for the desirable outcomes. |
| 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 studies analysed costs of the development and implementation/resources. Displayed aids might be more difficult to implement than handheld cognitive aids.  | Costs of development, dissemination and implementation of cognitive aids needs to be considered and investigated. These may vary from moderate costs for checklists or providers downloading an app onto their personal phone to higher costs for wearable applications.There may also be cost implications related training to use the cognitive aid |
| 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 studies analysed costs of resources.  |  |
| 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 studies analysed cost effectiveness | Despite no evidence being found, the use of cognitive aids may be cost effective for health care providers as it may potentially favour an improved outcome for resuscitation.  |
| 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 | There is no perceived impact on health equity. | Despite no evidence being found, we do not believe that the use of cognitive aids would have a negative effect on equity and may be cost effective for health care providers as it may potentially favour an improved outcome for resuscitation.  |
| AcceptabilityIs the intervention acceptable to key stakeholders? |
| Judgement | Research evidence | Additional considerations |
| ○ No○ Probably no● Probably yes○ Yes○ Varies○ Don't know | No studies assessed that category. | Cognitive aids, such as checklists, are widely used in medicine the task force argues that such cognitive aids are accepted by resuscitation providers. |
| FeasibilityIs the intervention feasible to implement? |
| Judgement | Research evidence | Additional considerations |
| ○ No○ Probably no● Probably yes○ Yes○ Varies○ Don't know | None of the studies investigated offered evidence regarding implementation issues, such as training or resource-related considerations. Nonetheless, it seems reasonable to supply cognitive tools for resuscitation practitioners to use during both training and real-life resuscitation.  | Implementing the use of cognitive aids seems to be feasible although there are costs associated with training and installing and maintenance of the necessary software in case of digital cognitive aids. |

# 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** | 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 |
| * We suggest the use of cognitive aids by health care providers in resuscitation (weak recommendation, very low certainty of evidence).
* We do not recommend the use of cognitive aids for lay providers initiating CPR (weak recommendation, low certainty of evidence).
* We did not examine the use of cognitive aids in health professional or lay rescuer training in resuscitation so no recommendation for or against can be issued
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| Justification |
| In making this recommendation we recognise that:* The EIT Task Force continues to prioritise this topic because international resuscitation councils commonly provide cognitive aids to resuscitation course participants and health care organizations (algorithms, pocket cards, flowcharts, infographics, etc.). However, it has not been determined if they are effective in improving patient outcomes or provider performance during actual resuscitation, as no evidence was found for the use of cognitive aids by trained health care providers during actual resuscitation events.
* In 2021 our evidence update focused on outcomes associated with CPR quality. In the review outcomes have been associated more towards improved team performance through adherence to protocol and process.
* Our recommendation has been issued differentiating health care professionals and laypersons as well as for routine use of cognitive aids during resuscitation and training for these providers as the conditions between training and clinical resuscitation differs substantially.
* For lay providers, there is consistent evidence that there are potentially clinically important delays in initiating CPR when using a cognitive aid; however, the evidence for impact on CPR quality metrics (e.g. rate, depth, chest compression fraction) is less consistent. We found insufficient evidence to issue a recommendation for the use of cognitive aids in layperson training.
* For health care professionals sufficient new studies provided the evidence to issue a recommendation for the use of cognitive aids during training. As no study reported the use of cognitive aids during patient resuscitation, the simulation study results might be used as a surrogate to justify the use of cognitive aids as these have been used over decades by all resuscitation councils.
* Due to no studies being found in resuscitation in the review in 2019, the Task Force has previously considered the trauma resuscitation environment sufficiently similar to the cardiopulmonary resuscitation environment to extrapolate evidence that shows that trauma resuscitation teams generally adhere to resuscitation guidelines better, make fewer errors and perform key clinical tasks more frequently if they use cognitive aids. Over the last few years sufficient new studies addressed the use of cognitive aids in resuscitation (however only in an simulation environment) the Task Force decided to exclude trauma studies in this review, as there may be important differences between the cardiac arrest and trauma resuscitation clinical environments.
* There were several studies that used composite scores as their primary outcome (e.g. score calculated based on completion of several clinical tasks). We included these studies for this systematic review however, given their heterogeneity, comparing and consolidating the results was not possible.
* We did not examine the use of cognitive aids in health professional or lay rescuer training in resuscitation and this needs to be examined in our next review.
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| Subgroup considerations |
| For health care providers and laypersons see considerations under “Justification”. |

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| Implementation considerations |
| None of the studies examined provided evidence to describe implementation concerns, e.g. training or resource implications. However, it appears easy and feasible to provide cognitive aids for health care professionals applying resuscitation to use such cognitive aids during training and actual resuscitation. |

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| Monitoring and evaluation |
| N.A |

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| Research priorities |
| * There is urgent need for adequately powered studies investigating the impact of cognitive aids in the real-world cardiac arrest environment on the neurologic intact survival of patients.
* Effective implementation strategies during training and real-life resuscitation for health care providers.
* Cost effectiveness studies on the use of cognitive aids during resuscitation and training.
* Which cognitive aids are more effective than others?
* High quality studies of the use of cognitive aids during health professional and layperson training.
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