

WORKSHEET for Evidence-Based Review of Science for Emergency Cardiac Care

Worksheet author(s)

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Clinical question.

Does the use of a checklist (I) during neonatal, paediatric and adult emergency care (P) as opposed to no checklist (C) improve outcomes (O) (eg compliance with guidelines, other outcomes)?

Is this question addressing an intervention/therapy, prognosis or diagnosis? Intervention

State if this is a proposed new topic or revision of existing worksheet:: New topic

Conflict of interest specific to this question

Do any of the authors listed above have conflict of interest disclosures relevant to this worksheet? No

Search strategy (including electronic databases searched).

Medline: ("Heart Arrest"[Mesh] OR "Resuscitation"[Mesh] OR "Emergency Treatment"[Mesh] OR "Surgical Procedures, Operative"[Mesh]) AND ("checklist"[text word] OR "mnemonic*" [text word] OR "cognitive aid"[text word] OR "prompter"[text word] OR "aide memoire"[text word] OR "reminder"[text word] OR "Mental Recall"[Mesh]). EMBASE search via Health Information Resources (formerly National Library for Health): "heart arrest" [as major descriptor] OR "resuscitation" [as major descriptor] OR "emergency treatment" [as major descriptor] OR surgery [as major descriptor] AND {"checklist" [text word] or "mnemonic*" [text word] OR "cognitive aid" [text word] OR "prompter" [text word] OR "aide memoire" [text word] OR "mental recall" [text word] OR "reminder" [text word] OR "recall" [as major descriptor] OR "reminder system" [as major descriptor]} . Cochrane database for systematic reviews. AHA endnote library. No date limits. Original search performed 31 May 2009 Updated search Medline (Matthew Weiss) xxxxxx, Embase (Nick Brennan) 26 November 2009.

• State inclusion and exclusion criteria

The following studies were included:

- 1) studies using checklists/cognitive aids as an intervention during real or simulated resuscitation
- 2) use of checklist/cognitive aids which required a cognitive element or active process of referencing directly by the user
- 3) studies including emergency care such as intra-operative emergencies were included as extrapolated data
- 4) studies using cognitive aids to improve recall of facts needed for advanced life support were included as extrapolated data

The following studies were excluded:

- 1) checklist/cognitive aid used as a method of preparation for an event,
- 2) checklist/cognitive aid used for assessment or debriefing of an event
- 3) CPR-prompt devices providing automatic mechanical feedback
- 4) dispatcher-assisted CPR

• Number of articles/sources meeting criteria for further review:

16 studies on Medline and Embase fulfilled the inclusion criteria.

AHA database: no articles pertaining to ILCOR question

Cochrane: no relevant reviews

Summary of evidence

Evidence Supporting Clinical Question

Good					Choa 2008 E1 Choa 2009 E1 Ertl, 2007 E1 Ward, 1997 E1 Berkenstadt, 2006 E2 Schneider, 1995 E2 Lerner, 2009 E3 Dyson, 2004 E4
Fair					
Poor				Mills, 2004 E6 Neily 2007, E6	Harrison, 2006 E2 Runciman ,1993 E5 McCallum, 2004 E4
	1	2	3	4	5
Level of evidence					

E1=Simulated lay provider BLS

E2=Simulated anaesthetic emergency

E3=Medical professional in simulated ALS

E4=Recall of ALS knowledge pre/post cognitive aid

E5=Expert opinion of cognitive aid algorithm

E6=Survey on opinion of using cognitive aid

Evidence Neutral to Clinical question

Good					Ward, 1997 E1 Bould 2009, E2 E3
Fair					
Poor					
	1	2	3	4	5
Level of evidence					

E1=Simulated lay provider BLS

E2=Simulated anaesthetic emergency

E3=Medical professional in simulated ALS

E4=Recall of ALS knowledge pre/post cognitive aid

E5=Expert opinion of cognitive aid algorithm

E6=Survey on opinion of using cognitive aid

Evidence Opposing Clinical Question

Good					Zanner, 2007 E1
Fair					
Poor					Nelson, 2008 E3
	1	2	3	4	5
Level of evidence					

E1=Simulated lay provider BLS

E2=Simulated anaesthetic emergency

E3=Medical professional in simulated ALS

E4=Recall of ALS knowledge pre/post cognitive aid

E5=Expert opinion of cognitive aid algorithm

E6=Survey on opinion of using cognitive aid

REVIEWER'S FINAL COMMENTS AND ASSESSMENT OF BENEFIT / RISK:

DISCUSSION: There is a diverse variety of mental, written and electronic checklists or aide-memoires used within medical practice (and even more used as part of educational and professional assessments) but little data on their *effectiveness as interventions* in improving clinical outcomes during emergency situations such as resuscitation. The limited evidence that does exist relates to proxy measures, such as performance in simulations and recall of factual information needed for resuscitation, and, often applies only to part of the resuscitation protocol and potential benefits or harm may be specific to the type of checklist used and the scenario rather than generalisable.

One study (Ward, 1997) tested cardiopulmonary resuscitation performance in students two months after certification in BLS. 3 groups were compared – no checklist, short checklist and long checklist, in the latter two cases given to the students for the first time at re-testing with a Resusci Anne. The short checklist and no checklist groups had similar levels of overall performance using while the detailed long checklist did significantly better than no checklist in performing key steps ($p<0.02$) and ratio of compressions to ventilation breaths ($p<0.01$). Importantly, this single study shows proxy outcomes which are highly *checklist-specific*. A major limitation of this study is that the intervention which worked would not be practical for use in public.

Four RCT studies have looked at the use of CPR instruction using mobile electronic technology in simulated BLS. One studied skill retention in non-medical hospital employees given an animation-assisted reminder tool on their mobile phone at the time of re-testing compared to no tool at more than 6 months after CPR training (Choa, 2009). Simulator performance in particular with chest compression was greater with the intervention ($p<0.001$). The same group found improved performance comparing their animated instruction to telephone instruction by dispatcher (Choa, 2008). In both cases the study commenced after the animated video clip was started eliminating any delay in starting resuscitation from the intervention. Two other studies looked at devices compared to no additional input in members of the public. In one (Ertl, 2007), although there were improvements in the performance of BLS, the personal digital assistant was operated by an assistant following the candidate's instructions. In the other (Zanner, 2007), the mobile phone first aid application given for use when "they thought it to be beneficial" resulted in a significant delay in the time to complete two complete cycles of CPR (4.24 vs 2.41 min; $p<0.001$).

In all these studies the equipment was provided on the day of testing and do not provide evidence for the benefit or harm of this technology in actual emergencies in patients. Of even more concern in many of the favourable simulation studies is the extent to which the study design does not capture or may artificially diminish any possible delay in initiating or performing CPR with the use of the cognitive aid, e.g. commencing after the video-clip was turned on for them (Choa, 2008;2009). Further trials should therefore use a study design which captures and does not artificially diminish any possible delay in initiating basic or advanced life support with the use of the cognitive aid.

Three studies looked at the use of checklists or cognitive aids by anaesthetic residents in simulated emergencies, viz. malignant hyperthermia (Berkenstadt 2006, 530, Harrison 2006, 551), advanced neonatal resuscitation (Bould 2009, 570), VF/pulseless VT and bradycardia (Schneider 1995, 358). The Berkenstadt (2006, 530) and Schneider (1995, 358) studies used computer-based aids, on which the doctors had training immediately before the studies started, while the Bould (2009, 570), and Harrison (2006, 551) studies each provided a poster, with instructions to the participants about its availability, in the first study, and no instruction, in the second. Both general and specific factors in the interaction between participants and the aids used in these scenarios are likely to have influenced the effectiveness of any specific aid on improving or impairing performance. For example, the effect of immediate pre-study training with a computer is likely to have artificially favoured the outcome of the aid; similarly, the 20-minute timescale of gradual clinical deterioration in the malignant hyperthermia scenarios might make the use of any aid more appropriate and useful (such as in ensuring accurate drug dosing). In contrast, the more acute neonatal emergency required a more rapid response within the 5-minute timescale of the Bould study (2009, 570), and, therefore, even though instructed that a poster would be available, time-pressure was identified as a factor by 24% of participants for not using it. In addition, the lack of any practical experience of newborn resuscitation during their anaesthetic residency might have contributed to a lack of insight into their own competence, and might explain the response by 29% that a checklist was not needed despite the universal poor performance.

Two other studies have looked at medical professionals in simulated emergencies, viz radiology residents in paediatric anaphylaxis (Lerner 2009, 703) and paediatric residents in pulseless VT and PEA (Nelson 2008, 138). The anaphylaxis scenario involved randomisation to use or no-use of a computer-based aid and assessed 4 primary tasks (calling "code, giving oxygen, giving epinephrine, and giving the right dose), while in the Nelson observational study (2008, 138) use of an aid was voluntary and 25% of residents chose the wrong algorithm. This raised a question as to whether the design of the cognitive aid used might have contributed to the cognitive error in this more complicated scenario.

The more simple use of an aid in factual recall of correct doses of drugs, fluids for resuscitation or reversible causes of cardio-respiratory arrest may be less prone to cognitive errors during the stress of performing ALS. This benefit of cognitive aids has been studied as an outcome in some of the above simulation studies and, if artificially separated from the more complex individual and team performance, would seem to be supportive of their use. Two further studies reinforce this point (Dyson 2004, 457, McCallum 2004, 477). Comparison of different aide-memoires on recall of causes of electromechanical dissociation was studied by telephone survey

in junior doctors one month after receiving one of two aide-memoires (Dyson 2004, 457). Median recall improved more in the “EMD-aide” than the “4Hs+4Ts” group ($p=0.03$). This may have been related to an increase in time spent studying the new aide-memoire compared to revision of “4Hs+4Ts” (which the Resuscitation Council introduced in 1997) rather than being specific to this mnemonic. Unfortunately, it did not include a “no checklist” control to allow assessment of mnemonics as an intervention against the effect of being in a study. As a checklist it only covers a limited aspect of the whole resuscitation protocol. The use of a portable resuscitation card (McCallum 2004, 477) improved accuracy of calculations when assessed by questionnaire but both these lacked a “no checklist” control. The latter study was more comprehensive as it also assessed how to call for assistance, estimate weight and select endotracheal tube size. Percentage of correct answers improved from 58 to 92% with the card. The effect of introducing an aid and any training associated with its introduction is likely to have a significant learning effect but there is no evidence that this effect is more than short-term. In this light, the introduction of checklists and aids to reinforce education and improve performance might be justified because of the potential of a non-checklist specific training effect on knowledge retention and performance by resuscitation teams if it were accompanied by frequent training but not without those controls. As the purpose of this review is to consider the evidence or any specific effect on outcomes from the use of cognitive aids or checklists, I have not included any contribution of potential educational benefits in the treatment recommendation.

KNOWLEDGE GAP;

Well-designed trials of cognitive aids in simulated and actual resuscitations are required to further determine potential benefit and harm. The utility of checklists or cognitive aids may be specific to the particular scenario, provider or type of tool used. Further studies are needed to clarify these issues.

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Citation List

Berkenstadt H, Yusim Y, Ziv A, Ezri T, Perel A. An Assessment of a Point-of-Care Information System for the Anesthesia Provider in Simulated Malignant Hyperthermia Crisis. *Anesth Analg*. 2006 February 1, 2006;102(2):530-2.

- *Level 5. Supportive to question. Good. RCT in 29 anaesthesia residents assessing access versus no access to point-of-care information system in a simulated malignant hyperthermia crisis*
- *Assessment was immediately after 30 minute training in use of the aid*
- *Time spent using the system ranged from 20-210 seconds (63+-45s)*
- *Intention to treat analysis of the groups showed a significant improvement in management scores with the aid*

Bould MD, Hayter MA, Campbell DM, Chandra DB, Joo HS, Naik VN. Cognitive aid for neonatal resuscitation: a prospective single-blinded randomized controlled trial. *Br J Anaesth*. 2009 Oct;103(4):570-5.

- *LOE 5. Neutral to question. Good. RCT in 32 anaesthesia residents, previously certified in neonatal resuscitation, of access versus no access to a resuscitation poster during simulated neonatal resuscitation.*
- *16 participants randomized to poster told there would be a poster available but 1/3rd felt retrospectively it was not needed.*
- *No difference between the groups with both groups performing poorly. Despite poor performance, only 26.7% of group with access used the aid frequently.*
- *Possibly limited by lack of familiarity with poster prior to evaluation in short 5 minute time of simulation.*

Choa M, Park I et al. The effectiveness of cardiopulmonary resuscitation instruction: Animation versus dispatcher through a cellular phone (2008). *Resuscitation*. **77**: 87-94

- *Level 5. Supportive to question. Good. Single-blinded cluster RCT assessing provision of animated memory-aid AA-CPRII on participants' mobile phones versus dispatcher-assisted CPR on CPR performance in 44 non-medical hospital employees.*
- *Both groups performed three cycles of CPR and their video-recorded performances were evaluated.*
- *The AA-CPRII group had a significantly better score on the 2005 AHA Guidelines-conforming checklist score and time to completion of 1 cycle compared to the control group ($p<0.001$).*
- *Psychomotor skills evaluated with the AA-CPRII group demonstrated better performance in hand positioning at 69 vs 57% ($p=0.033$) and compression rate 72 vs 58% ($p=0.015$) than the control group.*

- *The accuracy of compression depth ($p=0.4$), ventilation volume ($p=0.977$) and flow rate ($p=0.6$) were below 30% in both groups.*

Choa M, Cho J et al. Animation-assisted CPRII program as a reminder tool in achieving effective one-person-CPR performance (2009). *Resuscitation*. 80(6): 680-4

- *Level 5. Supportive to question. Good. Single-blinded RCT assessing provision of animated memory-aid AA-CPRII on participants' mobile phones on skill retention in 80 non-medical hospital employees six months after CPR training.*
- *Both groups performed three cycles of CPR and their video-recorded performances were evaluated.*
- *The AA-CPRII group had a significantly better score compared to the control group ($p<0.001$). Psychomotor skills evaluated with the AA-CPRII group demonstrated better performance in hand positioning ($p=0.025$), compression depth ($p=0.035$) and compression rate ($p<0.001$) than the control group.*

Dyson, E., S. Voisey, et al. (2004) Educational psychology in medical learning: a randomised controlled trial of two aide memoires for the recall of causes of electromechanical dissociation. *Emerg Med J* 21:457-460

- *Level 5. Supportive to question. Good. RCT comparing aide memoire, "EMD-aide" to the conventional "4Hs+4Ts" mnemonic in facilitating recall of causes of electromechanical dissociation (EMD) among house officers.*
- *Baseline ability to recall causes of EMD was recorded at one minute and overall. House officers were then sent a copy of either "4Hs+4Ts" or "EMD-aide" according to randomisation group. Recall ability was retested at one month.*
- *68 of 80 and 51 of 69 house officers completed the study in the "4Hs+4Ts" and "EMD-aide" groups respectively (NS) with similar baseline recall. After intervention median number of recalled causes was greater in the "EMD-aide" group, eight compared with seven at one minute ($p = 0.034$) and eight compared with seven overall, $p = 0.067$.*
- *Recall of all eight causes was more common in "EMD-aide" group, 54% compared with 35%, $p = 0.054$, and these house officers spent longer examining their aide memoire, $p<0.001$.*

Ertl L, Christ F (2007). Significant improvement of the quality of bystander first aid using an expert system with a mobile multimedia device. *Resuscitation* 74:286-295.

- *Level 5. Supportive to question. Good. RCT comparing performance in emergency care in 101 members of the public using a personal digital assistant versus control in 2 simulated emergencies, an unconscious trauma victim with severe bleeding and CPR.*
- *The PDA-supported group scored higher on objective structured clinical assessment (OSCE) with maximum score of 24, achieving 22 s 15 ($p<0.01$).*
- *The personal digital assistant was operated by an assistant following the candidate's instructions to simulate speech recognition software. This limited interpretation of any possible harm from delay in resuscitation using this technology.*

Harrison TK, Manser T, Howard SK, Gaba DM. Use of Cognitive Aids in a Simulated Anesthetic Crisis. *Anesth Analg*. 2006 September 1, 2006;103(3):551-6.

- *LOE 5, Supportive to question. Poor as it was a retrospective observational study of anaesthetic resident use of cognitive aids*
- *No training in use of the aids and use of any aid they thought appropriate to bring as well as having access to a poster on MH management and the help of another trainee available for help when requested therefore assessing team performance.*
- *Demonstrated improved resident performance with increasing use of cognitive aids*
- *Lowest performing residents were shown to have the lowest cognitive aid usage, such as overall dantrolene was mixed correctly 60% of the time but only 5% of groups not using a cognitive aid mixed it correctly.*
- *Cognitive aid use explained only 1/3 to 2/3rd of the variance in scores, highlighting the multiple human factors underlying team performance under stress.*

Lerner C, Gaca AM, Frush D, Hohenhaus S, Ancarana A, Seelinger T, et al. Enhancing pediatric safety: assessing and improving resident competency in life-threatening events with a computer-based interactive resuscitation tool *Pediatric Radiology*. 2009;39(7):703-9.

- *LOE 5. Supportive to question. Good. Randomized crossover of radiology residents using a computer-based cognitive aid available in either the first or second simulated paediatric anaphylaxis.*
- *Significant improvement in essential tasks such as correct dosing of epinephrine*
- *Significant learning effect*

McCallum, Z. and M. South (2004). "Development and use of a portable paediatric resuscitation card." Journal of Paediatrics & Child Health **40**(8): 477-80.

- *Level 5. Supportive to question. Poor. Non randomised questionnaire assessment of paediatric resuscitation knowledge in tertiary hospital paediatric doctors before and after introduction of a portable aide-memoire reference card containing reference normal values, including an algorithm for recognition and management of the seriously ill/arrested child.*
- *Sample of 18 retested 4 months after introduction of the card. The post-card group obtained significantly more correct answers than the pre-card group 92 vs 58% ($p < 0.0001$).*

Mills PD, DeRosier JM, Neily J, McKnight SD, Weeks WB, Bagian JP. A cognitive aid for cardiac arrest: you can't use it if you don't know about it. *Jt Comm J Qual Saf.* 2004 Sep;30(9):488-96.

- *LOE 4. Supportive to question. Poor. Cross sectional survey of physician opinion of the use of a cognitive aid during resuscitation*
- *Highlighted poor use of the cognitive aid despite the majority being aware of its existence*
- *Viewed favorably by the limited number of physicians who reported experience with the aid*

Neily J, DeRosier JM, Mills PD, Bishop MJ, Weeks WB, Bagian JP. Awareness and Use of a Cognitive Aid for Anesthesiology. *Joint Commission Journal on Quality and Patient Safety.* 2007;33:502-11.

- *LOE 4. Supportive to question. Poor. Cross sectional survey of physician opinion towards the use of a cognitive aid during anesthesia emergencies*
- *Viewed favorably by the limited number of physicians who reported experience with the aid*

Nelson KL, Shilkofski NA, Haggerty JA, Saliski M, Hunt EA. The use of cognitive AIDS during simulated pediatric cardiopulmonary arrests. *Simul Healthc.* 2008 Fall;3(3):138-45.

- *LOE 5, Opposing the question. Poor. Prospective observational study of 60 paediatric residents use of cognitive aids during a simulated "megacode"*
- *Frequent selection of an inappropriate algorithm while using a cognitive aid, but no reported data of frequency of inappropriate algorithm/treatment when no cognitive aid was used*
- *6 of 43 (14%) failed to initiate CPR or request epinephrine while asking questions about reversible causes of PEA. 5 of these 6 were actively using cognitive aids to treat these underlying causes. No control to assess causality but raises concern over possible delay in initiating BLS.*

Runciman WB, Webb RK, Klepper ID, Lee R, Williamson JA, Barker L. Crisis management - validation of an algorithm by analysis of 2000 incident reports. *Anaesthesia and Intensive Care.* 1993;21:579-92.

- *LOE 5, Supportive to question. Poor. Expert opinion on potential efficacy of checklist algorithm to diagnose and treat clinical anaesthetic problems*
- *Retrospectively analysis of cases reported to the Australian Incident Monitoring Study to determine if the algorithm might have changed outcomes*
- *Opinion that the algorithm would help diagnosis in 99% of the incidents and would have improved outcome in 12.6% of cases*

Schneider A. J. L., Murray W. B., et al. (1995). "'Helper:' A critical events prompter for unexpected emergencies." Journal of Clinical Monitoring **11**(6): 358-364.

- *Level 5. Supportive to question. Good. RCT comparing use of a computer-based prompter with no additional support in advanced life support scenarios during a simulated anaesthetic.*
- *39 anaesthetic residents presented with two emergency scenarios, ventricular fibrillation and second-degree heart block with assessment of selection of correct drugs and doses.*
- *The correct dose and use of drugs improved with the prompter. For example, correct dose of lidocaine was greater with the prompter 95 vs 58% ($p = 0.015$); similarly MgSO₄ was appropriately ordered more often 60 vs 10% ($p = 0.003$).*

Ward, P., Johnson L. A., et al. (1997) Improving cardiopulmonary resuscitation skills retention: effect of two checklists designed to prompt correct performance. Resuscitation **34**: 221-5

- *Level 5. Supportive and neutral to the clinical question. Good. RCT comparing the effects of two checklists designed to prompt correct CPR performance against no checklist.*
- *169 undergraduate students completed a certification course in cardiopulmonary resuscitation (CPR) and were retested at 2 months, 2 of the groups being given a checklist at the time of retesting.*
- *The short checklist and no checklist groups had similar levels of overall performance (neutral to clinical question) while the detailed long checklist did significantly better than no checklist in performing key steps ($p < 0.02$) and ratio of compressions to ventilation breaths ($p < 0.01$), (supportive to the clinical question).*
- *Importantly, this single study shows proxy outcomes which are highly checklist-specific.*

Zanner R, Wilhelm D, et al. (2007) Evaluation of M-AID, a first aid application for mobile phones. Resuscitation **74**: 487-494

- *Level 5. Opposing the question. Good. RCT comparing the use of a mobile phone first aid application with a binary “yes” or “no” algorithm versus control on CPR performance on a manikin in 119 members of the public.*
- *The mobile phone first aid application given for use when participants “thought it to be beneficial” resulted in a significant delay in the time to complete two complete cycles of CPR (4.24 vs 2.41 min; $p < 0.001$).*