ACORN AUSTRALIAN COLLEGE OF PERIOPERATIVE NURSES | JOURNAL OF PERIOPERATIVE NURSING

Volume 37
Issue 1 *Journal of Perioperative Nursing*

Article 6

3-19-2024

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Recommended Citation

Almoite, Simon and Foran, Paula (2024) "Barriers to and facilitators of using cognitive aids in perioperative emergencies: An integrative review," *Journal of Perioperative Nursing*: Vol. 37 : Iss. 1 , Article 6.
Available at: https://doi.org/10.26550/2209-1092.1317

https://www.journal.acorn.org.au/jpn/vol37/iss1/6

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Barriers to and facilitators of using cognitive aids in perioperative emergencies: An integrative review

Abstract

Problem identification: Perioperative emergencies, although infrequent, may lead to significant morbidity and mortality associated with anaesthesia and/or surgery. Human factor errors account for between 43 to 65 per cent of sentinel events in the perioperative environment. Cognitive aids were introduced to reduce a user's cognitive workload and assist in adherence to key interventions during emergencies. Despite the availability of these aids, implementation of their use remains low. This integrative literature review will identify the barriers to and facilitators of the implementation of cognitive aids during perioperative emergencies.

Literature search: An electronic database search of EBSCO databases (CINAHL Complete, Health Source: Nursing/Academic Edition, MEDLINE, MEDLINE Complete), Pubmed and Scopus were conducted to obtain contemporary literature. Duplicates were removed and inclusion and exclusion criteria were applied. A total of 14 articles were identified for inclusion.

Data evaluation and synthesis: Included articles were critically analysed and appraised using the JBI critical appraisal tools to assess for the methodological quality of the research, and the National Health and Medical Research Council (NHMRC) evidence hierarchy to assess for reliability and validity. A data extraction table (literature matrix) was used to record the article's author, date of publication, research title, population, study design, level of evidence, key findings, implications for practice and limitations. This aided in synthesis of the selected studies, thematic analysis and drawing conclusions.

Implications for practice: Strong design and staff education were identified as facilitators of cognitive aid implementation while poor design and lack of organisational support were identified as barriers to cognitive aid implementation. Nursing leaders and educators have a vital role to play in gaining organisational support to provide staff education and training and develop appropriately designed cognitive aids.

Keywords: cognitive aids, emergency manual, perioperative, operating room, anaesthesia

Introduction

Critical events in the perioperative period, although rare, can be a significant cause of morbidity and mortality in surgical patients[1]. Recent studies have found that, during this highly stressful situation, human factors such as impaired clinical decision-making, lack of team communication and absence of situational awareness, led to poor management and negative patient outcomes in the operating theatre[2,3]. In fact, it has been reported that 43 to 65 per cent of sentinel events that occur in the operating theatre are due to human factor errors[2]. It is essential for perioperative nurses, as part of the multidisciplinary team, to be familiar with human factor principles and possess non-technical skills to ensure patient safety during emergencies[4].

To mitigate human factor error, the introduction of cognitive aids was implemented during crisis resource management in the perioperative setting[5,6].Cognitive aids are defined as tools that assist in completing key tasks to effectively manage critical emergencies during the perioperative period[2,7]. These can be in the form of checklists, emergency manuals, algorithms or flowcharts[5,8]. Cognitive aids assist in reducing cognitive workload and stress and increasing adherence to timely recall of key interventions during critical events[6,9,10].Previous studies have shown the effectiveness of using cognitive aids in improving team performance during simulated crises[9]. Other studies have found increased clinical performance after the use of cognitive aids was implementation in their clinical practice[2,6].

Problem Identification

Despite the availability of published cognitive aids in the workplace, successful implementation of their use remains a challenge[2].Routine use of such aids during actual critical events in the operating theatre remain significantly low[2].Hence, this literature review will aim to answer the research question 'What are the barriers to and facilitators of the implementation of the use of cognitive aids during perioperative emergencies?'

Review methods

Search strategy

An integrative review methodology was employed using the guidance outlined in Whittemore and Knafl's[11] stages of integrative review. This integration of both qualitative and quantitative data allowed for a fully inclusive examination of this phenomenon[11].

An electronic database search was conducted to find the contemporary literature available. Databases searched were EBSCO databases (CINAHL Complete, Health Source: Nursing/Academic Edition, MEDLINE, MEDLINE Complete), Pubmed and Scopus. The following medical subject headings (MeSH) terms, Boolean operators and truncation were used for the search: "cognitive aids" AND "perioperative", "cognitive aids" AND "operating room", "cognitive aids" AND surgery, "cognitive aids" AND anaesthesia, "cognitive aids" AND nurs*, "cognitive aid" AND "perioperative", "emergency manual" AND perioperative.

Inclusion and exclusion criteria

To ensure contemporary scholarly literature, only peer-reviewed published papers were searched between 2018 to 2023. Full-text papers written in the English language were included in this review due to constraints in language interpretation. Research papers older than five years were cited forward through the Scopus database to obtain contemporary literature relevant to the chosen topic. Reference lists from searched papers were also reviewed and included. Studies that were not related to the perioperative setting or context, were published in languages other than English, reported poor-quality research or were published in non-peer reviewed journals were excluded from the study (see Figure 1).

Data evaluation and synthesis

The studies reviewed were primary research papers using quantitative, qualitative and mixed-methods methodologies to facilitate direct analysis of key findings for each study. Data extraction for this review included the author, date of publication, research title, population, study design, level of evidence, key findings, implications for practice and limitations. Included research papers were critically appraised and synthesised through thematic analysis. A data extraction table (see supplemental material) was used to record data related to barriers to and facilitators of the implementation of cognitive aids in the operating theatre. Based on these main themes, similar data were identified to generate subthemes for discussion and drawing conclusions.

Quality appraisal

To assess the reliability and validity of the research papers included in this review, the National Health and Medical Research Council (NHMRC) evidence hierarchy was used. Each paper was assessed for strength of evidence, possible risk of bias, clinical significance and relevance to the use of cognitive aids during perioperative emergencies.

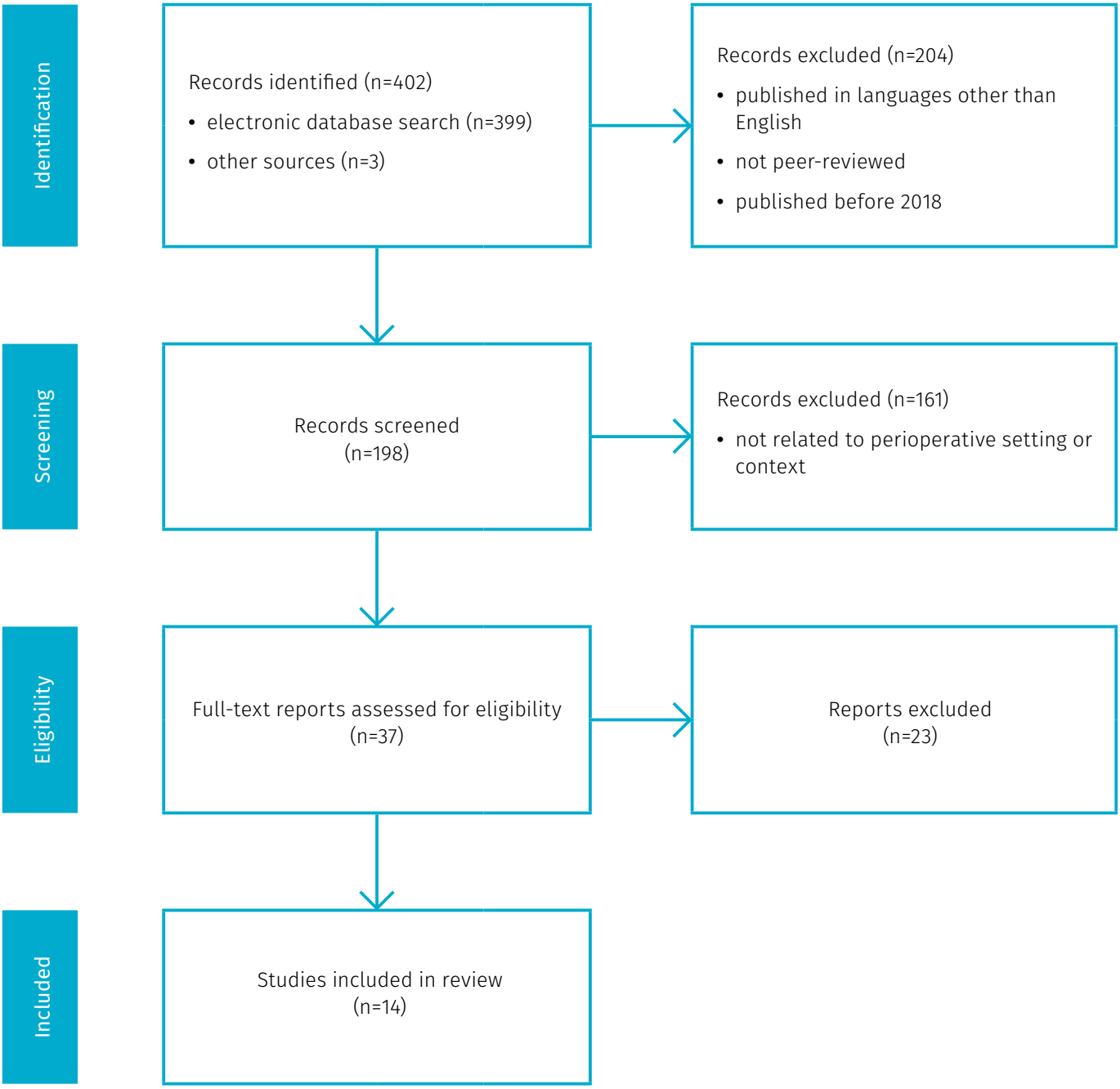

Figure 1: Flow diagram of paper selection process

Furthermore, included studies were critically appraised using the Joanna Briggs Institute (JBI) critical appraisal tools to assess for the methodological quality of the research. Each study was evaluated against eight to thirteen criteria with allocated scores of 'yes', 'no', 'unclear' and 'not applicable'. The overall appraisal of the quality of each research paper was interpreted by the author as low, moderate or high.

Results and discussion

A total of 14 research papers[1–3,5–10,13–17] were identified that reported on the use of cognitive aids during emergencies in the operating theatre and met the inclusion criteria. There were five level II randomised controlled trials (RCTs)[1,2,7,10,15], two level III-2 quasi-experimental studies[6,16], two level IV cross-sectional studies[3,5], one mixed-method study[14], one narrative review[17] and three qualitative studies[8,9,13]. After critical examination of these papers, two key themes emerged – barriers to implementing cognitive aids and facilitators of implementing cognitive aids. These themes and sub-themes are discussed below.

Barriers to implementation of cognitive aids

Barriers to implementation may be defined as a 'factors that hinder, limit or prevent people from engaging in a certain behaviour'[12, p.2]. The two sub-themes identified were 'lack of organisational support' and 'poor cognitive aid design'.

Lack of organisational support

Two cross-sectional studies[3,5] and one qualitative study[8] found that lack of organisational support was a significant barrier to effective implementation of cognitive aids during perioperative emergencies.

A cross-sectional study by Aldina et al.[3], where 368 surveys were completed by various perioperative professions, explored the key factors that influence effective implementation of cognitive aids during critical events in the perioperative period. The study found a statistically significant correlation between reduced success implementing cognitive aids and both lack of leadership support ($p < 0.0001$) and the absence of an organisational driver for change ($p = 0.0112$).

Training and knowledge sharing are aspects of organisational support that may also influence implementation of cognitive aids. In their cross-sectional study of anaesthesia providers in France and Canada, Blanie et al.[5] found that only 23 per cent of French anaesthetists and 27 per cent of Canadian respondents received formal training in the use of cognitive aids during medical emergencies in their workplace. In addition, Swedish Registered Nurse Anaesthetists (RNAs) who participated in a phenomenographic study by Knudsen et al.[8] reported a lack of knowledge about difficult airway algorithms. Knudsen et al.[8] found that the RNAs in their study viewed difficult airway algorithms as tools that were used by other members of their team but not shared with them.

Poor cognitive aid design

Another common barrier to implementation that emerged from the literature was poor design of cognitive aids[7,10,17]. In their 2019 narrative review, Kolawole et al.[17] reported that cognitive aids with simple, linear designs were preferred to complex branching algorithms. In an earlier RCT, involving 20 anaesthetist–anaesthetic assistant dyads, McIntosh et al.[7] investigated the usability of three cognitive aids in managing a simulated local anaesthetic (LA) toxicity emergency. Common issues identified by most dyads were dense text, excessive information and poor use of colour which led to prolonged and difficult retrieval of vital information during a simulated anaesthetic emergency[7]. Moreover, two-sided cognitive aids, cognitive aids with multiple-streamed flow and inappropriate use of coloured-text influenced users clinical performance, e.g. key interventions were missed and drug doses miscalculated.

These findings were supported by Clebone et al.[14] in a mixed-method study of anaesthetic residents and RNAs (n = 23). Traditionally, cognitive aids use a linear design with step-by-step presentation of information. Clebone et al.[14] investigated whether non-linear cognitive aids that used design features to enable faster retrieval of information were also perceived as easier to use than cognitive aids with a more traditional linear design.

This research used a survey with ratings between 0 to 100, 100 being the highest level of agreement, and structured interviews to assess how participants perceived the usability of cognitive aids. Findings revealed that non-linear cognitive aids that were designed for retrieval of specific information were viewed as easier to use than linear cognitive aids ($p < 0.01$ on each aid)[14].The cognitive aids designed for the study had colour-coded, categorised and clustered content and were perceived to be more useable than the alternative step-by-step cognitive aid[14].The researchers also highlighted that grouping crisis-specific interventions has significant implications for timely retrieval of vital information during crisis resource management[14].

Facilitators to implementation of cognitive aids

Facilitators to implementation may be defined as 'factors that favour, facilitate, or help people to engage in a certain behaviour'[12 p.2]. The two subthemes identified were 'strong cognitive aid design and content' and 'staff education and training'.

Strong cognitive aid design and content

The importance of design is supported by another study by Clebone et al.[10] who noted that health care providers may use 'sampling' when looking at cognitive aids during an emergency as they only need specific information. The researchers hypothesised that cognitive aids that were designed to enable sampling would allow users to find relevant information more quickly[10]. Their study compared speed of information retrieval and eye-tracking data of 23 anaesthesia care providers using one of three cognitive aids to manage one of three common intra-operative emergencies in a low-fidelity simulation. Cognitive aids 1 and 2 were designed according to cognitive science principles, with 'clustering' of information that shares a common thread, to enable sampling, and cognitive aid 3 had a more traditional step-by-step or linear design. The emergencies were anaphylaxis, hyperkalaemia, and LA toxicity.

Analysis of response times revealed a statistically significant correlation between the layout and design of cognitive aids and the time to gain critical information ($p = 0.006$ cognitive aid 3 vs cognitive aid 1; $p < 0.001$ cognitive aid 3 vs cognitive aid 2). Eye-tracking data showed that participants using the step-by-step cognitive aid spent more time obtaining critical information than participants who used either of the aids designed to enable sampling[10]. Although clinical performance was limited to a low-fidelity simulation, the researchers concluded that cognitive aids designed according to cognitive science principles may allow faster retrieval of information[10] thus enabling timely implementation of key interventions in actual perioperative emergencies.

King et al[13]. also reported that cognitive aids designed for accessibility of information allowed faster retrieval of specific information which may be a significant factor in the successful implementation of cognitive aids during a perioperative emergency. In an observational study of 12 anaesthetic professionals, King et al.[13] investigated the accessibility of key information in five published cognitive aids for managing malignant hyperthermia (MH). Using a calibrated eye tracking system, they measured each participant's cumulative time spent in obtaining information from these cognitive aids. Although participant's level of experience did not show any correlation with the research outcomes, findings revealed that retrieval of vital information was more rapid from the cognitive aid with potentially advantageous design features ($p < 0.001$) compared to the other four MH cognitive aids tested[13]. Potentially advantageous design features identified by the researchers included minimal colour blocking, simple typeface, single-page presentation and a linear, step-by-step layout[13].

Design that accommodates delayed access may also facilitate implementation of cognitive aids. Clebone et al.[1] hypothesised that most clinicians will have already instigated initial interventions prior to accessing a cognitive aid. They reanalysed previously published data from a range of simulated paediatric emergencies and found that in 95 per cent of the trials the time between emergency event trigger and cognitive aid use was between 90 and 354 seconds, depending on type of emergency[1]. The authors concluded that cognitive aids may be more effective if designed to accommodate being accessed at times after the event trigger. This finding is consistent with earlier studies by Clebone et al.[10] and King et al.[13] that support the importance of design and justify the need for better design of cognitive aids with more focus on the crisis-specific interventions. This could further assist clinicians in timely and effective decision-making when managing perioperative emergencies, which may also increase the uptake of cognitive aids in future critical events[1].

Staff education and training

Staff education and training also emerged as a facilitator of cognitive aid use within the perioperative environment. A quality improvement project by Gallegos and Hennen[16] found that staff were more willing to use a cognitive aid and perceived it in a more favourable light after in-service training about it. Similarly, Gleich et al.[6] evaluated anaesthesia team member performance after implementation of an emergency manual including cognitive aids and reported that familiarity and accessibility are crucial. In contrast, an RCT involving 25 senior anaesthetic trainees by Siddiqui et al.[15] found that overall uptake of a cognitive aid during simulated events was only 17.9 per cent, despite formalised education about the cognitive aid. The authors speculated that this may have been because the cognitive aid education was part of the general

orientation for trainees and so it was overshadowed by other material.

The positive impact of staff education was also shown by Zasso et al.[2] in their RCT involving 40 teams of three (anaesthesia resident, anaesthetic nurse and respiratory therapist). In that study, participant teams were randomly assigned to either the intervention group or the control group. Both groups received education about crisis resource management including team communication and the idea of cognitive aids. The intervention group also received extra training that familiarised participants with using a cognitive aid for managing airway emergencies; the control group did not receive this extra training. The teams in both groups then participated in a simulated airway emergency, 'can't intubate, can't oxygenate' (CICO) with the cognitive aid on display during the simulation. Videos were taken of all teams managing the simulation and the videos were rated by three independent raters. It was found that the clinical decision to perform front of neck access was made significantly faster in the intervention group than the control group (mean SD, 80.9 54.5 vs 122.2 55.7 s, difference (95% CI) – 41.2 (- 76.6 to -6.0, p = 0.023][2]. It was also found that the intervention group used the cognitive aid more than the control group. Furthermore, an intention to use the cognitive aid, if available, in the future was indicated by nearly all participants in both groups (93.3 vs. 96.7%, P = 0.67)[2].

While these results indicate that training may facilitate the use of cognitive aids, the authors identified certain limitations to their study – in particular that results from a simulation scenario may not be transferrable to clinical situations, that the mostly junior participants may not be representative of the wider clinician population, and that the time between training and the simulation for teams varied between one and four weeks[2].

Training in and familiarisation with cognitive aids was also demonstrated to have a positive impact during an intra-operative emergency as reported in a case study by Merrell et al.[9] This qualitative study was carried out in a tertiary training hospital where introduction of cognitive aids, in the form of an emergency manual, had been supported by training and familiarisation for perioperative staff. The researchers interviewed the six clinicians who had been present during an intra-operative cardiac arrest and analysed the interview transcripts. The study revealed that cognitive aid use during an intra-operative emergency facilitated effective team performance through appropriate delegation of key roles and responsibilities, fostered a 'calm work environment' and reduced stress among the perioperative team[9 p.10]. Finally, a cross-sectional study by Alidina et al.[3] found that dedicated time to train staff was associated with more successful implementation of cognitive aids (p = 0.0189).

Limitations

This review was limited by the small sample size of included primary research. In addition, most of the included studies were performed in a simulated or controlled environment and involved anaesthesia team cohorts. Hence, care must be taken in generalising results from research in this review to real-life situations and perioperative emergencies where all perioperative staff, not just anaesthesia staff, would be involved.

Implications for perioperative nursing practice or research

The aim of this review was to identify and understand the barriers to and facilitators of implementation of cognitive aids during perioperative emergencies. Strong design and staff education were identified as facilitators of cognitive aid implementation while poor design and lack of organisational support were identified as barriers to cognitive aid implementation.

If cognitive aids are to be more widely implemented in perioperative settings cognitive aids must be well designed and their implementation must be supported by health service organisations. Nursing leaders and educators play a vital role in promoting quality improvement initiatives by supporting staff training and education in the use of cognitive aids during perioperative emergencies, not just the for the nursing team but for all multidisciplinary team members. Furthermore, findings from this review can assist nursing leaders to evaluate and improve existing perioperative cognitive aid designs using contemporary evidence-based literature and guidelines from professional bodies.

While most of the studies involved cognitive aids used in simulation training, there is still limited evidence of their effectiveness in actual clinical practice. For this reason, it is recommended that further research is conducted into the use of cognitive aids in real-world emergency situations. Likewise, due to a relatively small sample size of studies and studies involving only anaesthesia professionals, further research is needed with the multidisciplinary team to understand other factors that influence successful cognitive aid implementation.

Conclusion

This review identified lack of organisational support and poor design of cognitive aids as barriers to implementation and strong design and staff education and training as facilitators of implementation of cognitive aids. Organisational support, staff education and training, development of appropriately designed cognitive aids and effective implement processes are key to encourage increased use of these important tools.

Declaration of conflicting interests

The authors have declared no competing interests with respect to the research, authorship and publication of this article.

Acknowledgement

This paper was submitted to the University of Tasmania as part of the fulfilment of subject CNA803 Advanced Clinical Nursing Practice for the Master of Clinical Nursing (Anaesthetic and Recovery Nursing). The author sincerely wishes to thank Dr Paula Foran, unit coordinator, for her continued guidance throughout the master's course and work in preparing for this paper for publication.

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