BJA

British Journal of Anaesthesia, 119 (5): 1015–21 (2017)

doi: 10.1093/bja/aex256
Advance Access Publication Date: 27 September 2017
Quality and Patient Safety

Use of a hand-held digital cognitive aid in simulated crises: the MAX randomized controlled trial

R. Lelaidier[1,2,*], B. Balança[1,3,4], S. Boet[5,6], A. Faure[1,2], M. Lilot[1,7,8], F. Lecomte[8], J.-J. Lehot[1,4,8], T. Rimmelé[1,2,10] and J.-C. Cejka[1,2]

[1]Centre Lyonnais d'Enseignement par la Simulation en Santé, SAMSEI, Université Claude Bernard Lyon 1, Lyon, France, [2]Département d'Anesthésie-Réanimation, Hôpital Edouard Herriot, Hospices Civils de Lyon, 5 place d'Arsonval, 69003 Lyon, France, [3]Inserm U1028, CNRS UMR 5292, Centre de Recherche en Neurosciences, Team TIGER, Lyon, France, [4]Département d'Anesthésie-Réanimation, Hôpital Pierre Wertheimer, Bron, France, [5]Department of Anaesthesiology and Pain Medicine, The Ottawa Hospital, University of Ottawa, Ottawa, Ontario, Canada, [6]Department of Innovation in Medical Education, The Ottawa Hospital Research Institute, University of Ottawa, Ottawa, Ontario, Canada, [7]Département d'Anesthésie, Hôpital Femme Mère Enfant, Hospices Civils de Lyon, Bron, France, [8]Health Services and Performance Research Lab (EA 7425 HESPER), Université Claude Bernard Lyon 1, Lyon, France, [9]Département des Urgences, Hôpital Cochin, Paris, France and [10]EA 7426 Hospices Civils de Lyon—bioMérieux—Université Claude Bernard Lyon 1 'Pathophysiology of Injury Induced Immunosuppression', France

*Corresponding author. E-mail: lelaidier.rodolphe@gmail.com

Abstract

Background. Cognitive aids improve the technical performance of individuals and teams dealing with high-stakes crises. Hand-held electronic cognitive aids have rarely been investigated. A randomized controlled trial was conducted to investigate the effects of a smartphone application, named MAX (for Medical Assistance eXpert), on the technical and non-technical performance of anaesthesia residents dealing with simulated crises.

Methods. This single-centre randomized, controlled, unblinded trial was conducted in the simulation centre at Lyon, France. Participants were anaesthesia residents with >1 yr of clinical experience. Each participant had to deal with two different simulated crises with and without the help of a digital cognitive aid. The primary outcome was technical performance, evaluated as adherence to guidelines. Two independent observers remotely assessed performance on video recordings.

Results. Fifty-two residents were included between July 2015 and February 2016. Six participants were excluded for technical issues; 46 participants were confronted with a total of 92 high-fidelity simulation scenarios (46 with MAX and 46 without). Mean (SD) age was 27 (1.8) yr and clinical experience 3.2 (1.0) yr. Inter-rater agreement was 0.89 (95% confidence interval 0.85–0.92). Mean technical scores were higher when residents used MAX [82 (11.9) *vs* 59 (10.8)%; $P<0.001$].

Conclusion. The use of a hand-held cognitive aid was associated with better technical performance of residents dealing with simulated crises. These findings could help digital cognitive aids to find their way into daily medical practice and improve the quality of health care when dealing with high-stakes crises.

Clinical trial registration. NCT02678819.

Key words: audiovisual aids; Clinical Decision Support Systems; Decision Support Techniques; Patient Care Team/organization & administration; Group Processes; Simulation Training; Manikins; User-Computer Interface

Editorial decision: July 3, 2017; **Accepted:** July 5, 2017

Editor's key points

- Cognitive aids improve the technical performance of individuals and teams dealing with high-stakes crises, but it is not clear whether hand-held electronic cognitive aids are effective.
- The use of a hand-held cognitive aid was associated with better technical performance of residents dealing with simulated crises, indicating that digital cognitive aids are useful in improving the quality of health care when dealing with high-stakes crises.

Crises in medical practice are rare but stressful events that require fast response. Anaesthesia features many characteristics that increase the risk of error,[1] among which are human-based practice variability,[2] task interruption,[3] and external distraction.[4] High stress impairs cognitive skills, including decision-making, short-term memory, knowledge recall, and situational attention.[5 6] It has been demonstrated that adherence to guidelines is poor in high-stakes and stressful situations.[7] Technical performance and aptitude to follow recommendations decline over time[8] and are not lastingly improved by training.[9]

Cognitive aids are defined as prompts designed to help users complete a task or series of tasks.[10] Many designs of cognitive aids have been conceived, such as posters, flow charts, checklists, electronically displayed algorithms, or smartphone applications. Cognitive aids are not designed to supersede medical decision and leadership, but rather to help physicians deal with high cognitive load and to make the correct decisions in a stressful environment. Cognitive aids have been widely used for many years in non-medical high-stakes fields, such as civil aviation and nuclear plant control. They belong to the culture of these industries and are acknowledged as efficient tools to deal with critical events.[11 12] In health care, checklists and other types of cognitive aids have been shown to improve technical performance and guideline adherence in a wide range of situations,[13 14] such as malignant hyperthermia,[15] local anaesthetic systemic toxicity,[7] or a 'can't intubate can't oxygenate' crisis.[16]

Non-technical skills used for crisis resource management are of great importance in dealing with critical events.[17 18 25 26] The influence of cognitive aids on non-technical performance, in contrast to technical performance, has scarcely been investigated. Although some studies have highlighted a positive effect of cognitive aids on non-technical skills, no strong conclusion can be drawn on the effects of these tools on aspects such as leadership, situation awareness, communication, or decision-making.[16 19] In addition to the positive effects of cognitive aids, whether in simulated crises[11 20] or in day-to-day management of critical events,[21] they are also well perceived by caregivers. However, it is surprising that the implementation of these tools in operating theatres is not as common as their perceived and demonstrated usefulness would suggest. This might be because of design issues and poor practicability, but also because conventional cognitive aids are difficult to improve, update, and adapt to the distinctive features of each team.

Few studies have investigated the potential benefit of an electronic cognitive aid. A single study involving junior doctors providing advanced life support to simulated cardiac arrest victims found encouraging results for technical performance.[22] We hypothesized that the use of a digital, hand-held cognitive aid could improve the technical performance and affect non-technical performance of anaesthesia residents facing simulated crises. In the study reported here, we investigated the effect of a mobile phone application on the technical and non-technical performance of anaesthesia residents managing simulated critical events.

Methods

Study design

We conducted this randomized, controlled, unblinded study at the Lyon (France) centre for teaching by simulation in health care between July 1, 2015 and February 8, 2016, using a high-fidelity patient simulator (SimMan 3G; Laerdal Medical®, Stavenger, Norway). This study received Lyon University Hospital Ethical Board approval on March 12, 2015 and was registered on clinicaltrials.gov (NCT02678819).

Anaesthesia residents in postgraduate years 2–5 were invited to participate on a voluntary basis. Residents in their first clinical year were not included because of insufficient clinical experience. Details of the research project were emailed to all eligible residents. The simulation sessions were not part of a compulsory residency course. Oral informed consent was obtained before participation.

Outcomes

The primary outcome was technical performance. Diagnostic skills were not evaluated, because diagnosis was deliberately made obvious during the briefing. Technical performance was defined as adherence to guidelines from the French society for anaesthesia and intensive care (SFAR) or the European Society of Cardiology (for the cardiovascular scenario). For each scenario, a scoring system including 13–18 critical actions was elaborated, which was similar to various scoring systems used by other research teams.[7 11 13] Each action was associated with a score, as follows: zero (action not undertaken), one (action undertaken with wrong timing and, in the event of drug administration, wrong dose, duration, or route of administration), or two (action done correctly). The scores of each action were then summed and expressed as a proportion of the maximal score achievable. Scoring grids were developed with local independent trained anaesthetists and intensivists to meet an expert agreement.

The secondary outcome was non-technical performance. Leader's non-technical performance was rated by two experienced simulation instructors (J.-C.C. and R.L.). These independent observers used the Ottawa Global Rating Scale.[23] This validated scoring system is designed to assess individuals' performance. It does not help for the assessment of the whole team's functioning. It is composed of six scores for overall performance, leadership, problem solving, situation awareness, communication, and resource use. Each skill is scored from one to seven, with the sum of all scores leading to a maximal composite score of 42.

Application design

An electronic and hand-held cognitive aid compiling several protocols in the form of a smartphone application was designed (named MAX for Medical Assistance eXpert). The cognitive aid design was linear and sequential. Participants were required to read and acknowledge each step before being given access to the next one. Participants were free to navigate back and forth among the acknowledged steps of the procedure. A timer was included in the procedure for the steps requiring time monitoring (Appendix 1).