Cognitive Aids for Operating Room Crises – A Thematic Analysis of Implementer Experiences

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Abstract

Background: Strategies for the implementation of evidence-based interventions have proliferated, but it remains unclear how these strategies are operationalized for different types of interventions and contexts. Here, we examine seven implementation strategies--initially developed for implementing the World Health Organization (WHO) Surgical Safety Checklist (SSC)--for implementing cognitive aids for operating room (OR) crises.

Methods: We conducted semi-structured interviews with implementers of these aids exploring the use of each of the strategies previously studied with WHO SSC implementation as well as barriers and facilitators to implementation. We conducted a thematic analysis to identify and describe the use of the strategies. We mapped barriers and factors helping facilitate (facilitators) onto corresponding constructs from the Consolidated Framework for Implementation Research.

Results: We conducted interviews with 37 implementers across the United States. Most interviewees identified similar strategies in their implementation process, and none offered additional strategies that fell outside existing categories. There was substantial variation among implementers in how the strategies were deployed. Many of the barriers and facilitators were common across implementations.

Conclusion: Interviewees used a core set of strategies to implement cognitive aids for OR crises, but there was substantial variation in how implementers used these strategies, suggesting the flexibility of the strategies and the value of deliberately adapting strategies to local context. The transferability of implementation strategies from the WHO SSC to other OR-based cognitive aids demonstrates the utility of informing novel implementations with prior successful ones that share similar attributes with respect to intervention and/or context.
Introduction

Moving evidence-based interventions into routine clinical practice is challenging. While implementation science and associated fields have produced many frameworks, theories, and models\(^1\) and over seventy implementation strategies,\(^2\) we still do not have a good understanding of how to best choose or adapt implementation efforts to the intervention at hand.\(^3\)

Cognitive aids for operating room (OR) crises--such as the Emergency Manual: Cognitive Aids for Perioperative Critical Events, developed by Stanford Anesthesia Cognitive Aid Group (Stanford, CA) and the OR Crisis Checklists, developed by Ariadne Labs (Boston, MA)--can decrease errors and omissions during management of an OR crisis.\(^4\) However, given the resistance of surgical culture to cognitive aids, the long-established routines of the OR, and the infrequent (but inevitable) nature of OR crises, simply distributing cognitive aids for OR crises is insufficient to ensure their consistent and appropriate use.\(^5\)-\(^7\) In 2015, an Anesthesia Patient Safety Foundation expert conference included a survey in which 96% of attendees agreed that “there are many steps between an individual downloading a useful emergency manual and an institution effectively implementing it clinically,” yet there was no consensus on which steps were key and how best to perform them at various types of facilities.\(^8\)

To better understand the implementation of cognitive aids for OR crises, the research team conducted a survey of OR Crisis Checklist/Perioperative Emergency Manual implementers, asking them to select which of seven implementation strategies they used in their implementations: forming a multidisciplinary team, customizing the cognitive aid for the local facility, presenting the aid, pilot testing the aid, providing initial training, delivering ongoing...
training, and monitoring the use of the aid. We based these strategies on a decade of experience implementing the World Health Organization (WHO) Surgical Safety Checklist globally.9-11 From this survey, we found that performing more implementation strategies correlated to more reported use of the aid, but the survey did not explore how the strategies were employed.12

In this subsequent qualitative study, we analyzed semi-structured interviews conducted with a sample of the survey respondents selected from diverse settings, to explore how they pursued these seven strategies in their implementations. The study was undertaken to inform the enhancement of implementation advice for cognitive aids for OR crises and other similar interventions by revealing points of consistency and variation.
Methods

Study Design

We conducted semi-structured interviews with perioperative clinicians in the United States (US) who had implemented the OR Crisis Checklists or the Perioperative Emergency Manual in their health facility (referred to hereafter as “implementers”).

Participants

We selected implementers from those who had completed the OR Crisis Checklist/Perioperative Emergency Manual Implementation Survey, had indicated on the survey that we could contact them for an interview, provided contact information that enabled us to recruit them via email, and came from US facilities. To increase diversity in our sample, we developed a sampling grid based on facility size (number of operating rooms (ambulatory surgery centers (ASCs) and small hospitals: 1-4 ORs, medium hospitals: 5-15 ORs, large hospitals: 16+ ORs), geography (by state), level of implementation success (based on their response to the survey item “At my facility, the tool is used regularly during applicable clinical events.”), and academic/non-academic facility. Results were analysed by facility size and level of implementation success. Geography and academic status were used to increase the diversity of the sample but characteristics were not used to stratify the results. We also conducted ten key informant interviews with individuals identified as having expertise or knowledge in a particular area related to successful implementation of cognitive aids for OR crises. Overall, we aimed for a sample size of 40 participants based on the rule of thumb that saturation (i.e. no longer obtaining new, meaningful insights) is typically achieved with a sample of approximately 30 people. Interviewees did not receive any remuneration for their participation.
**Interview Guide**

We designed the interview guide to gain insight into how implementers performed the seven implementation strategies included in the OR Crisis Checklist/Perioperative Emergency Manual Implementation Survey. To determine the full range of strategies used, we also asked about any other activities conducted as part of the implementation and probed explicitly on strategies for increasing buy-in. Based on our own implementation experiences, consultation with the Emergency Manuals Implementation Collaborative (EMIC) steering committee (meeting presentations and personal communications), and implementation frameworks\(^2,15\), we recognized the importance of buy-in for successful implementation. While the survey included strategies that contribute to increasing buy-in from leadership and clinicians, often as a secondary benefit, we aimed to identify additional strategies that were used specifically for this purpose. We also asked questions about barriers and facilitators to each implementation strategy. The interview guide is provided in Appendix 1.

To assess clarity and appropriateness of interview questions, we piloted the interview guide with three survey respondents and made minor changes based on the implementers’ feedback.

**Data Collection**

Four team members conducted interviews, three of whom were experienced interviewers (see Appendix 2 for a list of which team members participated in each aspect of the study). An anesthesiologist-implementer from the team joined the first two interviews to ensure that the interviewers were probing the appropriate content. The senior qualitative scientist on the team
monitored a sample of all the interviews to provide feedback to other interviewers and to ensure quality control as well as provided training to the novice interviewer. The novice interviewer, a prominent anesthesiologist and former president of the American Society of Anesthesiologists, may have been known to interviewees (many of whom were anesthesiologists), and he received guidance on techniques to minimize his potential influence over interviewee answers. The other interviewers had no relationship to the interviewees.

We interviewed implementers once, and interviews were approximately 45 minutes; all interviews took place between June and August 2016. Interviews were conducted by phone, audio recorded, and transcribed by an external transcription company. Members of the study team reviewed transcript quality, and as a final quality check, coders referred to the original audio recording for any necessary clarification. We removed interviewees’ names and institutions from all transcripts and stored the transcripts on a secure computer drive.

**Data Analysis**

We performed a thematic analysis of the interviews in four steps. First, we coded the interviews. Study team members, including the interviewers, co-investigators, and principal investigator, created a deductive list of themes based on evidence in the literature and the interview guide. Three study team members coded the interviews in NVivo (Version 11.4.2 for Mac, Australia). The qualitative research specialist reviewed every interview’s coding to ensure quality. Throughout coding, the coders discussed any inconsistencies in themes until they reached consensus, including clarifying theme definitions as necessary.
Second, two of the coders analyzed the coded interviews thematically, focusing on how implementation strategies were used and barriers and facilitators associated with each strategy. Key findings were summarized for each theme.

Third, the analysts discussed findings with the study team to ascertain the relevance and potential implications of the findings.

Fourth, for any barrier or facilitator mentioned by at least 10% of interviewees, two team members mapped the factor onto the domains and subdomains of the Consolidated Framework for Implementation Research (CFIR). The entire study team reviewed the mapping and discussed disagreements until consensus was reached. The team selected a 10% cut off for inclusion of barriers and facilitators in order to balance the need to include factors that are likely to be relevant for other implementers while still capturing the diversity of experiences.

Ethics

The Partners HealthCare and Stanford Institutional Review Boards reviewed the study and determined that this project meets the criteria for exemption 45 CFR 46. We obtained verbal consent before the start of every interview, with this consent method approved by both IRBs for implementer phone interviews.
Results

Facility Characteristics

A total of 37 implementers from 37 facilities in 19 states (Appendix 3) participated in the study. Subgroup sizes varied due to interview response rates (Table 1). No discernible differences were detected in how low-success versus high-success implementers operationalized strategies nor in the barriers and facilitators they experienced. Differences between smaller and larger facilities are indicated.

| Facility Characteristics | Non-academic facility | Academic facility | Total |
|--------------------------|-----------------------|-------------------|-------|
| Small/medium hospital or ASC\(^a\) (1-15 ORs\(^b\)) | 8 | 2 | 10 |
| Large hospital (16+ ORs) | 1 | 17 | 18 |
| **Total** | **9** | **19** | **28** |
| Small/medium hospital or ASC (1-15 ORs) | 4 | 1 | 5 |
| Large hospital (16+ ORs) | 1 | 3 | 4 |
| **Total** | **5** | **4** | **9** |
| **Overall Total** | **14** | **23** | **37** |

\(^a\) ambulatory surgical center  
\(^b\) operating rooms

Implementation Strategies and Strategy Variants

Implementers reported using five strategies most frequently: forming a multidisciplinary implementation team, customizing the cognitive aid, presenting the aid, initial training, and ongoing training with the aid. Approximately half of implementers reported using either formal
or informal approaches to monitor use, and only a very few formally piloted the aid prior to rolling it out across the department. Implementers did not offer implementation strategies aside from the proposed seven and the overarching category of increasing buy-in.

The ways in which implementers used these strategies (strategy variants) differed substantially (see Table 2 for all the strategy variants and illustrative quotes). For example, strategy variants for presenting the aid ranged from low effort (sending emails about the aid) to high effort (one-on-one conversations, presentations at multiple meetings). Similarly, strategy variants for customization ranged from low-tech (laminated paper copies of the aid) to high-tech (electronic versions of the aid), and strategy variants for forming multidisciplinary teams differed by number and variety of professions involved.

Within this variation, large facilities generally pursued strategies in ways that reflected both their larger bureaucracy and greater resources. At large facilities only (defined as reported by 2 large facilities and no small/medium facilities), strategies such as customization, presenting the aid, and training included more participants from a wider range of professions and residents. Similarly, only large facilities implemented both electronic and printed versions of the aid and/or trained clinical staff using high-fidelity simulations as well as presentations. The most notable distinction between large and small/medium facilities was in monitoring. Six large facilities reported using formal monitoring mechanisms with 4 strategy variants; in contrast, only 1 small/medium facility reported using a formal monitoring mechanism. No strategy variants were reported exclusively by small/medium implementations (defined as reported by 2 small/medium facilities and no large facilities).
When asked about increasing buy-in, implementers identified three main strategy variants: 1) having one-on-one conversations with leadership and resistors, 2) presenting the aid at meetings, and 3) using the aid in simulation/training drills. These variants served multiple purposes: in addition to motivating the use and spread of these aids, one-on-one conversations and presenting the aid at meetings are both methods for making people aware of the aids and their purpose. Simulations/drills are ways to train OR teams on the use of the aid while also showing their purpose in a powerful experiential way. One implementer described the reaction of residents managing a crisis with and without the manual as “eye-opening...people are like ‘Wow! That was so much easier with this manual in place. It really helped me through the treatment process.’” She emphasized that the best way to achieve this eye-opening effect was through direct experience in simulation training.

At times, implementers involved leaders and other non-clinical critical staff members in implementation strategies that were developed for clinicians as a way of increasing buy-in across stakeholder groups. An implementer who customized the aid for use in an office setting reported she “felt like it was important for [the office manager] to be [at the training] because she might be the one calling the ambulance...one of my [locally added] protocols is the transfer of a patient to the hospital, which numbers do you call, who’s responsible for calling 911, stuff like that...and being part of the surgery center administrative support is important, so she was involved.”
Table 2. Implementation Strategy Variants

| Implementation Strategy | At Any Size Facility | At Large Facilitya | Illustrative Quotes |
|-------------------------|----------------------|-------------------|---------------------|
|                         | [Variant used in both large and small/medium facilities OR variant used in only 1 facility regardless of size] | [Variant used in at least 2 large facilities and no small/medium facilities] |                     |
| Form a multidisciplinary team | Professions included on teams:  
  ● Anesthesiologists  
  ● Nursing  
  ● patient safety/quality improvement leaders  
  ● OB/GYN*  
  ● Information technology*  
  ● Design and innovation*  
  ● CRNAs*  
  ● Residents*  
  ● Surgical education colleague*  
  Function of team:  
  ● Help with customization  
  ● Review the aid* | Additional professions included on teams:  
  ● Pharmacists  
  ● Surgeons  
  Additional functions of team:  
  ● Used the team to help with implementation plan (in addition to customizing) | “You really want interdisciplinary conversation, implementation, and practice from the get-go. The day that one person manages the emergency in an OR is the day that emergency won’t go very well. And you need everybody. So, let’s be colleagues and let’s be a team. Let’s talk about how we’re going to implement it, revise it and make it work so everybody at the end of the day knows it is better. And in doing so, you will find out that your nurses are your best friends.” (Large) |
|                         | Total n=12/28  
  Small/medium n=3/10  
  Large n=9/18 |                   | “It went through various committees. We have a patient safety committee that is made up of interdisciplinary team members. We have an OR executive committee so we had buy-in at each level so it wasn’t a project that was done solely spearheaded by one department which, in our experience, always leads to a project failure.”(Large) |
| Customize                | Changes to content:  
  ● Added or subtracted protocols to fit facility  
  ● Added local phone numbers  
  ● Ensured pharmacy formulating was consistent* | Additional changes to content:  
  ● Made own manuals informed by existing manuals  
  Additional customizations: | “I think [customizing] helped with the success of the checklist because the people that worked on either the customizations or owned that little part felt that they were the content expert. We felt local buy-in so the checklists are branded like our institutions. They are customized with phone numbers. They are customized with workflow and |
|                         | Total n=18/28  
  Small/medium n=6/10  
  Large n=12/18 |                   |                     |
Other customizations:
- Laminated pages
- Added page to explain institution’s emergency call button system*
- Added address*
- Changed language from “anesthesiologist” to “crisis manager”*
- Used local spellings*
- Added tabs to each protocol*
- Eliminated some pages that weren’t relevant to their location*
- Made some directions more concise*

Miscellaneous:
- Printed black and white copies to lower costs*
- Used a bright red binder*
- Laminated pages*
- Placed in clear plastic envelopes and velcroed to wall*
- Added back page that showed how to document critical events in the OR*
- Added flow map for emergencies*

- Created electronic format, available on local computers

- Had multiple interdisciplinary people help with customization to increase buy-in

then we’ve even further customized not just our main campus but our satellite site that is six blocks away that has a little bit of a different workflow or different phone numbers or different patterns of doing things so it makes it a workable checklist that really, in a local environment, is helpful.” (Large)

“Don’t just cookie cutter, you know, take something, print and plunk and expect it to be used.” (Large)

I took about four or five different ones and added and subtracted and pulled and removed...we took a whole bunch of things that [made sense] for our surgery center. We took things that didn’t make sense and omitted them...we have a hybrid. We took Harvard’s and Stanford’s and then put them together. (Large)
| Present aid | Where/how presented: | Additional places presented: | Additional people to whom it was presented: |
|-------------|----------------------|-----------------------------|---------------------------------------------|
| Total n=22/28 | ● Meetings (staff/department)  
● Emails  
● 1:1 conversations  
● PowerPoint presentations*  
● During orientations*  
● Time before cases*  
● Morning huddle*  
● “Electronic format”*  
● Section line meetings*  
● Quality department*  
● Teleconference*  
● Newsletters*  
● Word of mouth* |
| Small/medium n=7/10 | Who it was presented to:  
● Anesthesiologists  
● Nurses  
● Surgeons  
● Simulation educators  
● OR administrators  
● Key champions*  
● Front desk staff*  
● Surgical technicians*  
● Circulators*  
● OR team*  
● PACU staff*  
● Quality dept*  
● Med exec* |
| Large n=15/18 | Content of presentations:  
● Rational/purpose of aids  
● Promote awareness/familiarity |
| | “[Presenting the checklist] can be done by in-service, one-to-one in the operating room, discussions, things of that nature...definitely formal and informal.” (Large) |
| | “We had a staff meeting...it was our administrative office staff to our nurses to - it was everybody. Doctors, nurses, everybody across the board.” (Small/medium) |
|     | How to use the aid* | What the aid covers* | Provide encouragement* |
|-----|---------------------|----------------------|------------------------|
| **Pilot test**<br>Total n=3/28<br>Small/medium n=1/10<br>Large n=2/18 | Piloted in simulation center*<br>Piloted in tabletop simulation*<br>Used in drills (in-situ simulation), then modified*<br>Piloted with residents* | “I think a valuable piece of that step is some more testing amongst the anesthesiologists themselves, and then perhaps it's worthwhile to bring in a couple of other team members, and pick some of the checklists and actually mock-test them... So, a tabletop simulation, or you know, not sophisticated simulation in a medical simulator. Some way of testing a few of them anyway to make sure that they actually are what you want before you ask other people to use them.” (Large) |
| **Training**<br>Total n= 26/28<br>Small/medium n= 8/10<br>Large n=18/18 | Methods:<br>● Low tech training (e.g. drills)<br>● Ongoing training<br>● 1:1 peer training<br>● Debrief after training*<br>● Incorporate into orientation*<br>Clinical Participants:<br>● Nurses<br>● Anesthesiologists<br>● Educators*<br>● Perioperative team*<br>● Code blue team*<br>Non-clinical Participants:<br>● Administrative staff* | Additional methods:<br>● Used high and low tech simulations (small/medium sites only used low tech simulations)<br>Additional clinical participants:<br>● Included surgeons, surgical technicians, residents (full interprofessional OR teams) | “I’ve evolved as a simulation person, I started out, you know, everything had to be high fidelity and it’s as close to real life as possible and then now all the time I feel like you can actually get a lot more done if you just kind of keep it simple.” (Large) |

And then in the simulations themselves, if they’re not using the manual, we’ll throw in some prompts. I asked them, ‘Do you want to use the manual,’ or if they’re struggling with coming up with particular medications and I say, ‘Well, I think that medication is in the manual.’... It just goes to show that it is valuable and that it sort of jogs their memory to use it.” (Large)

“It was typically like a 20 or 30 minutes thing and what I would typically do was get one of the members in
### Other:
- During simulations, participants also worked on teamwork and communication skills
- Empower nurses to speak up through training*
- Check-in meetings every 3-4 months to understand how training is going and address any issues*

### On-going training

| Method                          | Total n=14/28 | Small/medium n=5/10 | Large n=9/18 |
|---------------------------------|---------------|---------------------|--------------|
| Simulation (including drills/in-situ simulation) |               |                     |              |
| Incorporate into Health Streams/courses      |               |                     |              |
| Incorporate into M&M meetings*      |               |                     |              |

**Frequency:**
- 2/year
- 1/year
- Every 2 years
- Ongoing during residency*
- Quarterly*

**Who gets trained:**
- New providers
- Residents
- All staff

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"Periodic drilling, I think is the obvious answer...I've been around the simulation community for a long, long time, and people ask when they come into the simulator, "How often do I need to be refreshed?"...I think that you need to keep practicing with it over time if we're going to turn it into a norm. Right? I think that that's what happened in the places that really do the surgery safety checklist well. If I went in and took their checklist away from them, everyone in the room would feel uncomfortable doing the next case. How long does it take to get there? How many uses of it does it take? I don't think anybody's studied it." (Large)

"It may sound like we’re beating a horse to death but what we would do is that we would have one of our M and M conferences and if the M and M involved one of the crisis checklist items then we would take that opportunity to reinforce to everybody what you would do if that happened during the case. So again, it brings it up to them, so..."
if someone presents a case of venous air embolism, then we always have to take that opportunity to say, “Okay, and remember if you have a venous air embolism this is how you access the crisis checklist and these are the tenets of management based upon the crisis checklist.” (Large)

| Monitor use               | Informal monitoring mechanisms: |
|---------------------------|---------------------------------|
| Total n=13/28             | Champion asks if people have used it; records stories of use |
| Small/medium n= 5/10     | Staff shares anecdotes of use with champion |
| Large n=8/18              | Champion asks about use during casual conversations |

Formal monitoring mechanisms:
- Survey*
- Weekly check-in with anesthesia scheduler who runs desk*
- Paper log of emergencies and indicate in log if aid was used*

| Formal monitoring mechanism: |
|-----------------------------|
| EMR data                    |
| Review use of aid in post-crisis debrief |

“I would query the staff and say, ‘has anybody used it?’, ‘did anybody even pull it out and take a look at it?’” (Small/medium)

Notes:
* There were no strategies mentioned exclusively by small/medium facilities [i.e., used in at least 2 small/medium facilities and no large facilities].
* indicates the strategy variant was used in only 1 facility (n=1).
Facilitators and Barriers

A small number of facilitators (Table 3) and barriers (Table 4) were common across many of the implementing sites. Buy-in was the most commonly cited facilitator, with nearly half of implementers expressing that general support from colleagues facilitated implementation. Some implementers specifically mentioned that support from the chair of anesthesia, nursing leadership, and/or the OR/perioperative director were useful. Implementers also indicated that clinicians’ acceptance of cognitive aids (i.e., having positive views of cognitive aids in general, not just this one) facilitated implementation. Several respondents spoke of the importance of changing organizational culture to make the use of cognitive aids in clinical work more acceptable. To begin this cultural shift, they recommended having providers participate in simulations with and without the aid to experience the difference in performance with the cognitive aid (training). Overwhelmingly, the most commonly cited barrier was insufficient time for training which then made scheduling difficult, especially for attending physicians. Conversely, dedicated time for training was frequently mentioned as a facilitator.

Some barriers and facilitators clustered by facility size. Small/medium facilities provided more opportunity to implement nimbly with less bureaucracy, increasing the efficiency of the implementation and enabling a single implementer to lead with minimal coordination or permissions required. For instance, while an implementer in a small/medium facility might hold a one-on-one conversation over a happenstance lunch with a single “influential” colleague to increase buy-in, an implementer in a large facility might need to schedule a lunch in advance with three “influential” colleagues in order to achieve the same effect. Simultaneously, the reduced size of small/medium facilities also created barriers: lack of staff to support
implementation, implementation expertise, and other resources led to a heavy dependence on a single implementer, which in turn could impede implementation.

In contrast, large facilities provided access to more staff, resources, and infrastructure for implementation. Implementers from large facilities spoke about intensive efforts for integrating formal training with the aid, with more resources and skilled leaders available for single or interprofessional immersive trainings. Some implementers found it helpful to think creatively about scheduling trainings during less busy clinical times, such as protected educational times, early mornings, weekends, and slower days. Simultaneously, large facilities suffered from increased bureaucracy, including slower and more formal change processes, complex scheduling barriers, and the need for many one-on-one conversations and large meetings to increase buy-in. For implementers from large facilities, monitoring the use of the aid during relevant clinical events posed a notable challenge. They found it impossible to reach all clinicians through informal monitoring mechanisms, and system constraints limited formal attempts to monitor use of the aid via the EMR. Monitoring challenges included uncertainty around why the aid was accessed (e.g. educational purposes or responding to a crisis), knowing only the crises in which the aid was used but not the crises in which it was not used, and incomplete clinician documentation.
Table 3. Facilitators Mentioned by at Least 10% of Implementers, by Consolidated Framework for Implementation Research (CFIR) domains

| CFIR Domain: Construct | Facilitators (n=# of sites in which the facilitator was identified) | Illustrative quotes |
|------------------------|-------------------------------------------------------------------|--------------------|
| Inner setting:         | Less bureaucracy; more autonomy to implement nimbly (n=6)         | “I don’t know what you mean by build buy in. It’s just this is the rule. Our rule is it’s in every room, so it’s in every procedure room, every operating room, it’s in our pre-op, it’s in our recovery and it’s on all of our crash carts...This is going to be in your back pocket so you don’t have to worry about it and if something bad happens, open the book and follow it. Cookie cutter. Easy.” (Small/medium) |
| Structural characteristics | Support for training  
  ● Dedicated time for training (n=11)  
  ● Training supported (valued) by the department (n=4) | “I can tell you from working in a hospital, it would not have been easy to do this, to put it in place. There would have been multiple committees and they would have had to argue about it and what color is the folder going to be and where are we going to place it, and a year later you’re still arguing and it’s not in place. This is something, like I said, day one, when I read about it and I knew it was coming and I saw you guys published it within three days, I had ours modified and I had it on our shelves. It wasn’t a question. There was not going to be a no.” (Small/medium) |
| Readiness for implementation - available resources | “The scenarios were something that I came up with along with the team, my chief partner. And leading this was the nurse educator who is extremely committed to the process and would come in at, at you know 5:30 am to set up ORs and help us get everything torn down in time for ORs to start on time. And the lead anesthesia tech was quite engaged as well as the lead Scrub tech in terms of supplying learners. But in terms of educational content, leadership and simple scenario development and equipment, that was really a partnership between myself and the nurse educator with one of our highly engaged surgeons.” (Large) |
| Characteristics of individuals: Knowledge/ beliefs about the intervention | General support for the implementation from colleagues (n=17) | “All of my colleagues in the anesthesia department were very supportive of the concept and particularly one of our senior members, who had been the chief of the department but has moved on to become the director of Preoperative Services in the institution...so having that, him as the director of preoperative services who gave the orders to the surgeons and the anesthesia department be supportive of the issue was very helpful.” (Large) |
|---|---|---|
| Support from specific roles: | Chair of anesthesia (n=11) | “And everybody in my department has Dr. Gawande’s Checklist Manifesto, was kind of mandatory reading for our safety and quality component of in-office OB care that we provide at the hospital. We got everybody copies… so we were already familiar with the checklist idea and we’ve done checklist for postpartum hemorrhage and shoulder dystocia on labor and delivery. So we were already familiar with it like that. So actually, bringing in the [emergency] checklist was welcomed.” (Small/medium) |
| | Nursing leadership (n=6) | |
| | OR/perioperative director (n=5) | |
| Acceptance of cognitive aids (n=11) | | |
| Inner setting: Readiness for implementation - available resources | Having a budget for implementation (n=7) | “I had a significant budget and so we actually purchased $10,000 of the manuals and distributed them the first time to the program directors.” (Small/medium) |
| | | “We were lucky that this was a top priority for our Department of Quality and Safety. The resources that we needed, we were given to have.” (Large) |
| Inner setting: Culture | Culture of patient safety (n=6) | “...we find more and more that we’re using more and more checklists for machine checks and patient safety. So we’re very attuned to checklists and I think it’s just been one more” (Large) |
| Process: Opinion leaders | Surgeon support for the aid (e.g., using it in the OR; believed it was acceptable to use) (n=5) | “The surgeon service chief signed off and were, ‘Yes, we’re committed to this. Yes, we’ll do this.’ That was critical.” (Large) |
|-------------------------|-------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|
|                         | “Surprisingly, the surgeons and the nurses seem to think it’s perfectly acceptable to pull out the manual. The surgeons had no problem thinking the anesthesiologist didn’t have all knowledge and need to have knowledge support.” (Large) |                                                                                                                                                       |

*The given n figures reflect only implementers who explicitly identified these factors as barriers or facilitators. Additional implementers described similar experiences; however, they did not refer to them as barriers/facilitators and are not included in the n.*
| CFIR Domain: Construct | Barriers (n=# of sites in which the barrier was identified) | Illustrative quotes |
|------------------------|-------------------------------------------------|---------------------|
| Inner setting/ readiness for implementation--available resources | Lack staff and skills to implement (n=4) | “I now have had...different roles throughout my career where I’ve taken on leadership but no one ever sat me down like, “Hey [implementer], you’re going to train your team on how to respond to a crisis. Here is what you should do,” and sort of a formal educational process for me to then teach people....[I]n the beginning when I would make up these little scenarios, it was a little awkward. I just didn’t exactly know what to do to create the best educational experience, so you make it up as you go and figure out what works and things that didn’t you adjust a little bit.” (Small/medium) |
| Process – reflecting and evaluating | Difficult to monitor use (n=4) | “[W]ithin each crisis checklist there is a script item that says, crisis, you know, venous air embolism. If you pull up the venous air embolism crisis checklist, if you click on the script item, it becomes part of the permanent record and will say, venous air embolism checklist in use...But then the problem with that is that the person has to click it for it to go into the record, so we know the minimum number of times that it was used. We feel like it’s used more frequently and someone just fails to document it.” (Large) |
| Inner setting: Readiness for implementation - available resources | Time for training (n=23) | “It was hard to be able to get five physicians scheduled...I think we ended up doing it at like seven a.m. because we usually start seeing patients at eight...So it has been a little hard to try to find time to do it and people were grumbly about coming in early but, oh, well." (Small/medium) |

“Very little [training is done with attendings] in fact. And it’s hard, not for a lack of trying. It’s hard to get, specifically, physicians, faculty physicians, in training for various reasons. Either they don’t have protected time for didactics such as the trainees do. Sometimes it’s hard to get them out of the clinical environment. Sometimes it’s hard to motivate them to attend.” (Large)
| Intervention characteristics: Complexity | Clinicians often forget to use/reach for it during a crisis (n=12) | “In a sense this was sort of a culture shift to have something like this, even just remembering that it's there when you're in the midst of an emergency or a potential emergency. If you don't remember it's there, you’re not gonna use it. (Small/medium) “But in terms of actually using it in crisis situation, I think it’s not something that people think about off hand.” (Large) |
| Hard to decide where to place aid (n=9) | “It took some ingenuity to find the correct place to attach the chain to. So that is a challenge. And whoever needs to implement those need to really spend a lot of time with their anesthesia machine, on which side they want to put it. Significant factors being you do not want the chain too long, you do not want the chain too short, and you need to make sure that the location is such that the book doesn’t keep getting dirty or sloshed on all the time. That positioning is a challenge.” (Small/medium) “Our initial goal was to actually put it on the wall...The OR leadership felt that we should not be hanging anything on the wall because they really wanted walls to be able to be cleaned in between surgeries...We ended up placing them on top of a shelf close to the circulating nurse. Away from the surgical field...It did not work.” (Large) |
| Intervention characteristics: Cost | Cost (n=7) | “It costs about $50 or above depending on which town you’re in to take it to Staples or something like that. And then the chain...so around 50 to 60 bucks [for each] location. That’s some good money there.” (Small/medium) |
| Time to train reduces profit (n=4) | “It’s all about time and money...Pulling people away from clinical activity, that’s money; somebody has to replace them and that costs money.” (Large) “I think you would really have to have upward administration on board to be able to take away surgical time to implement and practice this, so I think that would be a major hindrance for implementation.” (Large) |
| Characteristics of individuals: Knowledge/beliefs about the intervention | Physicians don’t think they need a cognitive aid/can rely on memory (n=7)  
- Senior physicians more resistant than junior physicians (n=7) | “There’s a bit of an old school way of thinking that if you’re really a good provider, you’re gonna remember everything.” (Small/medium)  
“[Senior faculty in anesthesiology] think it’s only for people that are stupid.” (Large)  
“I think the anesthesia resistance was coming from...they were afraid that with the use of emergency manual they would look less omniscient, right? That they didn’t have all the knowledge and that that would be a failure on them as a clinician that they really should know the ACLS for PEA arrest right in the top of their head...that was part of the issue” (Large) |

*aThe given n figures reflect only implementers who explicitly identified these factors as barriers. Additional implementers described similar experiences; however, they did not refer to them as barriers and are not included in the n.*
Discussion

We conducted a qualitative analysis of semi-structured interviews with implementers of cognitive aids for OR crises in which we inquired about seven implementation strategies adopted from the Surgical Safety Checklist implementation guide and about strategies for generating buy-in. No facilities reported strategies outside these seven strategies or the overarching buy-in category, although the ways people implemented these strategies (strategy variants) differed significantly. These implementation strategies are therefore likely to be sufficient for facilities seeking to implement the cognitive aids for OR crises, however, some of these strategies, and ways of applying them, are likely more important than others, at least in some contexts. For example, only 3 facilities pilot-tested the aid (i.e., small scale use of the aid prior to full roll-out) and all of these were conducted in simulations. Pilot testing of these aids by other means is difficult because the need to use them is rare given the low occurrence of crises, unlike for the WHO Surgical Safety Checklist which is used in every operation.\(^\text{16}\) In contrast, buy-in appears to be an essential component of implementation that gets infused into multiple strategies and is fostered both in activities that are explicitly aimed at generating support, as well as in strategies designed to serve other implementation objectives, such as training. Future research on the relative importance of strategies and ways of applying them, in various settings, would be a valuable contribution to the field.

The diversity in strategy variants suggests that implementers can utilize these seven implementation strategies in many different ways. Moreover, while we were not able to link specific variants to successful or unsuccessful implementation of the cognitive aid for OR crises, we believe that deliberate adaptation of an implementation strategy to a specific context likely
leads to stronger implementation. For instance, large facilities frequently suffered from the barrier of increased bureaucracy, but implementers were able to utilize the strategy of presenting the concept to multiple important stakeholders in order to move the implementation process forward. Similarly, in small/medium facilities with less bureaucracy but also fewer resources, implementers were able to utilize one to one conversations to generate crucial buy-in for the aid and commitment to implementation from clinicians. Thus, much like the aids themselves, implementers ought to carefully customize implementation strategies to their context.

Our results also suggest that implementation strategies developed or chosen for one intervention (the WHO Surgical Safety Checklist) can be successfully adapted to similar interventions (cognitive aids for OR crises). We remain uncertain as to what factors are most important in judging transferability a priori. Here, it may be the style of intervention (cognitive aid), the context (OR), or the people involved (surgical teams). As with the relative importance of strategies, determining transferability is another area ripe for future research.

We found that some barriers and facilitators varied in prevalence by facility size. However, implementation success may depend less on the size of the facility than on implementers’ adaptations to that size, harnessing inherent strengths and mitigating weaknesses. Size is only one of many organizational context characteristics implementers should consider as part of a deliberate adaptation of strategies for their facility. As identified in the CFIR framework, implementers may also need to consider other inner setting (local) factors, outer setting (context external to the organization) factors, the individuals in the organization, and implementation process, in addition to intervention characteristics.15
Our study has several limitations. The final sample contained somewhat less variation in facility characteristics than we intended. However, it included geographical diversity with interviewees from 19 states and representation of every cell in our demographic sampling schema, suggesting that our respondents were sampled from across a wide spectrum of implementation contexts despite the deviation from the original sampling plan. We are also unable to determine which strategy variants correlate to successful or unsuccessful implementation. We reached saturation in the implementation strategies as well as for barriers and facilitators, as we were no longer hearing novel variants. However, it is possible that we did not detect other rarely used variants or other rarely occurring barriers and facilitators. This is a limitation of all qualitative research, which is not intended to be generalizable but rather to reflect a sampling of the range of variation in a population.

Conclusion

This qualitative analysis of interviews with implementers of cognitive aids for OR crises demonstrates that the seven recommended implementation strategies, based on past experience with the WHO Surgical Safety Checklist, are relevant but possibly not all necessary for successful implementation of cognitive aids for OR crises. Facilities achieved varying implementation success using these strategies in diverse ways, some of which corresponded to facility size. As a practical extension of this research project, a cost-free toolkit was also developed from this research, containing modifiable resources for implementation of and training with these tools, available at https://www.implementingemergencychecklists.org/.
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Appendix 1. Interview Guide

OR Crisis Checklist Interview

Thank you for speaking with me today about implementing the OR Crisis Checklist/Emergency Manual at your facility. You may recall that you completed our online OR Crisis Checklist/Emergency Manual Survey. There were some very interesting findings from the survey and our goal with the interviews is to better understand the survey results by more deeply exploring what people did and did not do during implementation, and why. Ultimately, this information will be used to inform the development of an OR Crisis Checklist/Emergency Manual Implementation Tool Kit that will be provided to you at the conclusion of our project.

The interview will take approximately 45 minutes and will be audio-recorded so that we can transcribe the conversation for analysis. During the transcribing process all names of people and facilities, and any other identifiers, will be removed but I’d appreciate if you could please try to avoid using names and instead identify people by their role and facilities by their type. We will keep your identity confidential and no individual people or facilities will be identified in the presentation of the results.

Do you have any questions before we begin?

1. From the time it was decided to implement the checklist/manual at your facility and throughout the implementation process, whose support was most important to your implementation?
   a. In what ways did they show their support?

2. What was done to build buy-in for using the checklist/manual?
3. There are many things a facility can do to support implementation of the OR Crisis Checklist/Emergency Manual. When you did the survey you indicated activities that were and were not done at your facility. I’d like to go through that list again so we can discuss each of the activities in more detail, including reviewing what you did and how you did, what you didn’t do and why, and how you think the activities impacted the success of implementation.

| Survey response | Did your facility… | If yes: Probe HOW they did it | If no: Why not? | How, if at all, did doing this/not doing this affect the success of implementation? | Item specific questions |
|-----------------|-------------------|-------------------------------|-----------------|-----------------------------------------------------------------|------------------------|
| Only ask if survey indicates they did NOT do this: Place the checklist/manual in at least one operating room? For others, ask: How did you decide where to place the checklist/manual? What factors impacted the decision? | | | | | |
| Present the checklist/manual to staff? How and to whom was it presented? | | | | | |
| Create a multidisciplinary team to review the checklist/manual? Who was on the team? How, if at all, did the team promote buy-in from staff? | | | | | |
| Customize the checklist/manual? What did you customize? (e.g., clinical content, logos, phone #s) | | | | | |
| Pilot test the checklist/manual? (e.g., try it in one OR, test how it fits into workflows) | | | | | |

If no customization: ask why
Probe if the format was an issue
Probe if customization was impacted by deciding what to customize
| Survey response | Did your facility… | If yes: Probe HOW they did it | If no: Why not? | How, if at all, did doing this/not doing this affect the success of implementation? | Item specific questions |
|-----------------|---------------------|-----------------------------|----------------|--------------------------------------------------------------------------------------|--------------------------|
|                 | **Train the surgical team(s) to use the checklist/manual?** (To explain and/or probe: emergency drills, simulations or some other team training) | | | | Which disciplines participated in the training? <br> *If nurses, anaesthesia, surgeons and surgical techs participated ask: How were you able to get all of these disciplines to participate?* <br> *Did you do debriefings after the team trainings? If no: Why not?* <br> **Ask everyone:** Was time for training a challenge? *If yes: How did you [try to] deal with this?* |
|                 | **Do on-going training?** | | | | |
|                 | **Monitor use of the tool?** | | | | If monitoring: how is this information used? (Is this used for quality improvement? How?) |
|                 | **Other activities you did?** | | | | |
Q4-6 IF TIME PERMITS (otherwise continue to Q7):

4. How did you decide to do these implementation activities? [refer back to what was done]

5. Are there other things you wanted to do as part of bringing the checklist into use at your facility but that you haven’t done? If yes, why haven’t you done these? (explore challenges/barriers)

6. Do you think there are other things that could be done to make use of the checklist at your facility even more successful? What are they?
7. We’re interested in understanding the challenges your facility experienced in implementing the checklist/manual, and how your facility responded to these challenges. What were the challenges you faced in getting the checklist into use?

| Challenges identified in survey | Challenge | How did you facility deal with [add challenge]? | How successful do you think your facility was at dealing with this challenge? | Item specific questions |
|---------------------------------|-----------|-----------------------------------------------|--------------------------------------------------------------------------|------------------------|
| Opposition/resistance           | [In addition to the challenges you’ve mentioned, was there opposition or resistance from anyone about implementing the checklist?] | | | From whom was there resistance? Why did they resist? Is it considered acceptable to use the checklist/manual? |
| If budget is a challenge:       | What helped/hindered you getting a budget? What information would help you get your administrators to give you an appropriate budget? | | |
8. Has your facility used the checklist/manual during an OR crisis?

**If no:** Why not?

**If yes:** Can you describe a case for which the checklist/manual was used? Did the checklist/manual help the clinicians involved? How? How successfully do you think the checklist/manual was used? Why do you think you had this level of success?

**If used checklist/manual:** Did you debrief after the event?

**If no:**
Why not?
Is there someone at your facility with experience as a facilitator or debriefer?
What do you think you would have gotten out of a debrief?

**If yes:**
Who led or initiated the debrief? Why were they chosen?
Who participated in it?
What did you get out of doing the debrief?

9. If there was an applicable critical clinical event in your facility tomorrow, what percentage of the time do you think the checklist/manual would be used?
   a. Why?
   b. How would you know if it was used?
   c. What/who would trigger using the checklist/manual?
      (e.g., when a critical event begins, after the team tries to resolve the crisis but is unsuccessful, after the event is dealt with to make sure steps weren't missed, in debrief)

10. Have there been any negative consequences to introducing the checklist/manual?

11. Having gone through the process of implementing the checklist/manual, what would you have done differently if you could do it all over again?
   a. What would you do the same if you could do it again?
12. What advice would you give a facility that was considering implementing the OR Crisis Checklist/Emergency Manual?

13. Is there anything else about implementing or using the checklist/manual that you’d like to mention?
Appendix 2. Authors’ contributions

Natalie Henrich: This author helped with study design, data collection, analysis, and writing of the manuscript.
Emily Benotti: This author helped with data collection, analysis, and writing of the manuscript.
William Berry: This author helped with study design, analysis, and writing of the manuscript.
Alexander Hannenberg: This author helped with study design, data collection, analysis, and writing of the manuscript.
David Hepner: This author helped with study design, analysis, and writing of the manuscript.
Ami Karlage: This author helped with analysis, and writing of the manuscript.
Sara Goldhaber-Fiebert: This author helped with study design, data collection, analysis, and writing of the manuscript.

Appendix 3. Participants’ State

1. California
2. Colorado
3. Delaware
4. Florida
5. Illinois
6. Iowa
7. Maine
8. Massachusetts
9. Michigan
10. Minnesota
11. New Jersey
12. New York
13. North Carolina
14. Oregon
15. Pennsylvania
16. Rhode Island
17. Tennessee
18. Vermont
19. Washington