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Anesthesia Provider's Use and Perception of Emergency Cognitive Aids

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Anesthesia Provider's Use and Perception of Emergency Cognitive Aids

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Abstract

Cognitive aids have been shown to increase proper use of evidence-based practice treatment strategies in emergent scenarios. These treatment strategies can be unfamiliar to the provider as emergencies are rare, and when coupled with a heightened stress level and sense of urgency, relying on memory alone can be challenging. The purpose of this project was to implement a set of emergency use cognitive aids developed by Stanford University known as the Stanford Emergency Manual into a set of operating rooms and measure the anesthesia providers use and perception of the cognitive aid via pre-implementation and post-implementation e-mailed surveys.

Emergency Use Cognitive Aids in the Operating Room

Emergency use cognitive aids in the operating room have the potential to improve patient care and reduce errors of omission during crisis scenarios versus relying on memory alone.

Background

The potential for cognitive aids to reduce errors during surgical procedures has been recognized since the publication of the World Health Organization (WHO) surgical safety checklist in 2009 (Kromback et al., 2015). Emergencies in the operating room such as massive hemorrhage, malignant hyperthermia, and cardiac arrest can be common occurrences at large hospitals, yet a rare occurrence for individual clinicians, making successful management based solely on providers' memory of the treatment strategies difficult (Arriaga et al., 2013).

Emergency checklists are a type of cognitive aid that prevent anesthesia providers from missing critical steps during stressful events. Evidence suggests that failure of adherence to best practice during emergencies is common, and as a result, cognitive aids have long been used in high-risk industries such as aviation to handle crisis situations (Hepner et al., 2017). Failure to effectively treat emergent, life-threatening complications in surgical patients has been identified as the largest source of variation in surgical mortality among hospitals (Arriaga et al., 2013). Good clinical judgement and memory can be diminished in crisis situations due to the heightened stress level and increased mental workload, increasing the risk of deviation from best practices and the opportunity for forgotten steps in the treatment plan (Blanie et al., 2020). Critical events in high-risk professions such as anesthesia call for rapid, coordinated and accurate management while juggling an increased task load and stress level (Arriaga et al., 2013). There is evidence to suggest that during emergency situations in the operating room, using a well-designed cognitive

aid will lead to fewer missed critical steps than would working from memory alone (Hepner et al., 2017).

Problem Statement

Despite an abundance of evidence that deviations from best practice treatments occur in crisis operating room situations, not all hospitals utilize cognitive aids which could reduce these errors. The deviations from best practice have the potential to negatively impact patient outcomes, patient quality of life, and healthcare costs. This project implemented emergency use cognitive aids in the form of the Stanford Emergency Manual into the anesthetizing areas at the project site and evaluated anesthesia providers perception and use of the aids.

Organizational “Gap” Analysis of Project Site

The site of implementation for this project was a community hospital associated with an academic medical center that is open and accepting of evidence-based practice research projects. A skilled staff of anesthesia providers manage the anesthetizing areas at this institution and there was currently no cognitive aid manual for emergency situations in these operating rooms, making it a prime location for the implementation of this project.

PICOT Question

The PICOT question for this project was as follows: In anesthesia providers (P), will implementation of emergency use cognitive aids in the operating rooms at a small community hospital (I) compared to no emergency use cognitive aids (C), impact anesthesia provider’s perceptions and use of cognitive aids (O) over one month (T)?

Significance

The significance of this problem lies in the opportunity to improve patient outcomes and reduce morbidity and mortality that can be a high occurrence in anesthesia. Each year in the United States, anesthesia is reported to be the underlying cause in approximately 34 deaths, and the contributing factor in another 281 deaths (Li et al., 2010). Today, anesthesia-related mortality is around 1.1 per million persons per year in the United States (Steadman et al., 2017). Anesthesia carries with it a higher risk of emergency situations, which can lead to morbidity and mortality. For example, the incidence of anaphylaxis during anesthesia has been reported to range from 1 in 4,000 operations to 1 in 25,000 operations and can lead to cardiovascular collapse and airway obstruction if not promptly and correctly treated (Mali, 2012). The incidence of cardiac arrest associated with general anesthesia is 5.5 per 10,000 operations (Han et al., 2017). Laryngospasm emergency situations carry a 1% risk in both adult and pediatric patients, leaving patients at risk for sustained closure of vocal cords and loss of the patient's airway (Gavel & Walker, 2013). Respiratory complications of anesthesia-related aspirations can be fatal and occur as often as 1 in every 2,000 to 3,000 operations. Almost half of all patients who do aspirate develop a lung injury (Nason, 2016). In addition to the increased morbidity and mortality, intraoperative emergencies are expensive to the patient. The mean cost postcardiac arrest in the United States was \$11.1 billion in 2012, and the ability to reduce cardiac arrest by ten percent would have saved the health care system \$1.2 billion (Damlugi et al., 2018). Costs associated with malignant hyperthermia complications were estimated to be \$75,000 on average (Ho et al., 2018). Implementation of emergency use cognitive aids has great potential to improve our patient safety standards and patient outcome during surgical procedure emergencies.

Review of the Literature

Search Process

A comprehensive literature review was conducted during which several electronic sites were searched for peer-reviewed journals, articles and studies related to cognitive aid use in anesthesia. The World Health Organization was searched with the general term of cognitive aid, which produced many results. Despite the large number of articles this search generated, none of these articles were helpful in the setting of cognitive aids for anesthesia providers in the operating room. An attempt to narrow the search was made with the addition of Medical Subject Headings (MeSH) terms such as anesthesia cognitive aid, cognitive aid in surgery, anesthesia algorithm, and anesthesia protocol, but none were successful in finding relevant articles. Similar unsuccessful findings were encountered on the Center for Disease Control (CDC) website.

The most success was found on the National Institute of Health (NIH) website. After searching for anesthesia cognitive aid, 42 articles were found with five of these being directly relevant to the project. Successful search results were also found on the National Quality Measures Clearinghouse (NQMC) website, where searches found twelve articles with one being directly relevant. The journal bases PubMed and the Cumulative Index to Nursing and Allied Health Literature (CINAHL) Plus were also searched and presented 21 articles, with seven relevant articles. Inclusion criteria for the search included studies produced in the last seven years, written in the English language, full text, relevant to this project and peer-reviewed.

Randomized Controlled Trials

At the conclusion of the literature search, several articles were identified, all of which contained a common theme suggesting evidence of increased compliance with evidence-based practice treatment strategies when utilizing a cognitive aid during crisis scenarios.

Of the articles, eight were high-quality, level one evidence, randomized controlled trials (RCTs) involving anesthesia providers and operating room personnel such as Certified

Registered Nurse Anesthetists (CRNAs), operating room Registered Nurses, surgeons, anesthesia residents, fellows and attending physicians who were presented crisis scenarios. The control group was left without a cognitive aid and the experimental group was provided a cognitive aid to aid in treatment of whichever crisis scenario was encountered. All eight of these RCTs found that availability of a cognitive aid improved task performance and increased adherence to lifesaving, evidence-based protocols.

All of the RCTs were simulation-based, which may present a weakness as it is uncertain how close simulation studies could be generalized to real practice. They also were all unblinded studies which could potentially contribute to researcher and participant bias. However, creating RCTs in real-time practice utilizing a cognitive aid versus not utilizing an aid would be very difficult to conduct as it is impossible to predict when or where crisis scenarios will arise, and blinding of participants and researchers during simulation studies such as these is near impossible.

A strength of RCTs is that they covered a broad range of crisis scenarios including malignant hyperthermia (MH), local anesthetic toxicity (LAST), anaphylaxis, can't intubate and can't ventilate, severe hyperkalemia with circulatory failure, cardiac arrest with ventricular fibrillation, bronchospasm, massive hemorrhage, transfusion reaction, intraoperative ST-elevation myocardial infarction (STEMI) and acute hyponatremia as a consequence of transurethral resection of prostate (TURP) syndrome. Despite the varying crisis scenario presented, the common outcome in each RCT was evidence of increased compliance to best practice treatment when a cognitive aid is available versus provider memory alone (Arriaga et al, 2013; Urdman et al, 2020; St. Pierre et al., 2017). Use of a cognitive aid in crisis scenarios resulted in reduction of omitted critical management steps by 70%, $p < 0.001$ (Koers et al., 2019) and an increased

quality of non-technical performance such as leadership, problem-solving, communication, situational awareness and resource use (Lelaidier et al., 2017). During can't intubate-can't ventilate situations in anesthesia, the use of a cognitive aid resulted in an average of 6.4 fewer missed steps in cricothyroidotomy cannulation than the procedure based upon memory alone (Harvey et al., 2016). Cognitive aid use benefits also translate into pediatric practice. In a study of 25 senior anesthesia trainees at a university hospital, the use of cognitive aids in MH and LAST crises showed significantly superior clinical performance (Siddiqui et al, 2019).

Quasi-Experimental Studies

In addition to the RCTs, a quasi-experimental study with good quality, level II evidence was identified in the literature search. The study collected pre-implementation and post-implementation data via surveys to residents at Stanford after adoption of the Stanford Emergency Manual, which is a collection of anesthesia crisis cognitive aids developed by Stanford (Goldhaber-Fiebert et al., 2016). The study found that post-implementation of the emergency manual there was a positive shift in the safety culture for supporting the use of cognitive aids, and 78.9% of respondents who had used the emergency manual agreed or strongly agreed that it helped the team deliver better care to the patient (Goldhaber-Fiebert et al., 2016). The study showed strengths in a survey response rate of 52% and 57% for pre-implementation and post-implementation, respectively, and high validity from narrow confidence intervals (Goldhaber-Fiebert et al., 2016). A weakness of the study was lack of generalizability due to the survey occurring at a single academic center with one study population, but the reports serve as early proof of concept for implementation of the emergency manual cognitive aids (Goldhaber-Fiebert et al., 2016).

Conclusion

The evidence in support of this research project is strong. The literature review demonstrates a clear link between the use of cognitive aids and reduction of omitted critical management steps in emergent anesthesia scenarios which can lead to safer patient care and further supports the implementation of this research project.

Evidence-Based Practice: Verification of Chosen Option

The evidence-based practice implementation that was used in this project was the implementation of the Emergency Manual into the operating rooms at the project site. The Stanford Emergency Manual is a simulation-tested manual addressing 33 different crisis scenarios that could be encountered by the anesthesia provider and is available cost-free for download (See **Appendix D**) (Goldhaber-Fiebert et al., 2016).

Theoretical Framework or Evidence Based Practice Model

The theoretical framework helps to guide and inform the project which focuses on experiences and assumptions (Moran, et al., 2020). For this project the Shannon and Weaver model was selected, which focuses on effective communication between sender and receiver and factors affecting communication processes (Communication Theory, n.d.). With this theory to guide the project, the focus on the sender was Stanford University as they already developed an excellent aid, the encoder and note would be the actual aid itself, and the receiver is the anesthesia provider utilizing the note. This framework helped to identify any gaps in communication or noise that would make communication more difficult.

Goals, Objectives, and Expected Outcomes

Goals of implementing the Stanford Emergency Manual into the operating rooms at the project site were to increase anesthesia providers familiarity with cognitive aid use, positively impact anesthesia providers perception of cognitive aid use, and collect data about actual use of

the cognitive aid in real life acute events that may occur. A pre-implementation and post-implementation survey was distributed to anesthesia staff members which facilitated measurement of their use and perception of cognitive aids both before and after implementation. The goal was that anesthesia staff would see the cognitive aids as a useful tool in patient care and that the aids would have a positive benefit in correctly treating emergency events.

Project Design

Project Site and Population

The project site was a community hospital located in the midwest. Specifically, the project was implemented into all anesthetizing locations of this facility where the Stanford Emergency Manual was placed for use. The pre-implementation and post-implementation surveys were sent to all anesthesia staff via email.

Stakeholders

Early identification of stakeholders is important for the evidence-based practice (EBP) project. Stakeholders should be involved in the EBP project and kept up-to-date with its progress (Dang & Dearholt, 2018). The stakeholders involved in this project included anesthesia practitioners, nursing staff, surgeons, patients, and leadership such as the chair of the anesthesia department and the program director of the nurse anesthesia program. Anesthesia staff were directly involved in the use of the cognitive aids and ultimately determined if this project was helpful or not helpful. They had the responsibility of looking over the cognitive aids and utilizing them in emergent situations. Some may have found the cognitive aids helpful, but others could have been resistant to the idea of pausing to read an aid during a critical time. Nursing staff members are also stakeholders in this project because although the anesthesia provider themselves may often be the one utilizing the aid, this could always be delegated to a nursing

staff member in the room that could read out loud the steps involved. This would allow the anesthesia provider time for preparing medications or equipment while the aid is utilized. It is important that nursing staff are open and comfortable with this idea. Surgeons were stakeholders in this project because it is their patient and their operation that is taking place. If the cognitive aids improve patient care, their patients directly benefit, which results in better surgical outcomes, something every surgeon desires. It was important that surgeons feel this aid was helpful. Those in leadership at the hospital were also major stakeholders. The chair of anesthesia at the hospital and program director of the Certified Registered Nurse Anesthetist (CRNA) program would benefit from their hospital's improved patient safety and improved patient outcomes. Finally, the patient was the most important stakeholder. The patient's care has the potential to be improved which directly benefits their health and potentially their quality of life.

Setting facilitators and barriers.

The project site was a community hospital associated with an academic medical center which embraces a patient safety culture by supporting research and evidence-based practice projects. Anesthesia staff at this institution are generally accepting of new research and ideas; they were contacted via e-mail as the project was implemented. A potential barrier to the project at this site was the small size of the hospital which allowed for only seven anesthetizing area locations for manual placement and thus a small sample size.

Methods

Measurement Instruments

In order to measure the outcomes of this DNP project all anesthesia staff at the project site were e-mailed surveys to measure their actual use and perception of the cognitive aids. Surveys are an appropriate measurement instrument for this project because they are well

designed to collect information regarding attitudes, perceptions and behaviors. Informatics guided the measurement instrument designs via data-centered approaches to survey distribution and content. The groups which were measured included Certified Registered Nurse Anesthetists (CRNAs) and anesthesiologist attending physicians.

An eight-question pre-implementation survey measuring current use and current perceptions of cognitive aid use was e-mailed to the anesthesia staff two weeks prior to implementation of the emergency manuals in the operating room. The survey was a modified version of the survey used in Goldhaber-Fiebert et al., 2016 (See **Appendix A**). This pre-implementation survey consisted of Likert-type selections. One month after the implementation of the emergency manual, a subsequent e-mail was sent out to all anesthesia staff which contained a ten-question, post-implementation survey measuring the anesthesia providers post-implementation perception of cognitive aids (See **Appendix B**) and a six-question survey regarding their actual use of the emergency manual in acute situations, if applicable (See **Appendix C**). Both surveys measured responses via Likert-type, multiple choice, select all that apply and free text responses. The e-mails contained a link to the survey through Qualtrics software. All responses remained anonymous. Due to the exploratory nature of this hypothesis-generating pilot study, the survey questions from Goldhaber-Fiebert et al., 2016, were not formally validated using psychometric analyses, but multiple experts developed the questions through rigorous, consensus-building modified Delphi process and the survey did undergo pilot testing (Goldhaber-Fiebert et al., 2016).

Data Collection Procedures

This project followed the Plan-Do-Study-Act (PDSA) cycle framework and was divided into three phases: pre-intervention, intervention, and post-intervention.

During the pre-intervention time period the researcher was working within the Plan section of the PDSA cycle framework by setting predictions, goals and deciding what data to gather. The initial survey (see **Appendix A**) was distributed via e-mail to the anesthesia group at the project site by the project author. The e-mail contained a link to the anonymous survey through Qualtrics software. In order to increase participation, there was a reminder at the one-week time mark from the initial e-mail to again encourage anesthesia providers to participate. The results were recorded and stored for comparison after the post-implementation survey data was collected.

The intervention phase took place after the second pre-implementation survey reminder email was distributed and encompassed the Do phase of the PDSA cycle framework. During this phase the cognitive aids were placed into the operating rooms and an additional email was distributed to all anesthesia staff at the project site informing them of cognitive aids “go live” status and encouraging their use of the cognitive aids and participation in the study.

One month after the cognitive aids were placed into the operating rooms, a post-implementation survey was distributed to all anesthesia staff. The survey was of the same format as the pre-implementation survey through Qualtrics software. After allowing two weeks from the date of the post implementation survey distribution to allow adequate time for survey responses to be sent in, the data was analyzed by the project author and compared to the pre-implementation survey data during the Study phase of the PDSA cycle framework.

The aim of this data collection was to find if there was a change in the anesthesia providers perception of cognitive aid use after implementation, and if the aids were in fact actually used in practice. After data collection and analyses, the Act phase of the PDSA cycle

framework was followed while the researcher decided to either adopt the plan, change the plan or abandon the plan based on the results of the data analyses.

Informatics helped to guide this project by using a data-centered approach and survey measurement tools to demonstrate if implementation of cognitive aids had a positive perception change/culture shift on staff. Cultural characteristics of the project site helped to facilitate this project because the site is typically welcoming of research and change projects. This project was inclusive to all staff, gaining input from anesthesia providers of all cultures and backgrounds. The researcher remained aware of cultural competency and the importance of effectively communicating and working with individuals of different backgrounds and with different ideas.

Data Analysis

The independent variable of this research project was the Stanford Emergency Manual and the dependent variables being measured were anesthesia providers perception and use of cognitive aids. Demographic variables in this study included the type of anesthesia provider: CRNA or attending anesthesiologist physician. The expected outcome of this research was that implementation of the Stanford Emergency Manual into the operating rooms at the project site would increase anesthesia providers use of cognitive aids and have a positive impact on their perception of cognitive aid use. Descriptive statistics were used and data was collected from groups of providers at pre – intervention and post – intervention time points. For reporting of descriptive data regarding anesthesia providers perception and use of cognitive aids, numbers and percentages of survey respondents were presented from two-sample Z tests for proportions based on a sample size of eight for the pre implementation survey and sample size of six for the post-implementation survey.

Cost-Benefit Analysis/Budget

The costs associated with this project were from materials and software and were supplied by the author. The research conductor is a student and thus volunteered personal time free of cost. The costs of printing materials and materials to make the cognitive aids more sustainable such as lamination, paper rings and wires to hang the cognitive aid packets from anesthesia cart were \$83.07 with an additional \$114.00 to acquire the Statistical Package for the Social Sciences (SPSS) software that was used for data analysis (**See Appendix E**). Once the initial cost of printing cognitive aids was complete, new costs were not since the aids were not damaged or lost. The final total cost of \$197.07 was justified by the benefit this project has the potential to yield, specifically better patient outcomes due to reduced omission of critical management steps during emergent situations.

Timeline

The timeline for implementation of this project was around six months from initial proposal approval to the final presentation of results. Proposal approval was obtained three to four weeks into the fall semester in September, 2021. After approval, the project implementation began, starting with the pre-implementation survey e-mailed to anesthesia staff. Two weeks after the pre-implementation survey was distributed (October, 2021), the cognitive aids were placed into the anesthetizing locations. A post-implementation survey was distributed one month after the implementation of the cognitive aids, and data were analyzed. The project is scheduled for completion in January, 2022, and presentation of the results is projected in February, 2022 (**See Table 1**).

Ethical Considerations/Protection of Human Subjects

This project did not require IRB approval from Washington University in Saint Louis prior to initiation. The project study is aimed not at patients, but rather anesthesia providers and was considered IRB exempt since it was a quality improvement project and not a research study.

When examining the post-implementation surveys regarding actual use of the cognitive aids in acute events, it is possible that a respondent could have accidentally included a type of patient identifier in the survey when describing its use. For this reason, instructions were provided in the post-implementation survey informing respondents to not use any sort of patient identifiers when describing the situation in which the emergency manual was utilized. The DNP student conducting this study followed diligent Health Insurance Portability and Accountability (HIPPA) guidelines and standards of care to ensure patient protection. The risks to patients in the operating rooms with the emergency manual were no different than risks to a patient in an operating room without the emergency manual available.

Evaluation and Outcomes

Project Results

A total of twelve anesthesia providers were sent both the pre-implementation and post-implementation surveys. Survey response rates were 66% (three anesthesiologist attending physicians and five CRNAs) for the pre-implementation survey and 50% (four anesthesiologist attending physicians and two CRNAs) for the post-implementation survey with one response, or 8% response rate, for the second half of the post-implementation survey regarding actual use in a real critical event.

In the pre-implementation survey, 12.5% of respondents strongly agreed that cognitive aids can be created effectively for many specific events in the practice of anesthesia. This rose to

66.67% of candidates who strongly agreed after the implementation of the Stanford manual in the post-implementation survey ($p=0.037$) (See **Appendix F**). In the pre-implementation survey, 100% of respondents either agreed or strongly agreed that we should have cognitive aids for critical response events easily accessible in our operating rooms. In the post-implementation survey, 100% of respondents agreed or strongly agreed that having emergency manuals in the operating rooms improved patient care.

The percent of respondents who reported using an aid at least weekly rose 25% from the pre-implementation to post-implementation surveys ($p=0.332$) (See **Appendix G**). When asked if a patient presented with suspected local anesthetic toxicity, would they would use a cognitive aid during the acute event if readily available? They responded 100% in both the pre-implementation and post-implementation surveys that they either agreed or strongly agreed, with the percent who strongly agreed increasing from 25% in the pre-implementation survey to 66.67% in the post-implementation survey ($p=0.116$).

In the post-implementation actual use survey, one respondent replied that he/she used the manual during an actual event. The event was described as a bronchospasm in which the manual improved patient care by providing a second check that the patient was treated as appropriately as possible. The anesthesia provider strongly agreed that the emergency manual helped the team deliver better care to the patient and noted no barriers to the effective use of the manual during the incident.

Strengths and Limitations

A strength of this quality improvement project was the high survey response rate for both the pre-implementation and post-implementation surveys, 66% and 50% respectively. The most significant limitation to this project was the small sample size ($N=12$). Other

limitations include this project occurring at a single community hospital with one study population. Because of the emergency manual's design is for use in rare and critical situations, the feedback on actual use is limited with the short timeline available for project implementation. Selection bias is also a possibility, given that anesthesia providers who chose to respond may have opinions weighted more strongly for or against the topic.

System/Practice Impact

Policy Implications

The results of this project demonstrate three main conclusions: 1) Anesthesia providers experienced a positive perception to the use of emergency manuals in anesthetizing locations, 2) Having the manuals available increases the use of the cognitive aid reference, and 3) Using the emergency manuals in acute events helped to improve patient care. Based on these results, the author recommends that all anesthetizing locations have an emergency manual cognitive aid available for anesthesia providers to reference. Policy change requires strong nursing leadership, and as a doctorally prepared nurse anesthetist, the author is willing to work with other leaders and stakeholders within the department of anesthesiology to implement this practice change. Upon completion of this project, discussion ensued with the Director of Anesthesiology at the project site, and it was decided that the site will continue to use of the emergency manuals in the anesthetizing locations.

Impact of Results on Practice

The impact of these survey results suggests that patient care will be improved with the addition of emergency manuals in anesthetizing areas. Benefits of cognitive aid use during emergency situations have been shown repeatedly in both simulation and real practice settings. The heightened stress level of emergent settings coupled with potential unfamiliar

treatment strategies can make relying on memory alone challenging and difficult for the provider. Incorporating the Stanford Emergency Manual into the operating rooms provides clinicians with a quick reference for a multitude of unfamiliar crisis scenarios to ensure proper evidence-based practice treatment strategies are utilized. Anesthesia providers at the project site have positive perceptions of using the manuals and these anesthesia providers feel that manuals are a positive addition to the anesthetizing areas.

The potential for prolonged sustainability for this project is high. The emergency manuals were printed and laminated for durability and tethered to the anesthesia carts to prevent loss or misplacement of the manuals. No further costs should be incurred unless the manual were to become damaged or lost.

Summary and Conclusion

Future Implementation

The clinical scholarship gained from completion of this project is that emergency manuals in anesthetizing locations improve patient care and anesthesia providers have a positive reaction to having these manuals readily available for use. Based upon this information, in the future, more hospitals should acquire emergency manuals and distribute them throughout their anesthetizing locations. Recommendations include implementation in hospitals throughout the country. The implementation of the manuals by manual printing and lamination is a manageable task but the Stanford Emergency Manual is also available preprinted and in booklet form for easier distribution for an additional cost, if desired.

Dissemination Plan

Dissemination of this project will occur through several routes. Initially, a power point presentation will be presented virtually to Goldfarb School of Nursing. Second, a

poster will be displayed during a poster presentation day at the school. Third, this project will be submitted for publication in the International Student Journal of Nurse Anesthesia.

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Appendix A. Complete Survey, Pre-Implementation

1. Cognitive aids can be created effectively for many specific events in the practice of anesthesia:
 - Strongly disagree
 - Disagree
 - Neither agree nor disagree
 - Agree
 - Strongly agree

2. I currently use a cognitive aid of some type in my practice (electronic or hard copy):
 - Never
 - Yearly
 - Monthly
 - Weekly
 - Daily

3. You hear that your anesthesia colleague is actively treating REFRACTORY hypoxemia and referring to a cognitive aid. Would you characterize this as:
 - Using an unnecessary cheat sheet
 - Helpful for trainees only
 - Reasonable for all trainees, but they should not need it beyond the end of their training
 - Given the hypoxemia did not resolve as expected after initial treatments a cognitive aid is a good tool for an anesthesia provider to consult

4. If I had a patient with suspected local anesthetic toxicity, I would use a cognitive aid DURING the acute event (if readily available) to help ensure appropriate and efficient treatment of this event
 - Strongly disagree
 - Disagree
 - Neither agree nor disagree
 - Agree
 - Strongly agree

5. Would having a set of laminated cognitive aids for critical events in each OR be helpful to YOU in some of the following ways? MAY CHOOSE MORE THAN ONE – please mark all answers you agree with:
 - No
 - Yes, for reviewing during ‘downtime’ before an event occurs
 - Yes, for reference during some part of a critical event (e.g., slowly evolving, patient refractory or treatment, or rarely used medication dosage information)

- Yes, during an event, once there are enough people that someone could be READING IT OUT LOUD for the team
 - Yes, for reviewing or debriefing after a critical event is resolved
 - Comments:
6. Would having a set of laminated cognitive aids for critical events in each OR be helpful for teaching STUDENT registered nurse anesthetists or medical STUDENTS on an anesthesia rotation? YOU MAY CHOOSE MORE THAN ONE – please mark all answers you agree with:
- No
 - Yes, for reviewing during ‘downtime’ before an event occurs
 - Yes, for reference during some part of a critical event (e.g., slowly evolving, patient refractory or treatment, or rarely used medication dosage information)
 - Yes, during an event, once there are enough people that someone could be READING IT OUT LOUD for the team
 - Yes, for reviewing or debriefing after a critical event is resolved
 - Comments:
7. We should have cognitive aids for some critical response events easily accessible in our Operating Rooms
- Strongly disagree
 - Disagree
 - Neither agree nor disagree
 - Agree
 - Strongly agree
8. Which type of anesthesia provider are you?
- SRNA
 - CRNA
 - Resident or Fellow
 - Attending

Appendix B. Complete Survey, Post- Implementation

1. Cognitive aids can be crated effectively for many specific events in the practice of anesthesia:
- Strongly disagree
 - Disagree
 - Neither agree nor disagree
 - Agree
 - Strongly agree

2. I currently use a cognitive aid of some type in my practice (electronic or hard copy):
- Never
 - Yearly
 - Monthly
 - Weekly
 - Daily
3. You hear that your anesthesia colleague is actively treating REFRACTORY hypoxemia and referring to a cognitive aid. Would you characterize this as:
- Using an unnecessary cheat sheet
 - Helpful for first year trainees only
 - Reasonable for all trainees but they should not need it beyond the end of their training
 - Given the hypoxemia did not resolve as expected after initial treatments a cognitive aid is a good tool for an anesthesia provider to consult
4. If I had a patient with suspected local anesthetic toxicity, I would use a cognitive aid DURING the acute event (if readily available) to help ensure appropriate and efficient treatment of this event
- Strongly disagree
 - Disagree
 - Neither agree nor disagree
 - Agree
 - Strongly agree
5. Is having a physical copy of the Emergency Manual (set of bound, laminated cognitive aids for critical events) in each OR helpful to YOU? Please mark ALL THAT APPLY (you may choose more than one)
- No, I didn't know we had an Emergency Manual in each OR
 - No, I know about but never touch the Emergency Manual
 - Yes, for reviewing during 'downtime' before an event occurs
 - Yes, for reference during some part of a critical event (e.g., slowly evolving, patient refractory to treatment, or rarely used medication dosage information)
 - Yes, during an event, once there are enough people that someone could be READING it
 - Yes, for reviewing or debriefing after a critical event is resolved
 - Comments:
6. Is having an Emergency Manual in each OR helpful for teaching STUDENT registered nurse anesthetists or medical STUDENTS on an anesthesia rotation? Please mark ALL THAT APPLY (you may choose more than one)

- No
 - Yes, for reviewing during ‘downtime’ before an event occurs
 - Yes, for reference during some part of a critical event (e.g., slowly evolving, patient refractory or treatment, or rarely used medication dosage information)
 - Yes, during an event, once there are enough people that someone could be **READING IT OUT LOUD** for the team
 - Yes, for reviewing or debriefing after a critical event is resolved

7. Having Emergency Manuals in our operating rooms improves patient care

- Strongly disagree
 - Disagree
 - Neither agree nor disagree
 - Agree
 - Strongly agree

8. For each reason below, choose the level of barrier to effective Emergency Manual implementation

	Not a barrier	Somewhat of a barrier	Moderate barrier	Significant barrier
Events in the operating room happen too quickly	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Insufficient people available to help (e.g., nobody available as reader)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I don't think to consult an emergency manual under stress	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Professionals should know all this by memory	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
My colleagues may not approve	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

9. In what ways have you USED the Emergency Manual? Please mark ALL THAT APPLY (you may choose more than one)

- During a simulated intraoperative event
- Self Review or Teaching (i.e. not for management of a specific patient)
- BEFORE a potential event (e.g., self or team ‘Just in Time’ review for patient/case with higher risk for a critical event, e.g., difficult airway, hemorrhage, SVT, etc)
- DURING a critical event (as member of team or helper responding)
- AFTER a critical event (e.g., during a team debrief)
- I have never opened the Emergency Manual

10. . Please select how frequently you open the Emergency Manual for each type of use (on average)

	Never	Daily	Weekly	Monthly	Yearly
Self review	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Intraoperative teaching	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Review BEFORE a patient/case higher risk for an event	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Guidance DURING an intraoperative event	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Review AFTER a critical event	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

11. Which type of anesthesia provider are you?

- SRNA
- CRNA
- Resident or Fellow
- Attending

Appendix C, Complete Use, Post-Implementation Acute Event Use

1. Please select the number of times you've used the Emergency Manual DURING an acute intraoperative event since its implementation

- None (if none, skip to Question 21)
- 1 time
- 2 times
- >2 times

2. Please select all of the intraoperative critical event types for which you or your team have used the Emergency Manual

- Cardiac arrest – PEA/Asystole
- Cardiac arrest – VF/Pulseless VT
- Unstable Bradycardia
- Unstable SVT
- Amniotic fluid embolism
- Anaphylaxis
- Bronchospasm

- Delayed emergence
- Difficult airway
- Hemorrhage Massive/MTG
- Hypotension - Refractory
- Hypoxemia Refractory
- Local Anesthetic Toxicity
- Malignant Hyperthermia
- Myocardial Ischemia
- Oxygen pipeline failure
- Pneumothorax
- Power failure
- SVT Stable Tachycardia
- Total Spinal Anesthesia
- Transfusion Reaction
- Venous Air Embolism

3. Please describe HOW the Emergency Manual was used DURING THE MOST RECENT EVENT. **Please do not include any patient identifying information**

Free text:

4. For the SAME EVENT, please describe any facilitators, barrier, or limitations to effective use of the Emergency Manual

Free text:

5. For the SAME EVENT, please note any impact (good or bad) the Emergency Manual had on the patient's care

Free text:

6. During this SAME EVENT, the Emergency Manual helped the team deliver better care to the patient

- Strongly disagree
 - Disagree
 - Neither agree nor disagree
 - Agree
 - Strongly agree

Appendix D, Stanford Emergency Manual

http://web.stanford.edu/dept/anesthesia/em/semv3.1_digital.pdf?_ga=2.219553945.1406350378.1501440567-576169366.1501440567

[378.1501440567-576169366.1501440567](http://web.stanford.edu/dept/anesthesia/em/semv3.1_digital.pdf?_ga=2.219553945.1406350378.1501440567-576169366.1501440567)

Appendix E*Budget Table*

Nature of Expenditure/Item	Cost per Unit	# Units	Total Estimated Cost
Direct Costs			
500 sheet pack printer paper	\$13.63	1	\$13.63
Laminator	\$21.99	1	\$21.99
100 pack laminating pouches	\$8.23	2	\$16.46
100 pack paper rings	\$7.99	1	\$7.99
100 piece hanging wire	\$23.00	1	\$23.00
SPSS software 2 year subscription	\$114.00	1	\$114.00
TOTAL			\$197.07

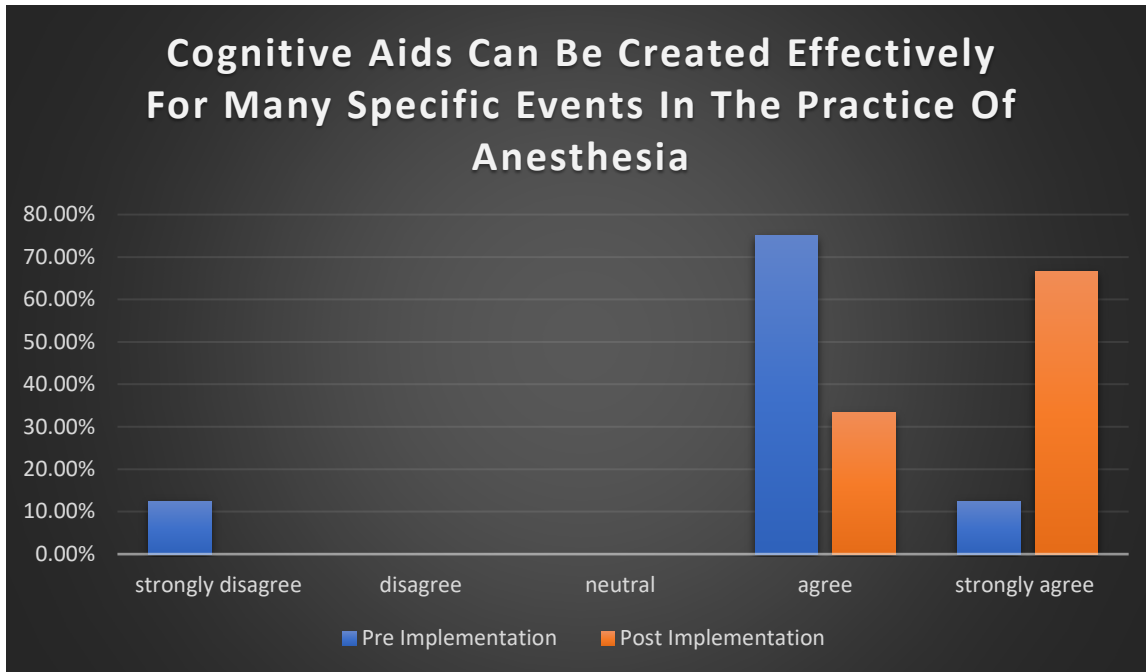
Table 1*Timeline Analysis*

Event	Date
Proposal Approval	September 2021
Pre-Implementation Survey E-mailed	Early October 2021
Implementation of Emergency Manual	Late October 2021
Post-Implementation Survey E-mailed	January 2022
Data Analysis	February 2022
Presentation of Results	February 2022

Appendix F

Pre Implementation (n=8)

Post Implementation (n=6)



Appendix G

Pre Implementation (n=8)

Post Implementation (n=6)

