The Use of Anesthesia Emergency Manuals for Intraoperative Crises

Valerie Cattano, Ingrid Emile, and Cara Seganti

Rutgers School of Nursing

DNP Chair: Maureen McCartney Anderson DNP, CRNA/APN

DNP Team Member: Thomas Pallaria DNP, CRNA/APN

Table of Contents

Abstract

Objective: A presentation and simulations were conducted to provide increased awareness and benefits of Anesthesia Emergency Manuals (AEMs), in order to increase its utilization during real crises that occur in professional practice.
Background: Anesthesia providers are often faced with new responsibilities and alterations in patient management. High stress conditions impair clinicians' ability to elicit evidence-based courses of management in an organized and timely manner. Recall and prospective memory of even the most experienced providers' declines during stressful situations. Emergency manuals introduced in anesthesia have improved compliance to guidelines during emergencies and improve patient outcomes. Practitioners who are introduced to cognitive aids during simulation training are more likely to use these checklists in a real emergency.
Study Design/Methods: This study is an experimental qualitative design. The study population is CRNAs (certified registered nurse anesthetists) and SRNAs (student registered nurse anesthetists). A pre-survey was administered, then the participants were given copies of the AEMs and a PowerPoint presentation was given regarding the efficacy of AEM use during OR emergencies. First a simulation scenario without the use of an AEM was conducted and then another simulation scenario with the use of AEM was conducted. Participants were debriefed and then an immediate post-survey was given. A follow-up survey was sent a month after simulations were conducted.
Conclusion: The results of this study supports that the use of AEMs improved adherence to critical steps in a crisis situation, while also supporting that simulations utilizing the AEMs increased future likelihood of AEM use.

Key Words: anesthesia, simulation, emergency manuals, anesthesia emergency manuals, cognitive aids, crisis, emergency

Introduction

Cognitive aids such as emergency manuals (EMs) and crisis checklists are increasingly becoming a topic of discussion as evidence continues to support their use in emergency situations. It has been estimated that for every 10,000 surgical operations there are 145 operating-room (OR) crises per year (Arriaga et al., 2013). Approximately 50% of adverse events that occur in the OR are avoidable errors (Gillespie & Marshall, 2015). Inefficient management of OR emergencies such as malignant hyperthermia or cardiac arrest, can lead to adverse outcomes (Huang, 2015). Utilization of cognitive aids during life and death situations in the OR proves to be a valuable resource in improving patient outcomes and preventing adverse events (Gillespie & Marshall, 2015; Goldhaber-Fiebert, Pollock, Howard, & Merrell, 2016; Hepner et al., 2017).

Many hospitals have supplied EMs in their ORs, however, many practitioners choose not to utilize these aids during emergency situations. Goldhaber-Fiebert et al. (2016) found less than half of anesthetists surveyed had used an EM at least once during a clinical event. Evidence suggests simulation training utilizing a cognitive aid enhances proper management of a crisis, leading to their increased use and maximized positive outcomes for emergent situations (Alidina et al., 2018; Goldhaber-Fiebert & Howard, 2013; Hepner et al., 2017). Arriaga et al. (2013) surveyed participants after partaking in a simulated crisis both with and without cognitive aids, and 97% reported they would continue to utilize a checklist after the simulations. Anesthesia professionals should be introduced to EMs or cognitive aids prior to emergency situations that arise in clinical practice (Alidina et al., 2018; Goldhaber-Fiebert et al., 2016; Hepner et al., 2017). This will allow them to be familiar with utilizing the tool during the critical event. Simulation-based training incorporating cognitive aids will enhance utilization of these

tools in future emergency situations in the operating-room (Alidina et al., 2018; Goldhaber-Fiebert et al., 2016; Hepner et al., 2017).

Background and Significance

Anesthesia care is constantly evolving. Anesthesia providers are often faced with new responsibilities and alterations in patient management. It can be very overwhelming to recall all the recommendations for management of a specific crisis, especially when that particular crisis is not often encountered. Time, efficiency, and execution of vital actions can be the distinction between life or death in operating room emergencies. In critical situations, clinicians are expected to make important decisions quickly, while providing well-coordinated and precise care. High stress conditions impair clinicians' ability to elicit evidence-based courses of management in an organized and timely manner (Goldhaber-Fiebert et al., 2016; Marshall, 2013).

Cognitive aids are commonly employed in other high-risk specialties that encounter stressful occurrences (Arriaga et al., 2013). Professions such as aviation and nuclear power utilize checklists to successfully manage emergency situations. In these vocations, cognitive aids are integrated into simulation training and are required to be implemented in actual critical events (Arriaga et al., 2013). Emergency manuals introduced in anesthesia have improved compliance to guidelines, leading to a decrease in adverse errors and patient morbidity and mortality (Wiggins et al., 2018). Practitioners who are introduced to cognitive aids during simulation training are more likely to use these checklists in a real emergency (Arriaga et al., 2013). Therefore, providing simulation training using cognitive aids to student registered nurse anesthetists (SRNAs) and certified registered nurse anesthetists (CRNAs) may increase the likelihood of using cognitive aids while in future professional practice.

Outcomes & Quality Measures

Management of operating room emergencies can be valued by assessing quality measures and patient outcomes. Although advances in patient safety has been evolving for many years, a true definition of patient safety is still not collectively recognized. However, Gluck (2012), defines patient safety as a healthcare discipline that employs "safety science methods" with the purpose of attaining responsible and honest methods of providing healthcare (p. 1149-1150). One must be able distinguish the difference between underlying illness and an adverse event. An adverse event can be defined as actual patient harm, that is considered preventable. Improper management of an emergency leading to an adverse event can result in decreased reimbursement from Medicare and thus incurred hospital costs (Gluck, 2012). Operating room emergencies are at increased risk for adverse events, and consequently increased institutional costs.

Initiating transformation with focus on quality and safety during continuing education, will provide the foundation for improving patient safety (Gluck, 2012). Enhanced patient safety can be accomplished with support from leadership, constant monitoring and adapting of methods, collaboration and feedback amongst team members, and encouragement from many levels of the institution with emphasis on patient safety. The aforementioned lay the groundwork for transforming patient safety and quality (Gluck, 2012).

Evidence supports that utilizing a checklist for emergency protocols will drastically improve patient outcomes. Checklists ensure the users do not miss critical steps during a crisis situation (Huang, 2015). Practitioners reported that use of a checklist during emergencies such as malignant hyperthermia and airway management resulted in less omissions, improved task organization, and overall enhanced team functioning (Marshall, 2013).

A comparison can be made between simulation-based training of emergency crises and

didactic methods. Familiarity with the EM prior to use in an actual emergency will increase the probability of implementing the EM habitually into practice (Huang, Parus, Wu & Zhang, 2018). Use of surgical safety checklists (SSC) can be related to the use of EMs. Compliance rates are most likely similar and routine usage of an SSC extensively varies from 12-100% with a mean of 75% (McGinlay, Moore, & Mironescu, 2015). Furthermore, staff reported that partial reasoning for non-use was improper training with SSCs. Compliance to implementation mainly suffers due to inadequate introduction of the cognitive aid, rendering stakeholder buy-in insufficient. This may be correlated to smaller institutions where everyone knows each other, and sufficient introduction of the EM was deemed unnecessary and thus skipped (McGinlay et al., 2015).

In 2013, the *New England Journal of Medicine* conducted a simulation-based trial from Harvard. Reports show that teams using cognitive aids missed 6% of critical steps, whereas teams without cognitive aids missed 23% of actions (Goldhaber-Fiebert & Howard, 2015). Evidence suggests that utilization of EMs in emergency situations will lead to a decrease in failure of the team to employ all evidence-based steps during management of the crisis (Hepner et al., 2017; Arriaga et al., 2013; Gillespie & Marshall, 2015). In one study, participants were surveyed after participating in a simulated crisis both with and without cognitive aids and 97% reported they would continue to utilize an intraoperative checklist (Arriaga et al., 2013).

There is overwhelming evidence that use of an EM can lead to improved patient outcomes and decrease morbidity and mortality rates, and thus decrease healthcare costs. However, there still appears to be a gap amongst knowledge and practice. Identifying barriers to utilization of EMs for emergency crises and determining evidence-based protocols for implementation, may alleviate this discontinuity between knowledge and practice. Furthermore, implementing simulation-based training and education on the use of EMs during continuing

education may promote stake-holder buy in and prevent resistance to their use.

Needs Assessment

Despite overwhelming evidence that the use of EMs limits the possibility of omitting critical steps during an emergency, there appears to be disparity when applying evidence into practice. There are several factors that prevent successful implementation of cognitive aids in the operating-room. It has been demonstrated that simply supplying EMs is inadequate in fostering quality and consistency of their use (Alidina et al., 2018; Goldhaber-Fiebert et al., 2016; Hepner et al., 2017). First and foremost, anesthesia providers must believe that EMs are paramount to patient safety. Stakeholder buy-in can be reinforced through statistics, education, and simulation (Goldhaber-Fiebert & Macrae, 2018; Hepner et al., 2017). Although it may be optimistic to say that a practitioner can successfully perform expert and comprehensive care, in reality this is difficult to accomplish due to the rarity of actual emergency situations (Isaak & Stiegler, 2016). Specifically, recall and prospective memory of even the most experienced providers' declines during stressful situations. Therefore, users must be familiar with the content of EMs before use in a crisis situation or it may not be properly implemented during the anxiety-fueled emergency (Goldhaber-Fiebert & Howard, 2013; Hepner et al., 2017; Isaak & Stiegler, 2016). Training, as well as refresher training is needed. These factors are key to establishing a favorable implementation environment.

On an institutional level, there are many considerations when aiming to successfully execute EMs into practice. Several studies found that leadership support is essential (Alidina et al., 2018; Goldhaber-Fiebert et al., 2016; Hepner et al., 2017). Placing EMs in both visible and an easily accessible area in each OR reinforces institutional support. Department meetings should be held to address the EMs and encourage constructive criticism in order to attenuate

apprehensions. These meetings can also be used to display approval from respected staff members or disseminate testimony validating the EMs use during crisis situations. This would further promote stakeholder buy-in. Implementation champions can be appointed to address questions or concerns, allowing staff to feel comfortable in the use of EMs. Higher success rates of EM implementation are directly correlated to the aforementioned factors, and institutions lacking these factors experienced deficient use amongst providers (Alidina et al., 2018; Goldhaber-Fiebert et al., 2016; Hepner et al., 2017).

Locally, an investigation was performed at a large university teaching hospital regarding the implementation of EMs in the ORs. An informal interview was also conducted with several stake-holders at this institution. It was found that implementation of EMs in the ORs was addressed via an email chain to OR staff. The email informed staff that the Stanford Manuals were located on the anesthesia carts and available for use. Since this email was sent several years ago and never readdressed, most present anesthesia providers were either not aware that their ORs contained EMs or they were unsure of their location. When inspecting the ORs for the tools, most rooms did not contain any EM. In rooms that did have them, they were located on the side of the anesthesia cart under a table top that flipped up. This was not an ideal location to notice or access the EM easily. After inquiring as to why some of the EMs were missing in rooms, it was found that some providers had taken them home with them or elsewhere to look through.

Problem Statement

Evidence supports the use of cognitive aids during emergency situations in the operating room. However, there seems to be several barriers to adoption and implementation of their use. Some hospitals have not yet supplied EMs to their staff. In hospitals that have supplied

emergency checklists, there seems to be insufficient use amongst providers (Alidina et al., 2018; Hepner et al., 2017). There appears to be a lack of uniformity in introducing and implementing EMs with hospital staff, and therefore cognitive aid use amongst anesthesia providers has been deficient (Alidina et al., 2018**;** Goldhaber-Fiebert et al., 2016). Crisis-simulation using EMs has proved to be one of the most important ways to effectively establish why EMs should be used and provides the skills necessary for implementation during practice (Goldhaber-Fiebert & Macrae, 2018). In order to combat some of the time and simulation equipment restraints affiliated with major organizations, it will be beneficial to introduce emergency manuals to nurse anesthesia residents and CRNAs. If SRNAs and CRNAs are educated about anesthesia emergency manuals and their efficiency and adherence to protocol is reinforced through simulation, then both SRNAs and CRNAs will be more likely to utilize the manuals in actual critical events.

Clinical Question

Will SRNA and CRNA use of anesthesia emergency manuals during crisis simulation increase efficiency and adherence to protocols for intraoperative crises, promoting future use of the EM in actual critical events?

Aims and Objectives

Inefficient management of patient care during an emergency can lead to adverse outcomes and increased patient mortality and morbidity, thus leading to increased hospital costs. Simulation training utilizing EMs are directly correlated to increased use of these cognitive aids during actual critical events, and thus may improve patient outcomes (Alidina et al., 2018; Goldhaber-Fiebert & Howard, 2013). The aim of this DNP project is to provide increased awareness and benefits of anesthesia emergency manuals in order to increase its utilization

during real crises that occur in professional practice. The objectives are to:

(1) Introduce Anesthesia EMs to SRNAs and CRNAs

(2) Volunteers will participate in simulated crisis situations without and then with the use of EMs

(3) Survey SRNAs' and CRNAs' opinion as to whether they found EMs to be beneficial and if they would be more likely to use it in their practice

Review of Literature

A comprehensive review of literature was conducted using the PRISMA process (Appendix A). The principal elements of the search consisted of the foundation and history of EM use in crisis management, requirements of a well-constructed cognitive tool, and simulation training for emergencies. Databases used were Pubmed, Scopus, Web of Science, Proquest, Ovid, and Google Scholar. A total of 240 non-duplicate articles were identified using the key-terms *emergency manuals*, *cognitive-aids*, *cognitive tools*, *crisis checklists*, *surgical checklists*, *operating room*, *anesthesia*, *emergency*, *critical events*, *crisis*, *crisis management*, *simulation-based training*, and *simulation*. Out of the non-duplicate articles found, 87 articles were discarded because the reviewed abstracts did not pertain to the use of cognitive aids during emergency situations. Inclusion criteria consisted of peer-reviewed articles, studies published within the past 10 years, English-language translation, and full-text availability. A total of 58 potential articles were identified. For quick reference and overview of the articles' evidence, refer to the table of evidence located in the appendices (Appendix B).

Fixation Error

Fixation errors are a form of cognitive fault where a provider will focus attention on a specific aspect of a problem while ignoring or taking into consideration other relevant

information and possible solutions. Fixation errors can be classified into three different categories. The first category is “this and only this” where only one resolution or diagnosis is considered for a problem. The second is “everything but this” where all other diagnoses are considered but the actual solution is not. The last category is “everything is ok” where the problem is not recognized or acknowledged (Ortega & Nasrullah, 2019). Fixation errors can significantly add to morbidity and mortality; hence, development of countermeasures must be made against fixation errors for patient safety (Fioratou, Flin, & Glavin, 2010).

Difficult airway management is still a significant problem in anesthesia. In an emergency such as an airway crisis, it is common for a provider to become fixated on one specific task. Over the years there has been improved developments in technology to aid in managing a difficult airway crisis, as well as written expert-based knowledge in the form of guidelines and algorithms. However, non-technical skills are also necessary in crisis in management. These skills include situational awareness, task management, decision making, and teamwork (Urtubia, Reviriego-Agudo, & Charco-Mora, 2018). Performance during a crisis is affected by high pressure, stress, and cognitive overload. Algorithms and guidelines are evidence-based best practice recommendations that commonly fail due to resistance and failure to implement. They exist to help the provider stop and think, problem solve, and manage a crisis ultimately helping to avoid fixation errors (Urtubia, Reviriego-Agudo, & Charco-Mora, 2018).

Aviation Industry

The parallels drawn between anesthesia and aviation are substantial. Both disciplines require readiness for crisis management at any moment in time. High risk decisions must be made during exceedingly stressful emergencies where lives are at stake. Experts in both professions must therefore exhibit meticulous practice in order to avoid detrimental errors

(Eltorai, 2018). Due to these significant similarities, the anesthesia field has adapted many strategies from aviation including the use of checklists and simulation training (Toff, 2010).

Since 1952, the Naval Air Arms and Airforce have worked to initiate improvement safety strategies. Analysis of unfavorable outcomes led to a change in pilot culture. Over the years, the aviation industry has manufactured several guidelines aimed to improve safety. During training, new pilots are instructed on standards of practice, thus establishing a strong foundation and preventing future errors. Cognitive aids have been successfully implemented into aviation training. The use of a checklist is one of the seven improvement standards introduced by the commercial airline safety organization (Kerber, 2014). The aviation industry has implemented simulation training using cognitive aids. Literature consistently demonstrates that the use of cognitive tools in simulation is valuable. The cognitive tool can function as an evaluation tool during educational training, allowing the user to ensure critical steps are consistently performed and enhance disclosure of the performance expected from the trainee (Wiggins, Morrison, Lutz, & O'Donnell, 2018).

The Airline Operations Manual is an essential part of the aviation industry's safety system. This manual contains up-to-date standard operating procedures and includes checklists for both normal and emergency situations. Pilots are not expected to recall the entire manual, but the manual should always be retrievable for reference. The Quick Reference Handbook only contains emergency checklists with explanations for reasons of different proposed actions and items to aid awareness of the current situation. This manual is kept in the cockpit where it can be quickly accessed (Toff, 2010).

Evidence supporting aviation emergency checklists.

In 2009, US Airways flight 1549 was forced to perform an emergency landing (Eisen &

Savel, 2009). The plane had flown into a flock of geese causing both engines to lose power. When the captain was alerted of the engine failure, he quickly instructed his first officer to obtain the flight emergency manual and run through the engine restart checklist. Briefly after being unsuccessful in restarting the engine, the captain determined that he would perform an emergency landing on the Hudson River. Once the plane landed, the first officer then ran through an evacuation checklist. Due to their systematic and efficient performance the captain and his first officer were able to save the lives of the 155 passengers that were onboard (Eisen & Savel, 2009).

The use of the emergency checklist and simulation training aided in the successful outcome of what could have been a tragedy (Eisen & Savel, 2009). Although the use of the checklist did not directly solve the problem of the engine failure, it helped save precious time by eliminating the thought that the engine could be fixed or restarted. The memory can sometimes be unreliable causing one to second guess steps to a procedure. This can lead to a "fixation error", where the provider repeatedly attempts to solve a perceived problem with the same maneuvers and do not consider other options. This is a common decisional error (Eisen & Savel, 2009). Through the use of the checklist, there was no need in continuously trying to fix the engine. The use of the checklist confirmed that each step in fixing the engine was followed correctly, so once fixing the engine was unsuccessful using the checklist it was no longer an option. The evacuation checklist was also used, facilitating the successful and safe evacuation of the passengers by the flight crew (Eisen & Savel, 2009).

Organizations Supporting Cognitive Aid Use

Use of anesthesia emergency manuals are endorsed by a collective of professional organizations known as the Council on Surgical and Perioperative Safety (CSPS) (Emergency

Manuals Implementation Collaborative, 2018). CSPS consists of many organizations including the American Association of Nurse Anesthetists (AANA), American Society of Anesthesiologists (ASA), and American College of Surgeons (ACS). World Health Organization (WHO) and Anesthesia Patient Safety Foundation (APSF) have also recommended the use cognitive aids during operating room crises. There is overwhelming support from professional organizations for implementation of EM or crisis checklists. However, it is evident there are barriers to application of their use. This has called for the development of a comprehensive plan to identify and conquer these barriers, with the intent to support EM use within the perioperative period amongst anesthesia providers.

The EMIC.

The Emergency Manuals Implementation Collaborative (EMIC) is a committee dedicated to encouraging use of emergency manuals in the perioperative setting and is endorsed by CSPS. In 2017, Harvard Ariadne Labs and Stanford Medicine partnered to form EMIC, in order to address barriers to anesthesia emergency manual use and provide resources for adaptation (OR Emergency Checklist Implementation Toolkit, 2019). They have jointly produced the operating room emergency checklist implementation toolkit (2019). The toolkit (2019) provides a step-by-step plan to help implement anesthesia cognitive aids within a professional organization.

The WHO.

In 2008, the WHO developed the Surgical Safety Checklist (SCC) as a means to decrease incidence of unsafe surgical care. The use of the checklist has been made a standard in thousands of operating rooms around the world. The SSC includes a “time out” procedure at different points throughout the perioperative period. The “time out” checklists include a “sign in” to the operating room, another prior to surgical start, and additional “time out” prior to the

patient leaving the operating room (WHO, 2008).

Other medical organizations.

Other professional organizations are encouraging that emergency checklists be made available (Hepner et al., 2017). The American Society of Regional Anesthesia and Pain Medicine recommends the checklist Local Anesthetic Systemic Toxicity (LAST) be accessible anywhere local anesthetics are being administered. High fidelity simulations were conducted, and it was found that the use of the LAST checklist resulted in better treatment, proper ACLS protocol, and improved management with the use of intralipids (Hepner et al., 2017).

The APSF.

In September of 2015, the APSF sponsored a workshop titled "Implementing and Using Emergency Manuals and Checklists to Improve Patient Safety" (Morell & Cooper, 2016). APSF President Dr. Stoelting and Dr. David Gaba operated as moderators. The goals of the conference were to increase the acceptance of emergency manuals and checklists amongst members of the perioperative care team. The conference included many stakeholders such as anesthesiologists, CRNAs, anesthesia associates, OR nurses and technicians, insurance providers, and companies associated with anesthesia interests. The conference started with an informative presentation led by Dr. Stoelting and addressed why emergency manuals and crisis checklists are indispensable in the anesthesia perioperative environment.

One presenter, Dr. William R. Berry, a principal research scientist at Harvard School of Public Health and chief officer for Ariadne Labs discussed recommendations for overcoming barriers to EM use (Morell, 2015). He notes that increased use of EMs will require not only dissemination of the EMs, but a major a culture shift to allow acceptance of the checklists. Checklists in medicine's viewpoint, are not synonymous with competence. Other

recommendations included highlighting that anesthesia providers' capacity to perform during a crisis may be distorted, additional evidence supporting the use of cognitive aids is needed to foster practitioner's belief in utilizing the checklists and change the culture, and finally, that training is needed to improve communication and teamwork (Morell, 2015).

After several other presenters, there were discussions and breakout sessions. Beneficial recommendations were developed during the breakout sessions. Some recommendations included creation of an "education/advocacy package" incorporating ways to implement EM use, the utilization of social media to maintain presence of proper use of EMs, and the presence of the manual during the pre-surgical timeout (Morell & Cooper, 2016). Based on APSFs recommendations, EMIC was developed and a toolkit for EM implementation was created (Emergency Manuals Implementation Collaborative, 2018).

History of Anesthesia Cognitive Tools

In 1924, Dr. Wayne Babcock was one of the first to highlight the importance of the use of emergency checklists (Arriaga et al., 2013). Then in 1988, the initial "catalog of critical events" for anesthesiologists was developed by David M. Gaba. Gaba's handbook is one of the earliest EMs created for anesthetic crises (Goldhaber-Fiebert & Howard, 2013). In 2004, after studies verify that many providers miss key steps during critical situations, Drs. Gaba, Harrison, Goldhaber-Fiebert, Lighthall, Fanning, and Howard developed pocket cards for perioperative critical events (Stanford Medicine, 2019). Next, Dr. Larry Chu published the Manual of Clinical Anesthesiology in 2011, which is a re-organized, visually appealing revision of the crisis management cognitive aids. In 2011, Harvard Ariadne labs developed and began to test their own original OR checklists, while Stanford Medicine launched a collation of 23 protocols that were already being tested in simulated crises. Several other checklists have been adopted within

certain specialties, such as the Labor and Delivery Crisis Checklists, Neuroanesthesia crisis checklists, checklist for trauma anesthesia, and Society for Pediatric Anesthesia checklists. Later, in 2017, Harvard Ariadne labs and Stanford Medicine came together to form EMIC with the goal of promoting successful implementation of OR emergency checklists (OR Emergency Checklist Implementation Toolkit, 2019). EMIC provides a comprehensive list of many of the anesthesia emergency checklists available.

Which Tool to Use?

The ideal cognitive tool assists in preventing the user from neglecting any critical tasks by guiding the user through a series of complex steps. The cognitive aid should consist of best practice guidelines and protocols, be relevant to the emergency situation at hand, be similar to format seen in training, and aid all team members in maintaining organization of tasks (Marshall, 2013). In order to increase efficiency during an emergency, the tool should be used in simulation so that team members can become familiar with its content (Marshall, 2013). In addition to the familiar and clearly readable content, the cognitive aid should be placed in easily accessible areas (Emergency Manuals Implementation Collaborative, 2018). The tools should also be able to be modified to fit the needs of each individual institution. Some cognitive tools that fit these descriptions and are currently being utilized in the clinical field are produced by Stanford Medicine and Harvard Ariadne labs.

Currently, there is widespread use of the Stanford Manual, which was expanded from Gaba's research. The Stanford Manual was produced in 2012, has most recently been updated in fall 2016, and is currently available for free download at http://emergencymanual.stanford.edu/. The newest update contains 26 of the most common OR emergency events. Cognitive aids such as the Stanford Manual have only been available for a short amount of time and therefore,

studies regarding their clinical implementation and use are only recently emerging in publications (Hepner et al., 2017). However, there is significant data supporting the use of these cognitive aids during simulation testing (Hepner et al., 2017; Stanford Medicine, 2019).

Another commonly used anesthesia emergency manual is known as Operating Room Crisis Checklists (Emergency Manuals Implementation Collaborative, 2018). This is a collective of the 12 most common anesthesia emergencies. It was originally produced in 2012 by Harvard Ariadne labs. The most recent publication was revised in April 2017 and is currently available for free download at www.projectcheck.org/crisis/html. Through the use of simulation testing, several studies' data support the use of these checklists during emergency situations (Arriaga et al., 2013).

Simulation-based Training

Emergency crises in the operating room can be multifarious, stressful, and prove to be defeating for even the most experienced healthcare providers. In order to combat the innumerable factors working against the clinician in such situations, the clinician must be educated and prepared for certain circumstances. Simulation-based training was first introduced by the aviation profession and then later adopted into the medical field. Simulation-based training provides learners with elaborate, yet controlled situations, allowing them to gain skills necessary for future emergency situations (Goldhaber-Fiebert & Howard, 2013; Hepner et al., 2017; Marr et al., 2012; Ziewacz et al., 2011). Scenarios for simulation are designed to address distinct goals, allowing the participant to apply their knowledge and execute a skill-set necessary to solve the problem at hand, all whilst in a controlled setting (Marr et al., 2012). Simulation-based training for medical emergencies has been shown to foster knowledge retention imperative for the management of medical crises and thus has become a pivotal educational tool to prepare

healthcare providers for emergencies and improve patient outcomes (Hepner et al., 2017; Marr et al., 2012; Ziewacz et al., 2011).

Studies have found that in order to successfully implement EMs into practice, providers must be familiarized with their content (Goldhaber-Fiebert & Howard, 2013; Hepner et al., 2017). Merely having the manual available during critical and stressful events does not ensure effective utilization during crisis situations. Simulation-based training using the EM acquaints users with its content and encourages stakeholder buy-in for future use. Debriefing after the simulations allows constructive criticism of errors, thus reinforcing necessary knowledge and skills required to successfully intervene in an operating-room emergency (Goldhaber-Fiebert & Howard, 2013; Hepner et al., 2017).

Emergency Manual Implementation

Several studies were conducted comparing the use and non-use of EMs during simulated critical event management. Hardy et al., (2018), Arriaga et al., (2013), Huang et al. (2018), and Ziewacz et al. (2011) assigned clinicians to two different groups which would either use the EM or recall management of critical events from memory. Each study consisted of an adequate sample size with experienced clinicians. The groups were scored based on their efficiency and adherence to recommended guidelines of the emergency events. In all four studies, it was shown that use of an EM during the simulated critical event was superior to memory recall. The participants were later surveyed regarding use of EMs during actual OR emergencies and results reflected an increased acceptance and use of EMs during actual critical events. Huang et al. (2018) found that greater than 85% of those surveyed had reported using an EM in at least one actual OR emergency after one year of their simulation implementation.

Although there is vast evidence supporting the use of EMs during simulated anesthesia related critical events, literature is lacking on actual EM implementation in real ORs. Only one study was found that contains data regarding EM implementation in a hospital setting. Gleich et al. (2019) implemented Stanford Anesthesia Emergency Manuals within a large academic anesthesia practice and observed important phases of the process from 2013 to 2016. However, this study contained many limitations and overall successful integration and implementation was not fully achieved. Gleich et al. (2019) introduced the EM at anesthesia departmental grand rounds and dispersed additional information via newsletters and their website. They conducted pre and post implementation verbal simulations with anesthesia attendings, anesthesia residents, CRNAs, and SRNAs. The staff were not required to use the EMs during post-implementation simulations. Unfortunately, statistical analysis between pre and post implementation was not performed due to limitations in sample size and many confounding variables. The article also does not mention any data regarding actual use of the EM during real critical events.

Theoretical Framework

Everett Rogers' diffusion of innovations theory is used as a conceptual framework to implement evidence-based research into practice (Appendix C). Rogers' theory describes the process by which new knowledge or *innovation* is disseminated amongst a social system and adopted or *diffused* into the practice and function of the system (Rogers, 2003). Rogers proposes that one should assume an innovation's perceived *attributes* influence rates of adoption of the innovation into practice (2003). The *attributes* which influence acceptance of an innovation are relative advantage, compatibility, complexity, trialability, and observability (Rogers, 2003). The individual must then decide to accept or reject the innovation before it to can be implemented (Rogers, 2003). Rogers's innovation-decision process consists of five pivotal components:

knowledge, persuasion, decision, implementation, and confirmation (Rogers, 2003; White & Dudley-Brown, 2012). The innovation-decision process occurs over the course of time via different communication channels within the social system (Rogers, 2003; White & Dudley-Brown, 2012).

Knowledge

Knowledge is acquired when a person is made aware of the innovation and obtains a modest appreciation for its purpose (Rogers, 2003; White & Dudley-Brown, 2012). In this project (Appendix D), the SRNAs and CRNAs will be presented with copies of the Stanford Anesthesia Emergency Manuals. The professionals will be able to explore the EMs contents and gain a general understanding of how they may be helpful in a crisis situation. A brief introduction to the Stanford Manual will be addressed.

At this first part of the process, the innovation's attribute of *complexity* becomes apparent. *Complexity* is defined as "the degree to which the innovation is perceived as difficult to understand and use" (Rogers, 2003, p. 16). The Stanford Anesthesia Emergency Manuals are durable, water-resistant, low flammability, easily storable, MRI-compatible, and content is easy to locate with tabs (Stanford Medicine, 2019). Stanford Medicine allows access to both electronic and physical copies, as well as customization to meet the needs of each local institution (2019). The Stanford Anesthesia Emergency Manuals are both user-friendly and can be molded to fit the individual needs of the user, therefore making the EM less *complex* and potentially easier for the individuals to adopt.

Persuasion

Persuasion occurs when additional information is gained, and the individual is able to form a positive or negative opinion about the innovation in question (Rogers, 2003; White &

Dudley-Brown, 2012). Persuasion can be described as presenting the social system, or in this case CRNAs and SRNAs, with evidence-based data to support the use of EMs in emergency situations. A PowerPoint presentation disseminating literary evidence to CRNAs and SRNAs will provide them with additional knowledge about EMs, allowing the individuals to form a stronger opinion on the matter. This stage of the innovation-decision process is where some additional *attributes* of the innovation will become apparent.

Relative advantage is defined as the perception of the innovation's superiority to the former practice it will now be replacing (Rogers, 2003). Cost, social perception, and satisfaction are some of the factors which are important to the individuals' assessment of *relative advantage* (Rogers, 2003). Presenting data on hospital costs of adverse OR events and comparing it to the cost implementing EMs may assist in increasing the CRNA & SRNAs perception of *relative advantage*, and therefore increase rates of adoptability. Unfortunately, social perception may decrease the rates of adoption because feelings of embarrassment may be unearthed if the individual needs to refer a checklist in order to guide crisis management.

Compatibility is defined as the perception of the innovation's parallels to current values, prior occurrences, and requirements of the prospective adoptees (Rogers, 2003). *Compatibility* and *relative advantage* have been viewed as very similar and are often used interchangeably (Rogers, 2003). However, preventative medicine is extremely important and is of great value to both CRNAs and SRNAs. EMs are a type of preventative innovation because their implementation provides a chance to lower the probability of a potential adverse event. Proving the EMs value in preventing negative outcomes will increase individuals' *compatibility* perception and therefore, increase the rate of adoption.

Decision

Decision involves the individual participating in activities which influence a choice to embrace or abandon the innovation (Rogers, 2003; White & Dudley-Brown, 2012). If CRNAs and SRNAs participate in simulations without and then with the use of EMs, the professionals will be able to relate the innovation to their own experience and have a deeper appreciation for the EM.

At this part of the process, the innovation's attribute of *trialability* comes into play. Rogers's defines *trialability* as the extent to which the innovation can be experimented with (2003). The potential adoptees can utilize the Stanford Anesthesia Emergency Manuals in a simulated crisis, allowing for a better understanding of the EMs function and usability. A trialable innovation allows the individual to learn by doing and therefore, renders a lesser degree of doubt within the innovation (Rogers, 2003). Additionally, the innovation's attribute of *observability* can be discerned. *Observability* is defined as the "degree to which the results of an innovation are visible to others (Rogers, 2003, p. 16). Simulation without the EM and then with the EM will provide the individuals with a comparison of their own performance during an emergency. Greater appreciation for use of the EMs during an emergency situation may be experienced, leading to an increased rate of adoption of the innovation.

Implementation

Implementation consists of the individual utilizing the innovation routinely in practice (Rogers, 2003; White & Dudley-Brown, 2012). For this part of the innovation-decision process, an immediate post-survey would be issued to both CRNAs and SRNAs who participated in the simulation activities. The post-survey would obtain data regarding the decision to accept or

reject use of the EMs, plans for future utilization EM in hospitals that already have them, and plans for advocating that their hospital should implement EM use.

Confirmation

Confirmation occurs when the individual re-evaluates the decision to adopt the innovation and makes another decision to either continue use or reject the previous decision (Rogers, 2003; White & Dudley-Brown, 2012). A one-month follow-up survey will be sent. This survey will gather data regarding actual continued use of EMs by the participants, if there is an increase in conversations about EMs amongst staff, and if any of the participants' hospitals decided to implement EMs. An increase in conversations about EMs amongst staff may indicate stakeholder buy-in.

Methodology

The purpose of this DNP project was to introduce and evaluate the effectiveness of Emergency Manuals during crisis situations in the operating room. CRNAs and SRNAs were presented with a Stanford Anesthesia Emergency Manual so they could examine it and understand the role it may play. A presentation was then be held to further present evidence on the use of EMs during emergency situations. Next, emergencies were simulated with volunteer CRNAs and SRNAs, first without and then with the use of an EM. A pre-survey, immediate post-simulation survey, and follow-up survey was completed to ascertain provider's likeliness and actual implementation of EMs into practice.

Setting

Implementation of this project was conducted at both [redacted] and the [redacted] (Appendix E). On September 16th and 23rd 2019, the presentation and simulations were

conducted with volunteer [redacted] SRNAs in the [redacted] simulation lab located [redacted]. On October 4th and 5th 2019, the presentation and simulations were held with volunteer SRNAs and CRNAs who attended the [redacted] fall meeting in a conference room located at the [redacted]. Simulations were held in a separate area with simulation equipment that was brought to the site.

Study Population

The study population was both volunteer CRNAs and SRNAs who attended the [redacted] fall meeting and who are currently enrolled as a student in the doctoral nurse anesthesia program at [redacted]. Inclusion criteria consisted of CRNAs and SRNAs who participated in the simulation activities. Exclusion criteria consisted of SRNAs who have not participated in clinical and CRNAs who are no longer practicing clinically. The study population is inclusive of 45 [redacted] SRNAs and 100 SRNAs and CRNAs who attended the [redacted] fall meeting. The total study population consists of 145 SRNAs and CRNAs. The sample population was achieved on a volunteer basis. Simulation groups consisted of 5 people. At both the [redacted] Site and the [redacted] fall meeting, simulations took place on 2 separate days, for a total of 4 days of simulations. The simulations were held throughout the day, at the convenience of the volunteers. The goal for the total sample size consisted of 106 participants. This sample size would allow a 95% confidence interval with a 5% margin of error. We reached a sample size of 54 simulation participants. This sample size allowed a 85% confidence interval with an 8% margin of error.

Subject Recruitment, Costs, and Compensation

Potential participants from the [redacted] SRNAs program were emailed flyers (Appendix F) by the program's administrative assistant, [redacted], a month prior to the September 9, 2019 monthly [redacted] Nurse Anesthesia Program meeting. At the program meeting, SRNAs

were informed about the processes of the study and asked to volunteer to participate for simulation days. Volunteers were asked to arrive at the indicated time on one of the designated days. Recruitment flyers (Appendix G) for CRNAs and SRNAs attending the [redacted] meeting were posted on the [redacted] website and included in the marketing for the fall 2019 meeting. The flyers listed the description, location, and time the presentations and simulations were held. Participants at the [redacted] meeting were asked to volunteer for simulations after they are informed about the processes of the study. There were no incurred costs amongst participants in this study and financial compensation was not provided to participants. The participants were only required to donate some of their time for participation in this study. It required approximately 60-90 min of time to complete the surveys, presentation, and simulation activities.

Consent Procedure and Risks/Harms

As per International Review Board (IRB) guidelines, human rights were protected for all participants in this study. Implied consent was accomplished when the participants voluntarily filled out the surveys, listened to the presentation, and participated in simulations. Hard copy consent forms (Appendix H) were provided before implementation of the project. Discussion of the study activities took place before implementation with all participants. Discussion of each step occured again as each of the activities were about to occur. At any point in time, the participants were free to withdraw their participation, and was reiterated throughout the course of the study. Contact information for the all investigators was made available for any inquiries regarding the study. There were no risks or harms to participants of this study.

Study Interventions

A pre-survey was given, then several Stanford Anesthesia Emergency Manuals were passed around for participants to look through. A PowerPoint presentation was then given.

The presentation included data regarding the efficacy of EM use during operating-room emergencies. The presentation also incorporated information concerning effectiveness of simulation-based training during emergency situations.

Multiple simulations utilizing 2 different scenarios were conducted. A group of 5 participants participated in one scenario with and then one scenario without the EM. This allowed participants to compare their own performances and foster an appreciation for the use of EMs in crisis situations. One scenario consisted of a malignant hyperthermia crisis (Appendix I) and the other consisted of venous air embolism (Appendix J). The written scenarios were constructed using the textbook Nurse Anesthesia by Nagelhout & Plaus (2014). This text provides the pathophysiology, clinical events, manifestations, and laboratory findings for each emergency. Causes and events that may lead to the emergency is thoroughly explained. This text was used as a guide to develop the scenarios for simulation use.

Efficacy of participants performance was assessed based completion of recommended guidelines by Stanford Medicine (2019) and timing of their completion (Appendix K and Appendix L). After both simulations were completed, the participants were presented with grading rubrics. The grading rubrics were synthesized from the Stanford Anesthesia Emergency Manuals. The Stanford Anesthesia Emergency Manual is a collective of cognitive aids that has been validated in multiple studies (Stanford Medicine, 2019). The anesthesia EM can function as an evaluation tool during educational training, allowing the participant to ensure critical steps are consistently performed and enhance disclosure of the performance expected from the trainee (Wiggins et al., 2018). The total time to completion and numbers of steps completed in both scenarios were documented and discussed with the participants after both simulations.

A post-survey was given immediately after the simulations to assess if they were now more willing to utilize EMs in future practice. A follow-up survey was sent via email November 6th, 2019 via Qualtrics, to assess if participants still valued the use of EMs in real clinical practice. Only 32 of the 54 participants responded.

Outcomes Measured

Outcomes were measured via data collected from the pre-survey (Appendix M), post-survey (Appendix N), and follow-up survey (Appendix O). All three surveys assessed basic demographic data. The pre-survey was used to ascertain a baseline assessment on participants knowledge and use of EM in their current clinical experience. It also provided the principle investigators (PIs) with the opinions of the participants on the usefulness of EMs and if they would consider actual use in practice. The post-survey given after the presentation and simulations, collected the same data as the pre-survey, which was useful in evaluating the intervention. The follow-up survey assessed the continued acceptance and utilization of EMs in the clinical area, which further supports the intervention.

The surveys were constructed utilizing a guide provided by Artino, La Rochelle, Dezee, and Gehlbach (2014). The provided guide was synthesized to help researchers develop well organized surveys and obtain the desired measurements. Surveys that are poorly designed and do not answer questions appropriately can lead to unreliable data that can interfere with results (Artino et al., 2014). A survey scale was used for more accurate measurement. Survey scales are a series of similar questions meant to assess all aspects of the intended construct. This allows for more detailed results than just asking a simple direct question. The mean score of the questions within the scale can then be used for the study (Artino et al., 2014). Artino et al. (2014), discussed seven steps that can be used in creating a survey. The first step consists of

conducting a literature review, the second step entails conducting interviews, and the third step involves synthetizing the literature review and interviews. Step four requires developing the items. Steps one through four were completed when initiating this study. The survey questions were developed utilizing data obtained from the literature review and interviews with the stakeholders. Next, step five requires expert validation. Expert validation is carried out to assess relevancy of the questions in the survey with regards to the intended construct (Artino et al., 2014). This was done through a literature review. The investigators developed the questions utilizing the studies of expert researchers of previously conducted research. A focus on studies results and discussions, such as common barriers, were used to construct the surveys questions. Cognitive interviews and a pilot test are steps six and seven, respectively. Although an official pilot test was not done, the researchers disclosed the questionnaires to additional members of the profession, allowing assessment of the reliability of the items and confirmation that the questions are interpreted as intended.

Project Timeline

This project was completed over the course of a year (Appendix P). The first part of the project consists of developing the DNP Project Proposal. A proposal presentation to members of the DNP Project Team was held May 13th, 2019 for approval to submit to IRB. The project proposal was submitted to IRB on May 20th, 2019. IRB approved this project on July 19th, 2019 and then an email of the SRNA flyer was sent out to the [redacted] SRNAs on August 9th, 2019. On September 16th and 23rd, 2019 the presentations and simulations were conducted with [redacted] SRNAs. In October 4th and 5th, 2019 presentations and simulations were conducted with SRNAs and CRNAs at the [redacted] fall meeting. Follow-up surveys were sent November 4th, 2019. Data was analyzed through October to December 2019, after different phases of

implementation was completed. The results of this project were made available for distribution and defense of the of this project was held on January 20th, 2020.

Resources Needed

There are several items that were needed to complete the simulation activities for this project. The Stanford Emergency Manual is available for free download online. This was printed and distributed to participants. The simulation lab was used at [redacted] campus to conduct [redacted] SRNA simulations. Portable simulation equipment was provided by the [redacted]. There were little to no costs incurred for the PIs. The manuals were about a total of $10 to print.

Evaluation

Evaluation of the DNP project was completed to assess if increased awareness and simulation-based training with EMs encouraged the use of EMs in clinical practice. Methodology consisted of mainly of qualitative data attained via the provided surveys. A large enough sample population was achieved, thus increasing the validity of findings. Accuracy of findings was validated through constant consultation with several [redacted] faculty members regarding the correct approach to both implementation and data analysis.

Maintenance & Security

This research study was anonymous. No personal information including email addresses were linked to the surveys that can identify who the participant is. The only recorded and saved information was the surveys. The paper and electronic surveys were kept in the DNP Chair's locked office cabinet until the project was officially completed. The electronic surveys were kept on a password-protected USB drive only accessible to the PIs and DNP Chair. The paper surveys were disposed of in a shredding bin and the electronic surveys were erased from the

USB drive after project completion. The paper pre and post surveys were collected with no personal identifiers on them. The electronic follow-up surveys were distributed to all [redacted] meeting attendees via the [redacted] President who already had all attendee email addresses. The electronic follow-up surveys were distributed to all of [redacted] SRNAs via the Program Administrative Assistant who already had all of the [redacted] SRNAs email addresses. Study participants were informed to anticipate a follow-up email from either the [redacted] president or the Program's Administrative Assistant and to please complete the anonymous online survey. In this regard, no email addresses or personal information of participants was kept by the PIs. The participants emails were not be linked to survey responses in any way.

Data Analysis

Through consultation with [redacted] faculty, the PIs developed a strategy to generate the highest statistically significant results. Convenience sampling was used to obtain volunteers to participate in this study. In order to enhance validity of the findings, a target sampling size of 106 participants was desired. A sample size of 54 participants was achieved. After the data was collected, the PIs completed a statistical analysis. Descriptive statistical analysis was performed to interpret the data.

Results

After implementation, there was a total of 54 participants' pre and post survey responses that could be analyzed. The 54 participants consisted of 40.8% CRNAs and 59.2% SRNAs. Of these participants, 37% have been practicing for less than 1 year, 31% for 1-5 years, 13% for 5-10 years, and 19% for more than 10 years (Appendix Q; Appendix R). Before the intervention, the presurveys indicated that 35% of respondents did not know what an anesthesia EM was, while 22% remained neutral, and 43% knew what an anesthesia EM was. After the intervention,

the postsurveys indicated that 2% of respondents did not know what an anesthesia EM was, while 2% remained neutral, and 96% now knew what an anesthesia EM was (Appendix S). Before the intervention, the presurveys indicated that 6% of the participants thought the use of an EM would not help during an actual crisis, while 22% remained neutral, and 72% thought the use of an EM would help during an actual crisis. After the intervention, the postsurveys indicated that 2% of the participants thought the use of an EM would not help during an actual crisis, while 2% remained neutral, and 96% thought the use of an EM would help during an actual crisis (Appendix T). For data gathered on both the pre and post surveys, about 33% stated that their institution did not provide readily accessible EMs in their clinical area, while 33% remained neutral, and 34% stated that their institution provided readily accessible EMs in the clinical area. For data gathered on both the pre and post surveys, about 70% had not used an EM during an actual crisis, while 11% remained neutral, and 19% had used an EM during an actual crisis. Before the intervention, the presurveys indicated that 5% of respondents would not use an EM during an actual crisis, while 19% remained neutral, and 76% would use an EM during an actual crisis. After the intervention, the postsurveys indicated that 0% of respondents would not use an EM during an actual crisis, while 2% remained neutral, and 98% would use an EM during an actual crisis (Appendix U). Before the intervention, the presurveys indicated that 4% of respondents would not recommend the use an EM during a crisis, while 22% remained neutral, and 74% would recommend the use an EM during a crisis. After the intervention, the postsurveys indicated that 0% of respondents would not recommend the use an EM during a crisis, while 2% remained neutral, and 98% would recommend the use an EM during a crisis (Appendix V). For data gathered on both the pre and post surveys, the greatest barrier to utilizing an EM was accessibility accounting for 55% of responses, 30% due to lack of training,

7% due to fear of being judged, and 8% stated they do not think to reference a cognitive aid while under stress (Appendix W).

After implementation, follow-up surveys were sent out after a month. A total of 32 participants' follow-up surveys could be analyzed. The responses consisted of 21.9% CRNAs and 78.1% SRNAs (Appendix X). Of these responses, 44% have been practicing for less than 1 year, 41% for 1-5 years, 6% for 5-10 years, and 9% for more than 10 years (Appendix Y). In the follow-up survey, 15% of participants stated they had not recommended or discussed the use of an anesthesia EM for a crisis situation at their institution, while 19% remained neutral, and 66% of the respondents stated they have recommended or discussed the use of an anesthesia EM for a crisis situation (Appendix Z).

Discussion

Through the research that was conducted, it was predicted that SRNA and CRNA use of EMs during crisis simulation would increase effectiveness and adherence to guidelines for intraoperative emergencies as compared to memory-based management. During crisis simulations, it was found that more critical steps were carried out when using the EM than when utilizing memory alone, which supported other literature. With the introduction of this study, the PIs increased emergency manual awareness and introduced proper use of the manuals. By introducing the EM, providing data supporting the use of EMs in crisis situations, and providing simulation training utilizing the EMs, these interventions increased the willingness of future use of EMs during real OR emergency situations. Post-simulation surveys had a positive correlation with increased likelihood of use of EMs in future situations, shown by a 23% increase from negative to positive responses. Although there were low response rates for the follow-up surveys, the majority of the respondents stated they have recommended or discussed the use of

an anesthesia EM for a crisis situation, thus supporting the original predictions and other literature.

Implications for Clinical Practice

According to the results of this study, utilizing EMs in real OR crisis situations will improve efficiency and management of patient care, thus leading to improved patient outcomes and decreased incurred hospital costs. Stanford Anesthesia Emergency Manuals are a relatively small cost compared to future larger costs related to patient morbidity and mortality rates. Thus, EMs can be described as a preventative medicine tool.

Implications for Healthcare Policy

In order for sustainability of the utilization of EMs to occur, hospitals may need to implement a specific EM policy and provide the EMs to staff. Specific guidelines about when to use the EMs should be given, as well as instructions as to return the EM to its original spot after use. The EMs should be placed in every OR in an easily accessible area, such as attached to the anesthesia machine and code carts. Support from administration and leadership will be needed to maintain the use of EMs during crises. Other members of the OR staff, such as nursing, should be informed and instructed on when to implement the use of an EM and where the manuals are located. The manuals should be addressed in monthly meetings for both anesthesia and nursing staff, in order to support their use during emergencies.

Implications for Education

When first implementing the EMs, an educational meeting should be held with all staff. The meeting should discuss the benefits and uses, as well as the data supporting their use in real life crises. Simulations, although hard to coordinate in large institutions, may prove to be beneficial to maintain EM use over time. Simulations using the EMs have been proven to

increase the likelihood of use during real OR crises. The education departments can implement crisis simulations as part of continuing education credits. This would give staff incentive to participate.

Implications for Quality/Safety

After a crisis occurs, debriefing should be held with OR staff that participated in the crises. In addition to discussion of the events and their feelings, the practitioners should be encouraged to discuss how the use of the EMs aided or hindered the outcome of the event and what they could do in the future to improve their use. Management should review these recommendations and discuss or implement them in future meetings.

Limitations

Although participant feedback on the methodology of this study was positive, there may be several limitations. Due to the different settings of implementation, there were some variations to the equipment on hand. This may have affected participants' engagement in the simulations, overall affecting their views on anesthesia EMs. Another limitation seen was that the pre and post surveys were handed in person and collected with responses right away, while the follow-up surveys were sent via email later on. The lack of responses on the follow-up surveys could be due to the participants not checking their email, opening the email and then forgetting to complete it at a later time, or possible survey fatigue. Another limitation noted may have been that the participants pre and post surveys were not linked, thus restricting the statistical measures that could be used to analyze the data. Another limitation may have been the study population size; a larger population size would have added increased validity to our findings.

Sustainability & Plans for Future Scholarship

Dissemination of the results of this study occurred during [redacted] DNP oral and poster presentations, which was made available to the entire [redacted] University. The results of this study were also presented at the [redacted]'s Spring 2020 meeting, allowing SRNAs and CRNAs, the target population, to understand the impact that anesthesia EMs can have on their patient outcomes. This study was also submitted to the anesthesia and analgesia journal for publication.

Simulations using anesthesia EMs during crisis situations will be implemented with future SRNAs in the [redacted] Simulation lab, as a part of their education curriculum. Future SRNAs will be exposed to the EMs and benefits of their use, increasing their likelihood to use in future practice. Crisis simulations using the anesthesia EMs can also be implemented at future CRNA conferences. CRNAs can have the opportunity to earn continuing education credits by participating in the simulations, while also solidifying their practice with EMs.

Conclusion

Emergency situations in the operating room can prove to be challenging for even the most experienced anesthesia providers. Cognitive tools such as emergency manuals have been introduced to the medical field, allowing enhanced efficiency and management of crisis situations. An abundant amount of literature supports the use of anesthesia EMs during operating room emergencies as a way improve patient safety and outcomes. Although data encourages the use of anesthesia EMs, many providers are not utilizing such tools. This project aimed to augment awareness and understanding of anesthesia EM use, in order to increase the use of EMs in professional practice. Simulation-based training utilizing EMs appears to be a leading factor in providers decisions to accept or reject the use of the tool. Therefore, this study implemented simulation-based training with EMs and analyzed the impact of this intervention.

This study supported that the use of EMs improved adherence to critical steps in a crisis situation, while also supporting that simulations utilizing the EMs increased future likelihood of EM use.

References

Alidina, S., Goldhaber-Fiebert, S. N., Hannenberg, A. A., Hepner, D. L., Singer, S. J., Neville, B. A., … Berry, W. R. (2018). Factors associated with the use of cognitive aids in operating room crises: A cross-sectional study of US hospitals and ambulatory surgical centers. *Implementation Science, 13*(50), 1-12. doi:10.1186/s13012-018-0739-4

Arriaga, A. F., Bader, A. M., Wong, J. M., Lipsitz, S. R., Berry, W. R., Ziewacz, M. D., … Gawande, A. A. (2013). Simulation-based trial of surgical-crisis checklists. *The New England Journal of Medicine, 368*(3), 246-253.

Artino, A. R., La Rochelle, J. S., Dezee, K. J., & Gehlbach, H. (2014). Developing questionnaires for educational research: AMEE Guide No. 87, *Medical Teacher, 36*(6), 463-474. doi: 10.3109/0142159X.2014.889814

Eisen, L., & Savel, R. (2009). What went right: Lessons for the intensivist from the crew of US Airways Flight 1549. *Chest, 136*(3), 910–917. doi:10.1378/chest.09-0377

Eltorai, A. (2018). Lessons from the sky: An aviation-based framework for maximizing the delivery of quality anesthetic care. *Journal of Anesthesia, 32*(2), 263-268. doi:10.1007/s00540-018-2467-y

Emergency Manuals Implementation Collaborative. (2018). *About us*. Retrieved from https://www.emergencymanuals.org

Gillespie, B. M., & Marshall, A. (2015). Implementation of safety checklists in surgery: A realist synthesis of evidence. *Implementation Science, 10*(137), 1-14. doi:10.1186/s13012-015-0319-9

Gleich, S. J., Pearson, A. S., Lindeen, K. C., Hofer, R. E., Gilkey, G. D., Borst, L. F., … Martin, D. P. (2019). Emergency manual implementation in a large academic anesthesia

practice: Strategy and improvement in performance on critical steps. *Anesthesia & Analgesia, 128*(2), 335-341. doi: 10.1213/ANE.0000000000003578

Gluck, P. A. (2012). Patient safety: Some progress and many challenges. *Obstetrics & Gynecology, 120*(5), 1149-1159. doi:10.1097/AOG.0b013e31826feaa0

Goldhaber-Fiebert, S. N., & Howard, S. K. (2013). Implementing emergency manuals: Can cognitive aids help translate best practices for patient care during acute events? *Anesthesia & Analgesia, 117*(5), 1149-1161. doi:10.1213/ANE.0b013e318298867a

Goldhaber-Fiebert, S. N., & Macrae, C. (2018). Emergency manuals: How quality improvement and implementation science can enable better perioperative management during crises. *Anesthesiology Clinics, 36*(1), 45-62. doi:10.1016/j.anclin.2017.10.003

Goldhaber-Fiebert, S. N., Pollock, J., Howard, S. K., & Merrell, S. B. (2016). Emergency manual uses during actual critical events and changes in safety culture from the perspective of anesthesia residents: A pilot study. *Anesthesia & Analgesia, 123*(3), 641-649. doi:10.1213/ANE.0000000000001445

Hardy, J., Gouin, A., Damm, C., Compere, V., Verber, B., & Dureuil, B. (2018). The use of a checklist improves anaethesiologists' technical and non-technical performance for simulated malignant hyperthermia management. *Anaethesia Critical Care & Pain Medicine, 37*(1), 17-23. doi: 10.1016/j.accpm.2017.07.009

Hepner, D. L., Arriaga, A. F., Cooper, J. B., Goldhaber-Fiebert, S. N., Gaba, D. M., Berry, W. R., … Bader, A. M. (2017). Operating room crisis checklists and emergency manuals. *Anesthesiology, 127*(2), 384-392. doi:10.1097/ALN.0000000000001731

Huang, J. (2015). The initial steps of operating room emergency checklist. *Journal of*

Clinical Anesthesia, 27, 692-693. doi:10.1016/j.jclinane.2015.05.003

Huang, J., Parus, A., Wu, J., & Zhang, C. (2018). Simulation competition enhances emergency manual uses during actual critical events. *Cureus, 10*(8), 1-8. doi:10.7759/cureus.3188

Fioratou, E., Flin, R., & Glavin, R. (2009). No simple fix for fixation errors: cognitive processes and their clinical applications. *Anaesthesia, 65*(1), 61-69.

Isaak, R. S., & Stiegler, M. P. (2016). Review of crisis resource management (CRM) principles in the setting of intraoperative malignant hyperthermia. *Japanese Society of Anesthesiologists, 30*, 298-306. doi:10.1007/s00540-015-2115-8

Kerber, C. (2014). Changing our culture: Adopting the military aviation safety system. *Journal of NeuroInterventional Surgery, 6*(5), 332-341. doi:10.1136/neurintsurg-2013-011070

Marr, M., Hemmert, K., Nguyen, A. H., Combs, R., Annamalai, A., Miller, G., … Cohen, S. M. (2012). Team play in surgical education: A simulation-based study. *Journal of Surgical Education, 69*(1), 63-69. doi:10.1016/j.jsurg.2011.07.002

Marshall, S. (2013). The use of cognitive aids during emergencies in anesthesia: A review of the literature. *Anesthesia & Analgesia, 117*(5), 1162-1171. doi:10.1213/ANE.0b013e31829c397b

McGinlay, D., Moore, D., & Mironescu, A. (2015). A prospective observational assessment of surgical safety checklist use in Brasov Children's Hospital, barriers to implementation and methods to improve compliance. *Romanian Journal of Anesthesia and Intensive Care, 22*(2), 111-121.

Morell, R. C. (2015). APSF workshop and EC Pierce lecture address importance of cognitive aids. *Newsletter: The Official Journal of the Anesthesia Patient Safety Foundation, 29*(3), 41-64. Retrieved from https://www.apsf.org/article/apsf-workshop-and-ec-pierce-lecture-

address-importance-of-cognitive-aids/

Morell, R. C., & Cooper, J. B. (2016). APSF sponsors workshop on implementing emergency manuals. *Newsletter: The Official Journal of the Anesthesia Patient Safety Foundation, 30*(3), 45-76. Retrieved from https://www.apsf.org/article/apsf-sponsors-workshop-on-implementing-emergency-manuals/

Nagelhout, J. J., & Plaus, K. L. (2014). *Nurse anesthesia* (5th ed.). St. Louis, MI: Elsevier Saunders.

OR Emergency Checklist Implementation Toolkit. (2019). *Everything you need to implement the checklists.* Retrieved from https://www.implementingemergencychecklists.org/

Ortega, R., & Nasrullah, K. (2019). On reducing fixation error. *Newsletter: The Official Journal of the Anesthesia Patient Safety Foundation*, *33*(3), 102. Retrieved from https://www.apsf.org/article/on-reducing-fixation-errors/

Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). New York, NY: Free Press.

Stanford Medicine. (2019). Emergency manual: Implementation tips. Retrieved from http://emergencymanual.stanford.edu/implementation_tips.html#_Toc_8

Toff, N. (2010). Human factors in anaesthesia: Lessons from aviation. *British Journal of Anaesthesia*, *105*(1), 21-25. doi:10.1093/bja/aeq127

Urtubia, R., Reviriego-Agudo, L., & Charco-Mora, P. (2018). Vortex: What is the expected contribution of this novel approach to airway management? *Trends in Anaesthesia and Critical Care*, *20*, 37-42.

Wiggins, L., Morrison, S., Lutz, C., & O'Donnell, J. (2018). Using evidence-based best practices of simulation, checklists, deliberate practice, and debriefing to develop and improve a regional anesthesia training course. *AANA Journal, 86*(2), 119-126.

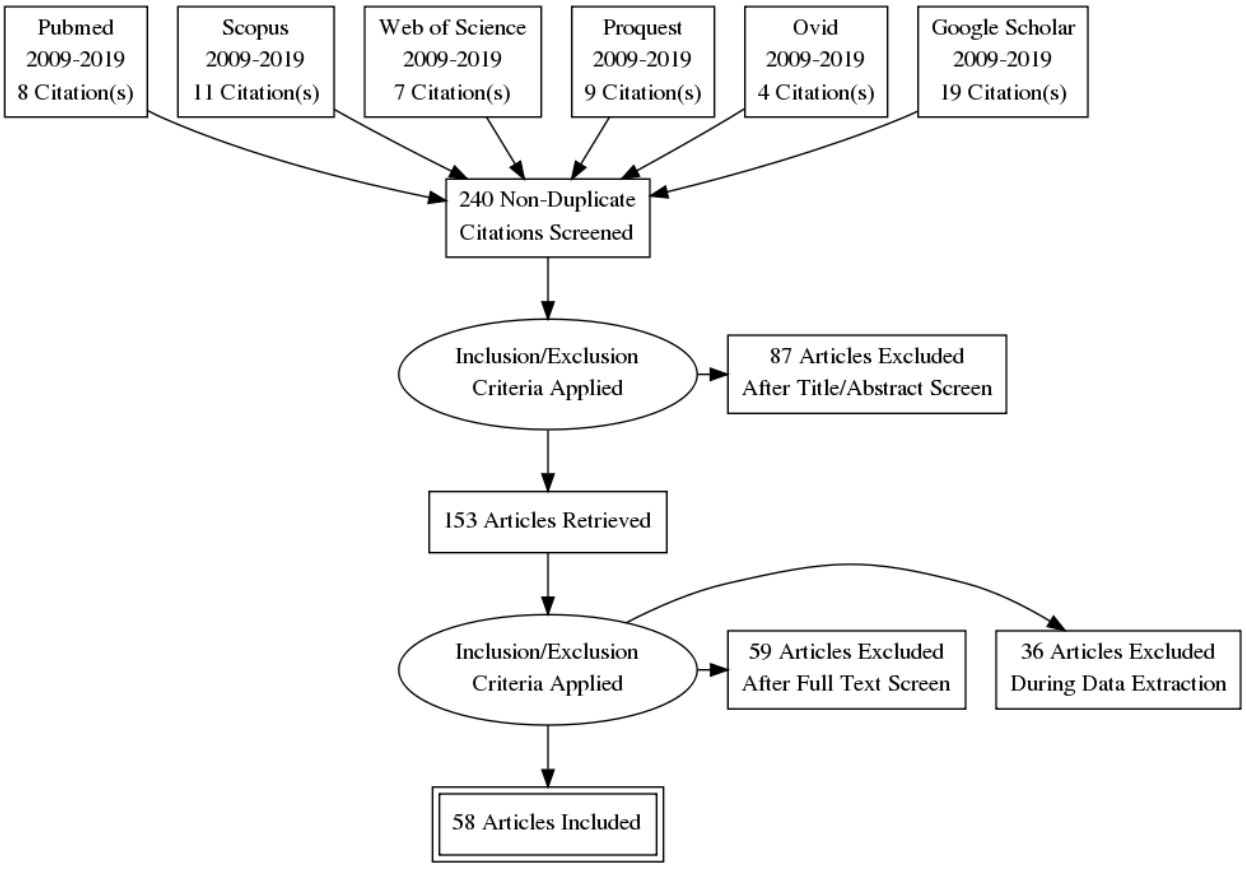
White, K, & Dudley-Brown, S. (2012). *Translation of evidence into nursing and health care practice*. New York, NY: Springer Publishing.

World Health Organization. (2008). *World alliance for patient safety: Implementation manual surgical safety checklist* (1st ed.). Retrieved from https://www.who.int/patientsafety/safesurgery/ss_checklist/en/

Ziewacz, J. E., Arriaga, A. F., Bader, A. M., Berry, W. R., Edmondson, L., Wong, J. M. … Gawande, A. A. (2011). Crisis checklists for the operating room: Development and pilot testing. *Journal of American College of Surgeons, 213*(2), 212-217. doi:10.1016/j.jamcollsurg.2011.04.031

Appendix A

PRISMA Table



Appendix B

Evidence Table

Article #	Author & Date	Evidence Type	Sample, Sample Size, & Setting	Study findings that help answer the EBP question	Limitations	Evidence Level & Quality
1	Alidina et al., 2018	Experimental study with meta-analysis	368 respondents from US hospitals and ASC who downloaded OR cognitive aids between January 2013-January 2016	Successful implementation was associated with leadership support and dedicated time to train staff.	Outcome measure can be a perception rather than actual measurement. Responses were via email, therefore, there is a risk for duplicate responses. Survey was given a single time, limiting sustainability.	I/A
2	Arriaga et al., 2013	Randomized control trial	ORs in 3 different institutions. 17 OR teams simulated 106 crisis scenarios.	Team performance was improved with utilization of the checklist versus simulation of a crisis from memory alone.	Surgeons were absent during most of the simulations. Small study population.	I/A
3	Eltorai, 2018	Consensus panel	N/A	Simulation based studies used in aviation can parallel those in anesthesiology. Simulation will allow anesthesiologists to review their challenges, mistakes, and opportunities for improvement.	N/A	IV/A

4	Gillespie & Marshall, 2015	Systematic review of a combination of RCTs	N/A	The use of SSC can be more successful if staff are actively participating in implementation. Evaluation of the implementation may further enhance participation in practice.	Quality of review is only as strong as primary studies. The intervention delivery may be unreliable. The reviewer's judgement cannot be homogenous.	I/A
5	Gleich, 2019	Quasi experimental with meta-analysis	59 pre-implementation participants including physician anesthesiologists, resident physicians, CRNAs, and SRNAs. 60 in the post-implementation at [redacted] in Rochester, MN.	Simulation pre-implementation resulted in 16 out of 30 steps. Simulation post-implementation resulted in 19.5 out of 30 of the critical steps.	Results are not generalizable. Only anesthesiology personal were included. There was no reliable control group.	II/B
6	Gluck, 2012	Clinical practice guidelines	N/A	Reformation in medical education can help transform culture and enable expert management for patient safety.	N/A	IV/A
7	Goldhaber-Fiebert & Howard, 2013	Consensus panel	N/A	Utilizing a framework to implement EM use in simulation will help improve patient care.	N/A	IV/A
8	Goldhaber-Fiebert & Macrae, 2018	Consensus panel	N/A	Performance during a crisis significantly increases when a cognitive aid was used.	N/A	IV/A

9	Goldhaber-Fiebert et al., 2016	Pre-posttest quasi experimental	34 pre-implementation surveys. 42 post-implementation surveys.	There is a positive correlation for increased use of a EM during an event and increase personal use during self-review, intra-operative educational resource, review of EM before a patient's case, and post- event EM after a crisis	Single academic center with one study population. Survey questions were not validated with psychometric analysis. Survey did not undergo pilot testing. Surveys can be criticized for having low response rate. Only anesthesia residents were surveyed.	II/A
10	Hardy et al., 2018	Two group randomized control	12 anesthesiologists in checklist group. 12 anesthesiologists in control group.	Anesthesiologists who utilized the checklist had higher performance scores than those who did not. Treatment dose of dantrolene was administered in 15.7 minutes with manual use versus 22.4 minutes in the control group.	Checklist used was simulation not actual crisis	I/A
11	Hepner et al., 2017	Clinical practice guidelines	N/A	97% of participants in a simulation study would want to use a checklist if one were available in an emergency.	N/A	IV/B
12	Huang, 2015	Literature Review	N/A	Utilization of a checklist results in significant	N/A	V/B

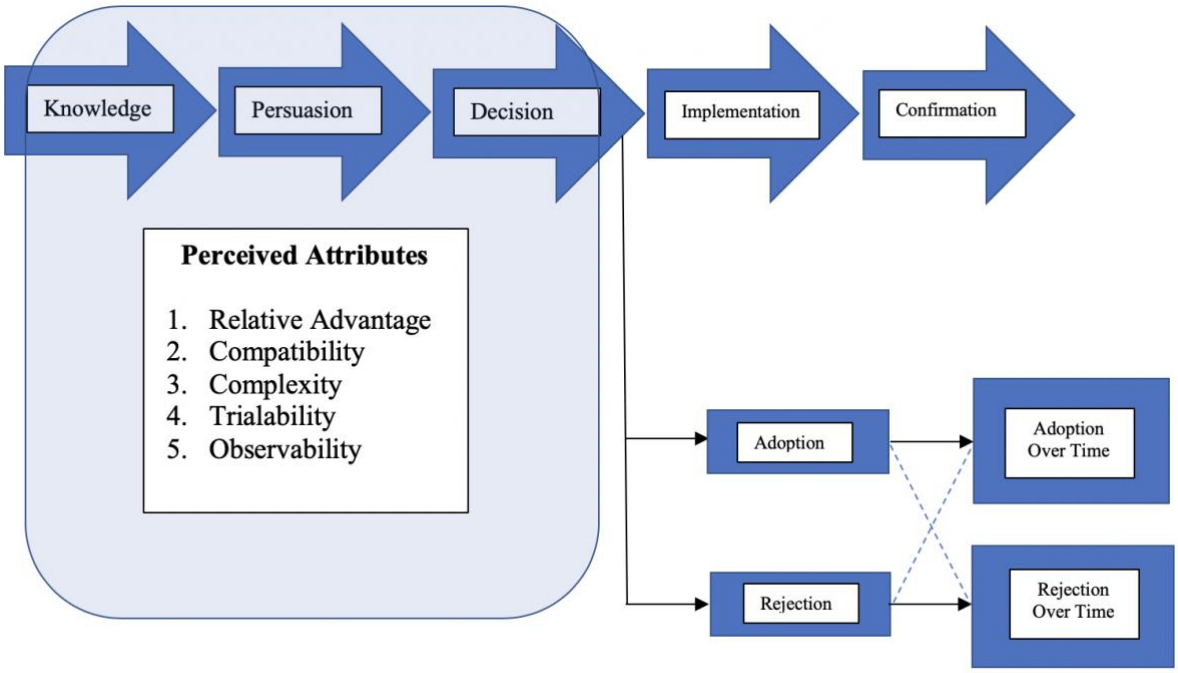
				improvement of outcomes in OR emergencies.		
13	Huang et al., 2018	Pre- posttest quasi experimental	106 anesthesia providers in 2 different hospitals	There is an increased use of EMs post simulation	Anesthesia delivery in China is not standardized, therefore, differences may exist of what an actual critical event includes. Accuracy and honesty cannot be verified after asking participants to recall critical events.	II/A
14	Isaak & Stiegler, 2016	Literature Review	N/A	Utilizing crisis resource management can provide expert management in an emergency.	N/A	III/B
15	Kerber, 2014	Consensus panel	N/A	A change in culture to use checklists can reduce morbidity and mortality.	N/A	IV/B
16	Marr et al., 2012	Quasi experimental study with meta-analysis	30 case videos were analyzed involving 44 residents pre-simulation and post-simulation in a New York State level I trauma center.	Simulation provides a low stress learning environment for real life emergencies. Simulation can result in improved team interaction and enhancement of patient care.	Clinical performance may differ between participants particularly, residents. Types of traumas and their severity may have differed between pretraining and post training.	II/A

17	Marshall, 2013	Literature Review	N/A	Sufficient training in the use of an emergency manual is lacking. It is reasonable to predict simulation prior to actual use of an EM may increase its effectiveness.	N/A	III/A
18	McGinlay et al., 2015	Quasi experimental with meta-analysis	Adherence to the SSC was assessed on 40 surgeries over a 10-day period. 5 nurses, 5 doctors, and 5 registrars were then asked questions inquiring ways to improve the checklist.	Implementation of an SSC resulted in significant reductions in incidence of deaths and complications. Particularly, understanding the checklist is likely the reason for the improved outcomes.	Only 40 operations were included with only 15 evaluations by staff. Patients outcomes were not assessed. The type of formal training the staff underwent was not asked. The participants knew the use of the checklist was being monitored, which may have caused Hawthorne effect.	II/A
19	Toff, 2010	Clinical Practice Guideline	N/A	It is apparent more training is needed to encourage use of a guideline. Practitioners may be hesitant to use a protocol due to fear of judgment.	N/A	IV/B
20	Wiggins et al., 2018	Pre-test posttest quasi experimental with meta-analysis	49 CRNAs at a single health care institution.	High quality simulation verifying knowledge and skill can close the	Small sample size of 49 CRNAs from one healthcare organization.	II/A

				knowledge gap of regional anesthesia for CRNAs.	Difficult to prove course improved credentialing because only 5 CRNAs were credentialed after the program.	
21	Ziewacz et al., 2011	Randomized Control Trial with meta-analysis	In 2 ORs, 11 participants were exposed to 8 simulations. 4 simulations used a checklist 4 did not.	There was a 6-fold reduction in failure to follow critical steps in management of emergencies for the 8 scenarios.	Not a blinded study. Simulation has not been linked to actual clinical performance.	I/B

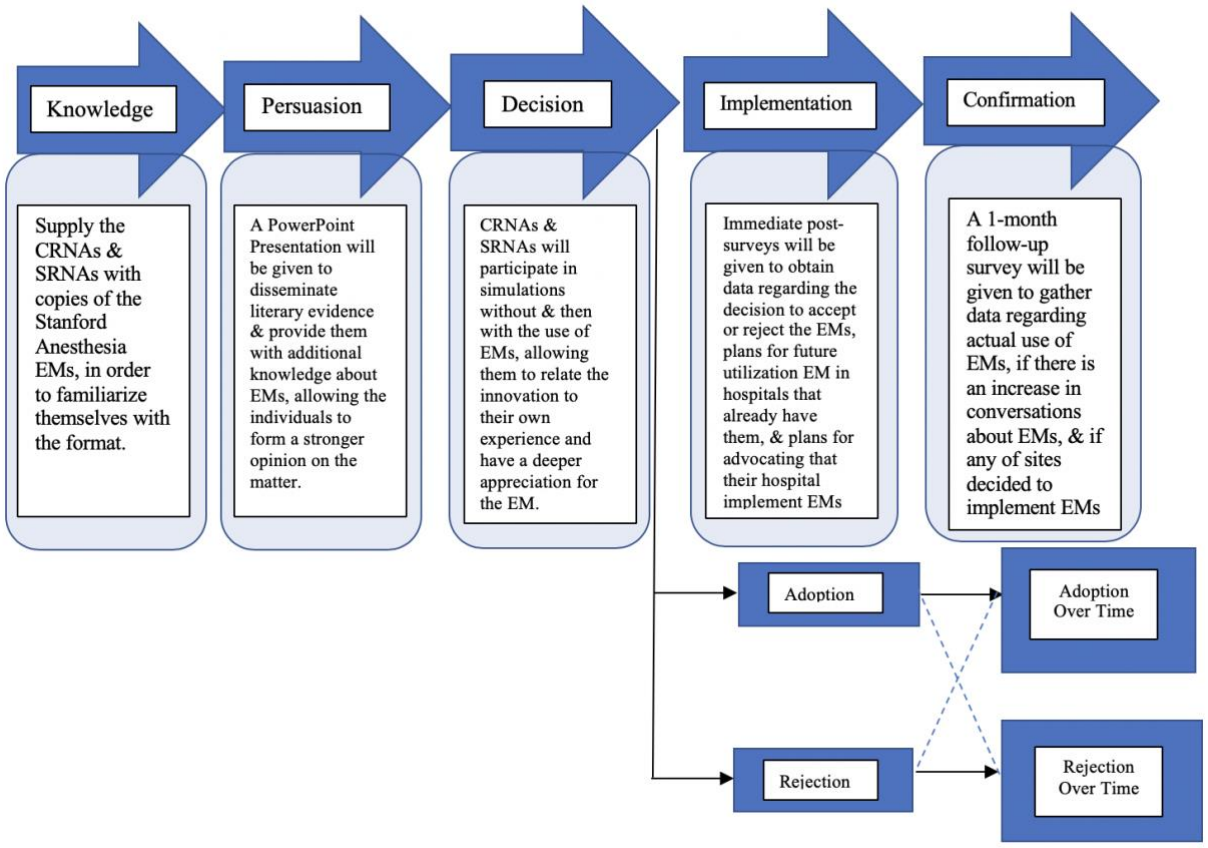
Appendix C

Rogers's Diffusion of Innovations Concept Map



Appendix D

Rogers's Concept Map Applied to Anesthesia Emergency Manuals



Appendix E

[redacted] Letter of Cooperation

Letter of Cooperation (Site Agreement)

Date: 04/22/19

Re: Letter of Cooperation For [redacted]

Dear Dr. McCartney Anderson,

This letter confirms that I, as an authorized representative of [redacted] allow the Principal Investigator and co-investigators access to conduct study related activities at the listed site(s), as discussed with the Principal Investigator and briefly outlined below, and which may commence when the Principal Investigator provides evidence of IRB approval for the proposed project.

- **Research Site(s)**: [redacted]
- **Study Purpose:** *To evaluate if education about anesthesia emergency manuals and simulation training using emergency manuals will lead to increased utilization during professional practice.*
- **Study Activities:** *A pre-survey will be given, then an anesthesia emergency manual will be passed out for the participants to look through. A PowerPoint presentation will then be given. Next, a simulation will be conducted without the use of an emergency manual and then conducted with the use of an emergency manual. An immediate post-survey will then be completed. A follow-up survey, one month later will be sent out via email through the* [redacted]
- **Subject Enrollment:** *The study population will be volunteer CRNAs and SRNAs who attend the* [redacted] *fall meeting. Inclusion criteria will only consist of CRNAs and SRNAs who participate in simulation activities. Exclusion criteria will consist of SRNAs who have not participated in clinical and CRNAs who are no longer practicing clinically. A total of 30 volunteers will be needed.*
- **Site(s) Support**: *The site agrees to provide the space and equipment for the presentation and simulations. Equipment includes a mock OR and patient, including a vital signs program to utilize during simulations. We also agree to disseminate the follow-up surveys to the entire* [redacted] *meeting attendees so that data will remain anonymous.*
- **Data Management:** *The only data collected will be data from the anonymous surveys.*
- **Anticipated End Date:** *October 5th and 6th, 2019*

We understand that this site's participation will only take place during the study's active IRB approval period. All study related activities must cease if IRB approval expires or is suspended. I understand that any activities involving Personal Private Information or Protected Health Information may require compliance with HIPAA Laws and Rutgers Policy.

Our organization agrees to the terms and conditions stated above. If we have any concerns related to this project, we will contact the Principal Investigator. For concerns regarding IRB policy or human subject welfare, we may also contact the Rutgers IRB (see orra.rutgers.edu/hspp).

Regards,

Appendix F

[redacted] SRNA Recruitment Flyer

RUTGERS
School of Nursing

ANESTHESIA EMERGENCY MANUAL SIMULATION RESEARCH STUDY

SRNA VOLUNTEERS NEEDED FOR SIMULATION STUDY!

THE PURPOSE OF THIS STUDY IS TO ASSESS WHETHER USING ANESTHESIA MANUALS DURING SIMULATED EMERGENCIES INCREASES EFFICIENCY IN CRISIS MANANGEMENT & LEADS TO AN INCREASE IN ACTUAL USE.

COME LEARN ABOUT RECOMMENDED GUIDELINES TO MANAGING INTRAOP EMERGENCIES & PARTICIPATE IN A STUDY THAT AIMS TO INCREASE EMERGENCY MANUAL AWARENESS AND USE IN THE OR

THE USE OF ANESTHESIA EMERGENCY MANUALS FOR INTRAOPERATIVE CRISES

WHERE: [redacted]

WHEN: Sept 16, 2019 & Sept 23, 2019 at 12:00pm

Time Commitment: 60-90min

Inclusion Criteria: SRNAs who participate in the simulation activities

Exclusion Criteria: SRNAs who have not participated in clinical

PI Contact Information: Maureen McCartney: [redacted]
Co-Investigators: Valerie Cattano [redacted]
Ingrid Emile [redacted]
Cara Seganti [redacted]

[redacted]

v3 7.15.19

Rutgers, The State University of New Jersey

Appendix G

[redacted] Fall Meeting Recruitment Flyer

RUTGERS
School of Nursing

ANESTHESIA EMERGENCY MANUAL SIMULATION RESEARCH STUDY

CRNA/SRNA VOLUNTEERS NEEDED FOR SIMULATION STUDY!

THE PURPOSE OF THIS STUDY IS TO ASSESS WHETHER USING ANESTHESIA MANUALS DURING SIMULATED EMERGENCIES INCREASES EFFICIENCY IN CRISIS MANANGEMENT & LEADS TO AN INCREASE IN ACTUAL USE.

COME LEARN ABOUT RECOMMENDED GUIDELINES TO MANAGING INTRAOP EMERGENCIES & PARTICIPATE IN A STUDY THAT AIMS TO INCREASE EMERGENCY MANUAL AWARENESS AND USE IN THE OR

THE USE OF ANESTHESIA EMERGENCY MANUALS FOR INTRAOPERATIVE CRISES

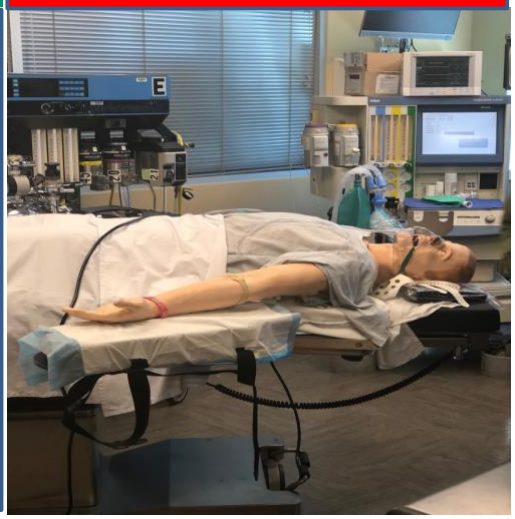
WHERE: [redacted]

WHEN: OCT 4, 2019 & OCT 5, 2019 at 7:00am

Time Commitment: 60-90min

Inclusion Criteria: Only CRNAs and SRNAs who participate in the simulation activities

Exclusion Criteria: SRNAs who have not participated in clinical and CRNAs who are no longer practicing clinically



PI Contact Information: Maureen McCartney [redacted]
Co-Investigators: Valerie Cattano [redacted]
Ingrid Emile: [redacted]
Cara Seganti: [redacted]

[redacted]

v3 7.15.19

Rutgers, The State University of New Jersey

Appendix H

Participant Consent Form

RUTGERS

Rutgers School of Nursing
Stanley S. Bergen Building
Rutgers, The State University of New Jersey
65 Bergen Street
Newark, NJ 07101-1709

CONSENT TO TAKE PART IN ANONYMOUS RESEARCH

TITLE OF STUDY: The Use of Anesthesia Emergency Manuals for Intraoperative Crises
Principal Investigator: Maureen McCartney Anderson DNP, CRNA/APN
Co-Investigators: Valerie Cattano RN, BSN, CCRN, SRNA
Ingrid Emile RN, BSN, CCRN, SRNA
Cara Seganti RN, BSN, CCRN, SRNA

This consent form is part of an informed consent process for a research study and it will provide information that will help you decide whether you want to take part in this study. It is your choice to take part or not. Your alternative to taking part in the research is not to take part in it.

Who is conducting the study and what is it about?
You are invited to take part in a research study that is being conducted by Maureen McCartney Anderson (faculty), Valerie M. Cattano (student), Ingrid Emile (student), and Cara Seganti (student) who are in the Rutgers University Doctoral Nurse Anesthesia Program. The purpose of the research is to determine the value of simulation while using emergency manuals for operating room crises.

Maureen McCartney Anderson may be reached at [redacted], Valerie Cattano may be reached at [redacted], Ingrid Emile may be reached at [redacted], and Cara Seganti may be reached at [redacted]

What will I be asked to do if I take part in the study?
We anticipate approximately 106 subjects will take part in the research. You will be asked to fill out a in a pre-survey, partake in a presentation, participate in 2 simulations, fill out post-survey, and fill out a 1 month follow-up survey. The information will be anonymously collected. No one will know which responses are yours. Your participation for the entire study will require about 60-90 minutes.

What are the risks of harm or discomforts I might experience if I take part in the study?
We do not foresee risks to subjects participating in this study.

Are there any benefits to me if I choose to take part in this study?
The benefits of taking part in this study may be increased likelihood to use emergency manuals during operative room emergencies and therefore, better patient outcomes. However, it is possible that you may receive no direct benefit from taking part in this study.

Will I be paid to take part in this study?
You will not be paid to take part in this study.

How will information about me be kept private or confidential?
This research is anonymous. No personal information including email addresses will be linked to the surveys that can identify who the participant is. The only recorded and saved information will be the surveys. The paper and electronic surveys will be kept in the DNP Chair's locked office cabinet until the project is officially completed. The electronic surveys will be kept on a password-protected USB drive only accessible to the PIs and DNP Chair. The paper surveys will be disposed of in a shredding bin and

[redacted]

RUTGERS

Rutgers School of Nursing
Stanley S. Bergen Building
Rutgers, The State University of New Jersey
65 Bergen Street
Newark, NJ 07101-1709

the electronic surveys will be erased from the USB drive after project completion. The paper pre and post surveys will be collected with no personal identifiers on them. The electronic follow-up surveys will be distributed to all [redacted] meeting attendees via the [redacted] President who already has all attendee email addresses. The electronic follow-up surveys will be distributed to all of [redacted] SRNAs via the Program Administrative Assistant who already has all of the [redacted] SRNAs email addresses. Study participants will be informed to anticipate a follow-up email from either the [redacted] president or the Program's Administrative Assistant and to please complete the anonymous online survey. In this regard, no email addresses or personal information of participants will be kept by the PIs. The participants emails will not be linked to survey responses in any way.

What will happen to information I provide in the research after the study is over?
After the study is over the information collected for this research will not be used or distributed to investigators for other research.

The research team and the Institutional Review Board at Rutgers University are the only parties that may see the data, except as may be required by law. If the findings of this research are professionally presented or published, only group results will be stated.

What will happen if I do not wish to take part in the study or I later decide not to stay in the study?
It is your choice whether you take part in the research. You may choose to take part, not to take part or you may change your mind and withdraw from the study at any time. If you do not want to enter the study or decide to stop taking part, your relationship with the study staff will not change, and you may do so without penalty and without loss of benefits to which you are otherwise entitled. Please note, however, that once you have submitted your responses, you may no longer withdraw them as we will not know which ones yours are.

If you have questions about taking part in this study, you can contact the Principle Investigator: Maureen McCartney Anderson at [redacted] or the Co-Investigators: Valerie Cattano at [redacted], Ingrid at [redacted] and Cara Seganti at [redacted]

If you have questions about your rights as a research subject, you can call the IRB Director at Newark HealthSci (973)-972-3608.

We will provide you a copy of this consent form for your records.

By beginning this research, I acknowledge that I am 18 years of age or older and have read and understand the information. I agree to take part in the research, with the knowledge that I am free to withdraw my participation in the research without penalty.

[redacted]

Appendix I

Malignant Hyperthermia Scenario for Simulation

Chief Complaint: "I'm having a gastric lap band put in"

History of Present Illness: P.D. is a 33-year-old male who presents for a scheduled gastric lap band procedure for obesity.

Past Medical History: Morbid Obesity, Diabetes, Chronic Back Pain

Past Surgical History: S/P Left ACL Repair in 2009

Social History: Patient denies tobacco, alcohol, and illicit drug use

Medications: Metformin 500mg 2x a day; Percocet (5mg oxycodone/350mg acetaminophen) 1 tab q4-6h PRN

Allergies: NKDA

Height: 180.34cm (71 inches; 5'11'')

Weight: 161.4 kg (355 lbs)

NPO Status: NPO since Midnight

Prior Anesthesia Hx/Complications: None

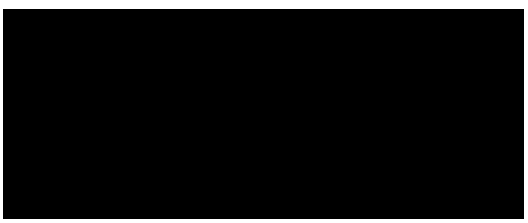
ASA/Mallampati: ASA: III; Mallampati: III

Airway Assessment: No chipped, cracked, loose, or missing teeth

Vital Signs: **HR** 84, **BP** 140/80, **RR** 16, **SpO2** 99% on RA, **Temp** 36.9°C (98.4°F)

Labs: HH 10/30.3, **Plt** 308, **WBC** 5.10, **PT/PTT** 13/30, **INR** 0.8, **Na** 140, **K** 4.2, **Cl** 99, **Mg** 2.2, **Ca2+** 9, **Bicarb** 25, **Cr** 0.8, **BUN** 10, **pCO2** 38, **pO2** 97, **pH** 7.35

CRNA Assessment: pt A&O x3 with movement of all extremities; pt on RA with symmetric expansion and no use of accessory muscle, clear upon auscultation; HR regular, S1 & S2- no additional heart sounds noted, +2 palpable pulses in all 4 extremities, +2 pedal edema, no JVD noted; audible/active bowel sounds in all 4 quadrants; 20G in **L**AC & 18G in **R**AC



Appendix J

Venous Air Embolism Scenario for Simulation

Chief Complaint: "I'm getting rid of my AVM"

History of Present Illness: J.S. is a 30-year-old male who presents for surgical resection of AVM

Past Medical History: AVM rupture with intracerebral hemorrhage

Past Surgical History: S/P Craniotomy/Evacuation of hematoma (9/2014); Cerebral Angiogram (5/2016), AVM Embolization (11/2018)

Social History: Patient denies tobacco, alcohol, and illicit drug use

Medications: Acetaminophen 500mg Q6h PRN for headache

Allergies: PCN

Height: 167.64cm (66 inches; 5'6'')

Weight: 79 kg (174 lbs)

NPO Status: NPO since Midnight

Prior Anesthesia Hx/Complications: None

ASA/Mallampati: ASA: III; Mallampati: 1

Airway Assessment: No chipped, cracked, loose, or missing teeth

Vital Signs: **HR** 60, **BP** 118/76, **RR** 16, **SpO2** 98% on RA, **Temp** 37°C (98.6°F)
Labs: HH 12/43, **Plt** 355, **WBC** 6, **PT/PTT** 10/25, **INR** 0.8, **Na** 148, **K** 4.3, **Cl** 102, **Mg** 2, **Ca2+** 9, **Bicarb** 25, **Cr** 0.9, **BUN** 12, **pCO2** 38, **pO2** 98, **pH** 7.34

CRNA Assessment: pt A&O x3 with movement of all extremities; pt on RA with symmetric expansion and no use of accessory muscle, clear upon auscultation; HR regular, S1 & S2- no additional heart sounds noted, +2 palpable pulses in all 4 extremities, no pedal edema, no JVD noted; audible/active bowel sounds in all 4 quadrants; 20G in **R** forearm & 18G in **R**AC

Appendix K

Malignant Hyperthermia Grading Rubric

- Identify that the patient has Malignant Hyperthermia

Early Signs	Possibly Late Signs
○ Increased ETCO2	○ Hyperthermia
○ Tachycardia	○ Muscle Rigidity
○ Tachypnea	○ Myoglobinuria
○ Mixed Acidosis (ABG)	○ Arrhythmias
○ Masseter Spasm/Trismus	○ Cardiac Arrest

- Discontinue Anesthetic Triggers (Volatile Agents & Succinylcholine)
- Increase FIO2 to 100% at high flow of 10 L/min
- Increase Minute Ventilation (Avoid Air Trapping)
- Stop the Procedure
- Call MH Hotline (1-800-MH-HYPER or 1-800-644-9737)
- Prepare 2.5 mg/kg IV Dantrolene or Ryanodex Bolus
    - Dantrolene: Dilute 20mg Dantrolene vial in 60mL preservative-free sterile water
    - Ryanodex: Dilute 250mg vial in 5mL preservative-free sterile water
- Rapidly Administer Dantrolene or Ryanodex until patient has stabilized
    - Continue 1 mg/kg q 4-6h or 0.25 mg/kg/h for 24h
- Assess and Treat:
    - Metabolic Acidosis
    - Hyperkalemia
    - Arrhythmias
- Actively cool the patient until 38˚C is reached

Time Start: _____

Time End: _____

Appendix L

Venous Air Embolism Grading Rubric

- Identify that the patient has a Venous Air Embolism
  - Air of TEE or change in doppler tone (if monitoring)
  - Decrease in ETCO2
  - Decrease in BP
  - Decrease in SPO2
  - Increase in CVP
  - Onset of dyspnea & respiratory distress or cough in awake patient
- Increase FIO2 to 100% at high flow
- Flood the surgical field with saline
- Place surgical site below heart (if able)
- Aspirate air from central line if present
- Give rapid fluid bolus to increase CVP
- Turn down or off volatile anesthetic
- Give epinephrine (start 10-100 mcg) to maintain cardiac output
- Start CP if BP is catastrophically low
- Consider TTE or TEE echocardiography to assess air and RV function
- Consider left lateral decubitus position
- Terminate procedure if able

Time Start: _____

Time End: _____

Appendix M

Pre-Survey

RUTGERS

Rutgers School of Nursing
Stanley S. Bergen Building
Rutgers, The State University of New Jersey
65 Bergen Street
Newark, NJ 07101-1709

By beginning the survey, you have agreed to participate in this research study, with the knowledge that you are free to withdraw your participation at any time, without penalty. Please fill out this survey to the best of your capability and circle your response.

Emergency Manual Pre-Survey

1). My credential is:

CRNA SRNA

2). I have been practicing as an anesthesia provider for:

Less than 1 year 1-5 years 5-10 years Greater than 10 years

3). I know what an Anesthesia Emergency Manual (ex. Stanford) is.

Strongly Disagree Disagree Neutral Agree Strongly Agree

4). I think the use of an Emergency Manual would help during an actual crisis.

Strongly Disagree Disagree Neutral Agree Strongly Agree

5). My institution provides readily accessible Emergency Manuals in my clinical area.

Strongly Disagree Disagree Neutral Agree Strongly Agree

6). I **HAVE** used an Emergency Manual during an actual crisis situation.

Strongly Disagree Disagree Neutral Agree Strongly Agree

7). I **WOULD** use an Emergency Manual during a crisis situation.

Strongly Disagree Disagree Neutral Agree Strongly Agree

8). I would recommend the use of an Emergency Manual during a crisis situation.

Strongly Disagree Disagree Neutral Agree Strongly Agree

9). I believe the greatest barrier to utilizing Emergency Manuals is (please circle **one**):

Accessibility

Lack of training

Fear of being judged

I don't think to reference a cognitive aid under stress

v1 6.03.19

Appendix N

Post-survey

RUTGERS

Rutgers School of Nursing
Stanley S. Bergen Building
Rutgers, The State University of New Jersey
65 Bergen Street
Newark, NJ 07101-1709

By beginning the survey, you have agreed to participate in this research study, with the knowledge that you are free to withdraw your participation at any time, without penalty. Please fill out this survey to the best of your capability and circle your response.

Emergency Manual Post-Survey

1). My credential is:

CRNA SRNA

2). I have been practicing as an anesthesia provider for:

Less than 1 year 1-5 years 5-10 years Greater than 10 years

3). I know what an Anesthesia Emergency Manual (ex. Stanford) is.

Strongly Disagree Disagree Neutral Agree Strongly Agree

4). I think the use of an Emergency Manual would help during an actual crisis.

Strongly Disagree Disagree Neutral Agree Strongly Agree

5). My institution provides readily accessible Emergency Manuals in my clinical area.

Strongly Disagree Disagree Neutral Agree Strongly Agree

6). I **HAVE** used an Emergency Manual during an actual crisis situation.

Strongly Disagree Disagree Neutral Agree Strongly Agree

7). I **WOULD** use an Emergency Manual during a crisis situation.

Strongly Disagree Disagree Neutral Agree Strongly Agree

8). I would recommend the use of an Emergency Manual during a crisis situation.

Strongly Disagree Disagree Neutral Agree Strongly Agree

9). I believe the greatest barrier to utilizing Emergency Manuals is (please circle **one**):

Accessibility

Lack of training

Fear of being judged

I don't think to reference a cognitive aid under stress

v1 6.03.19

Appendix O

Follow-up survey

RUTGERS

Rutgers School of Nursing
Stanley S. Bergen Building
Rutgers, The State University of New Jersey
65 Bergen Street
Newark, NJ 07101-1709

By beginning the survey, you have agreed to participate in this research study, with the knowledge that you are free to withdraw your participation at any time, without penalty. Please fill out this survey to the best of your capability and circle your response.

Emergency Manual Follow-Up Survey

1). My credential is:

CRNA SRNA

2). I have been practicing as an anesthesia provider for:

Less than 1 year 1-5 years 5-10 years Greater than 10 years

3). I participated in Simulation activities.

Yes No

4). I think the use of an Emergency Manual would help during an actual crisis.

Strongly Disagree Disagree Neutral Agree Strongly Agree

5). My institution provides readily accessible Emergency Manuals in my clinical area.

Strongly Disagree Disagree Neutral Agree Strongly Agree

6). I **HAVE** used an Emergency Manual during an actual crisis situation.

Strongly Disagree Disagree Neutral Agree Strongly Agree

7). I **WOULD** use an Emergency Manual during a crisis situation.

Strongly Disagree Disagree Neutral Agree Strongly Agree

8). I have recommended/ discussed the use of an Emergency Manual for a crisis situation at my institution.

Strongly Disagree Disagree Neutral Agree Strongly Agree

9). I believe the greatest barrier to utilizing Emergency Manuals is (please circle **one**):

Accessibility

Lack of training

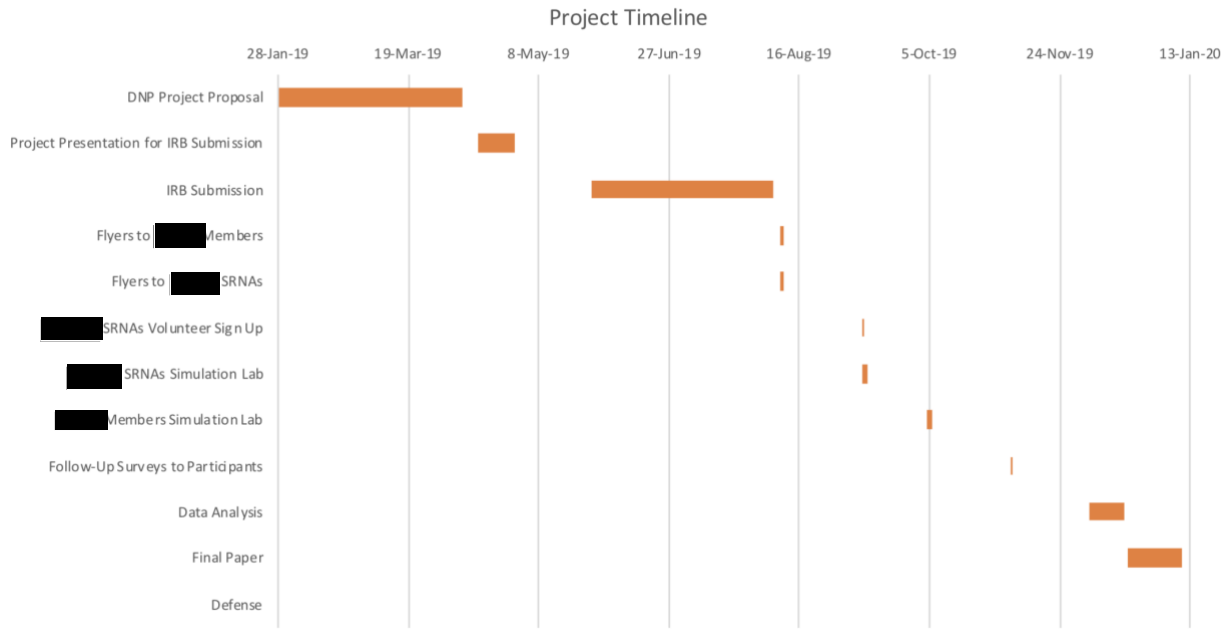
Fear of being judged

I don't think to reference a cognitive aid under stress

v1 6.03.19

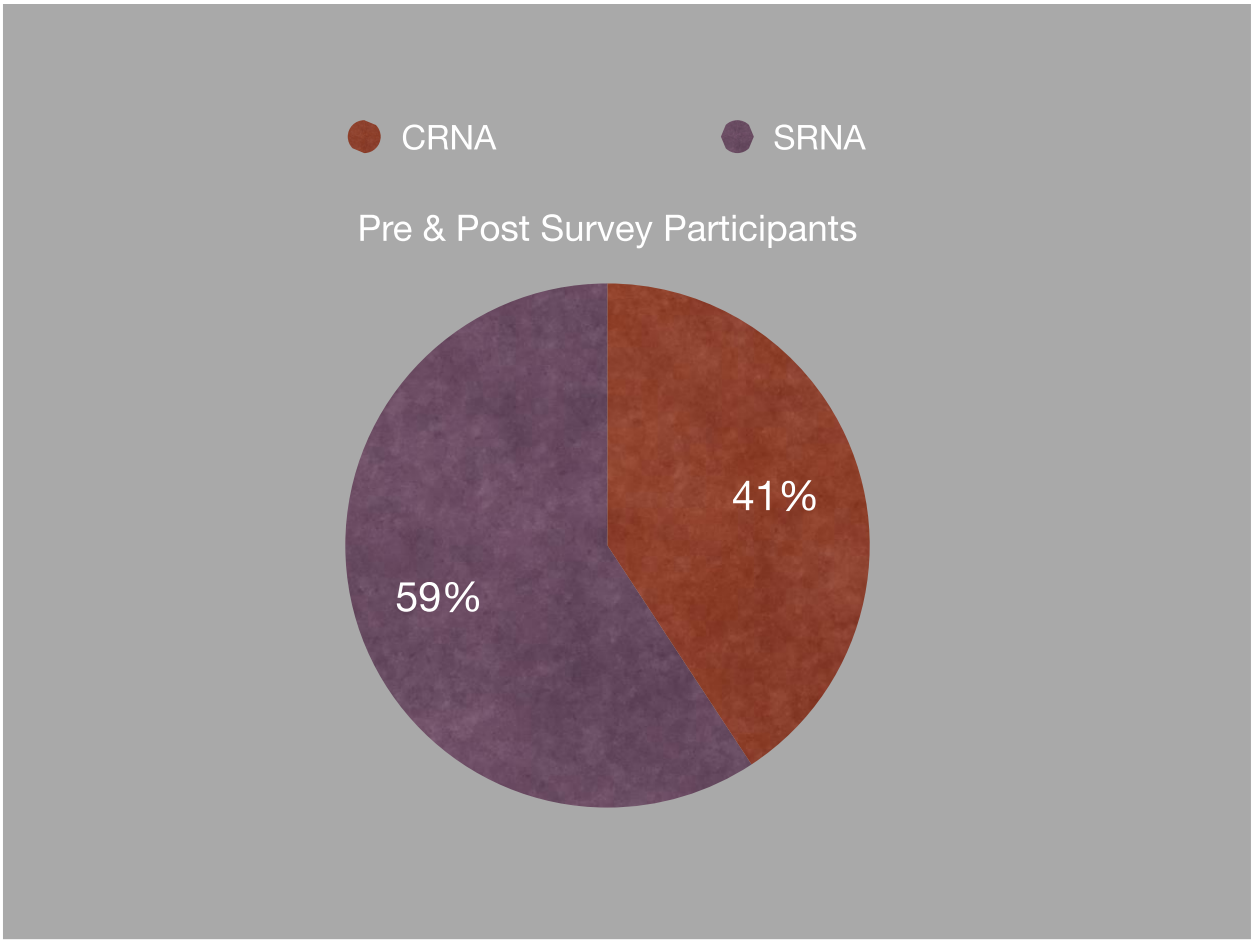
Appendix P

Gantt Chart



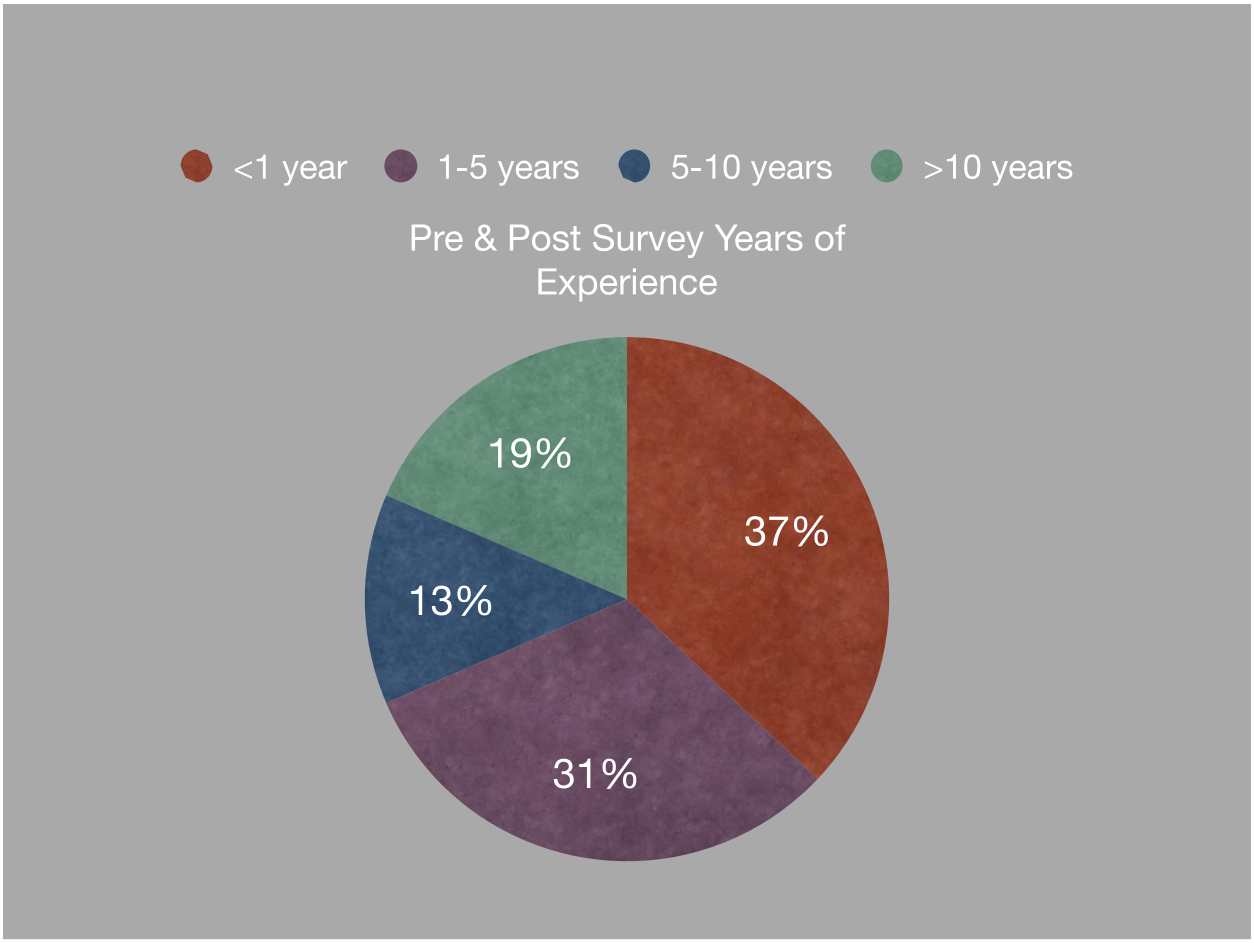
Appendix Q

Pre & Post Survey Participants



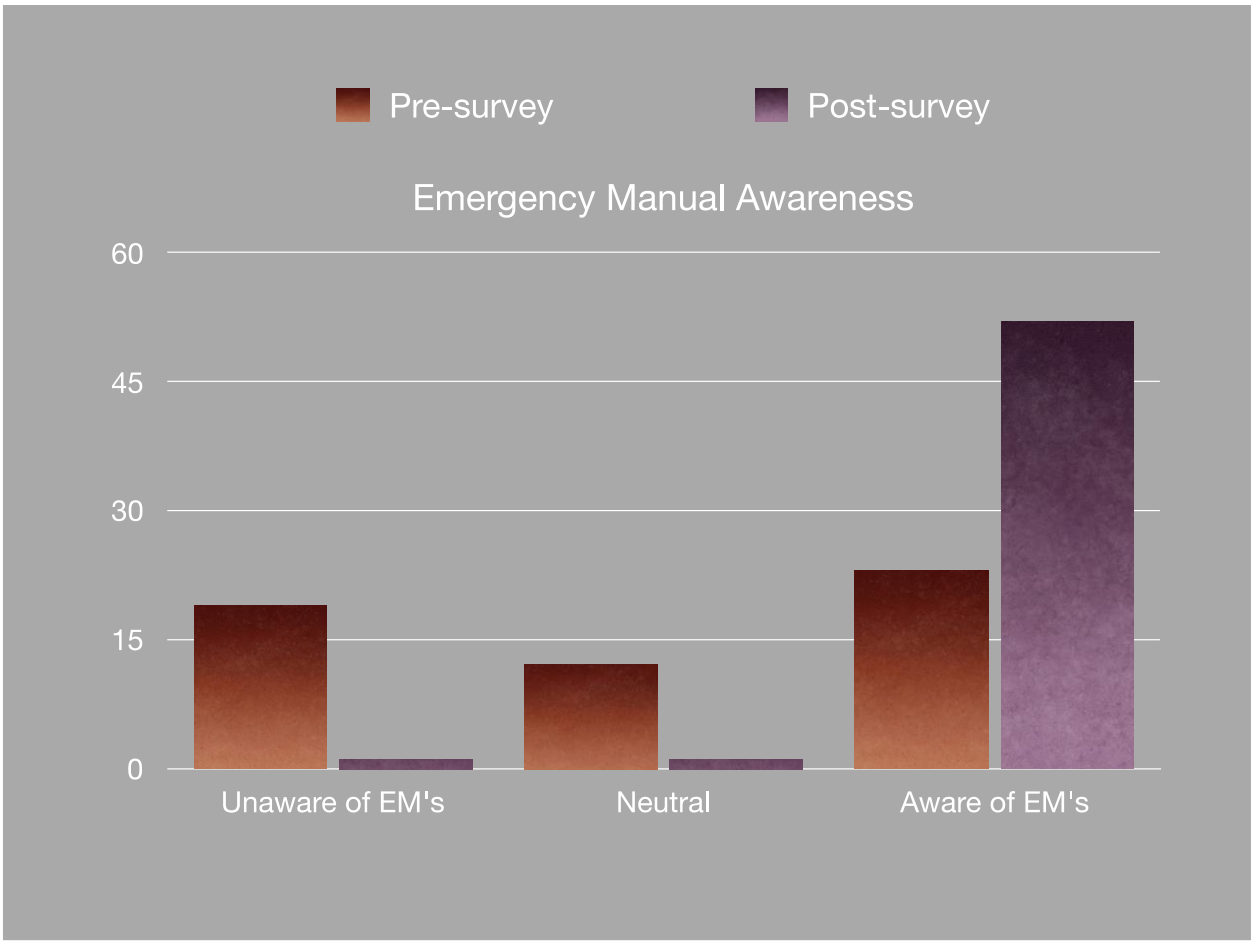
Appendix R

Pre & Post Survey Years of Experience



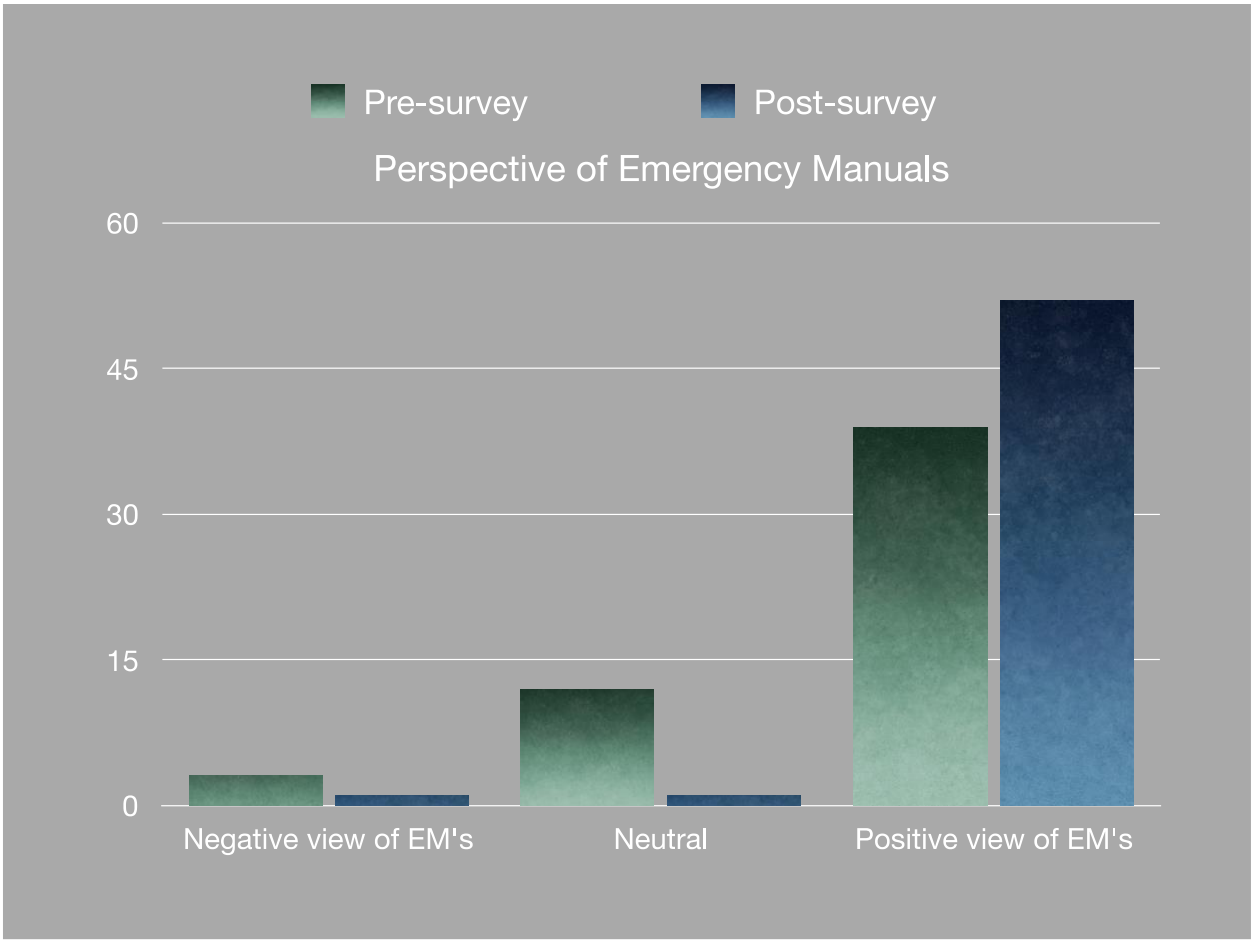
Appendix S

Emergency Manual Awareness



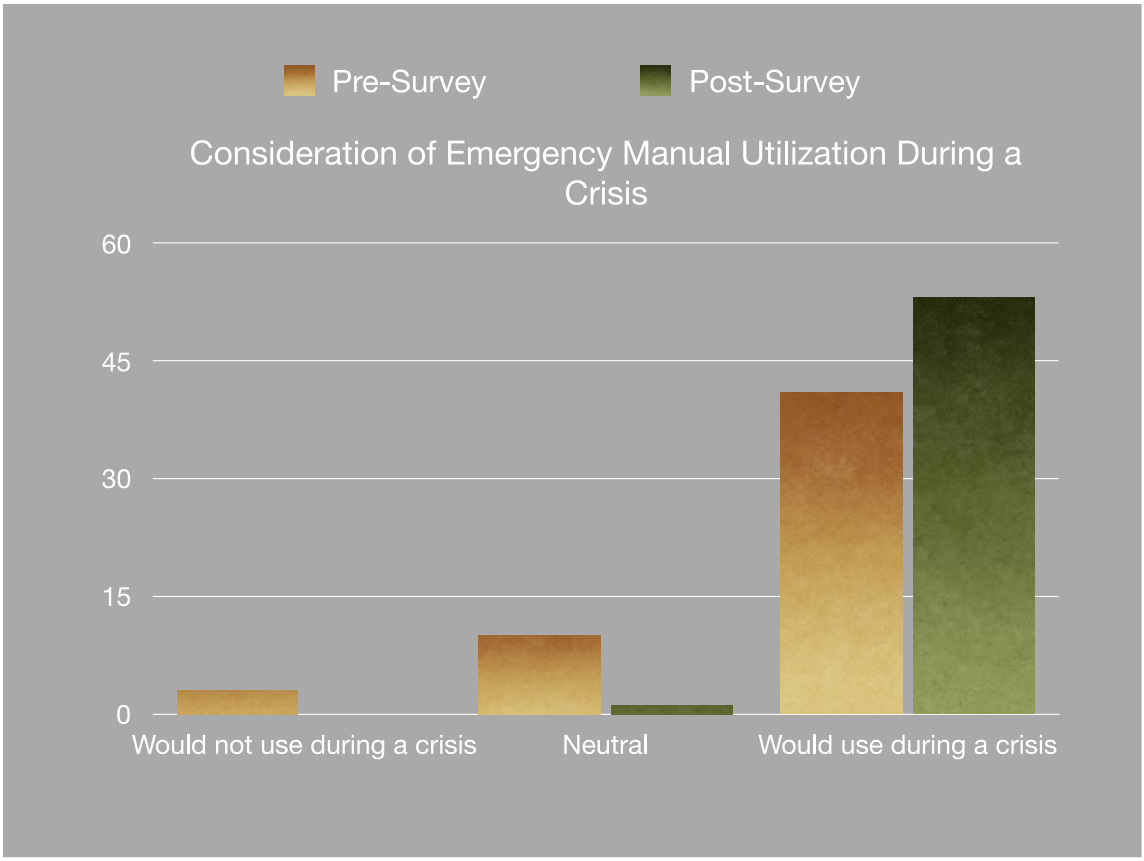
Appendix T

Perspective of Emergency Manuals



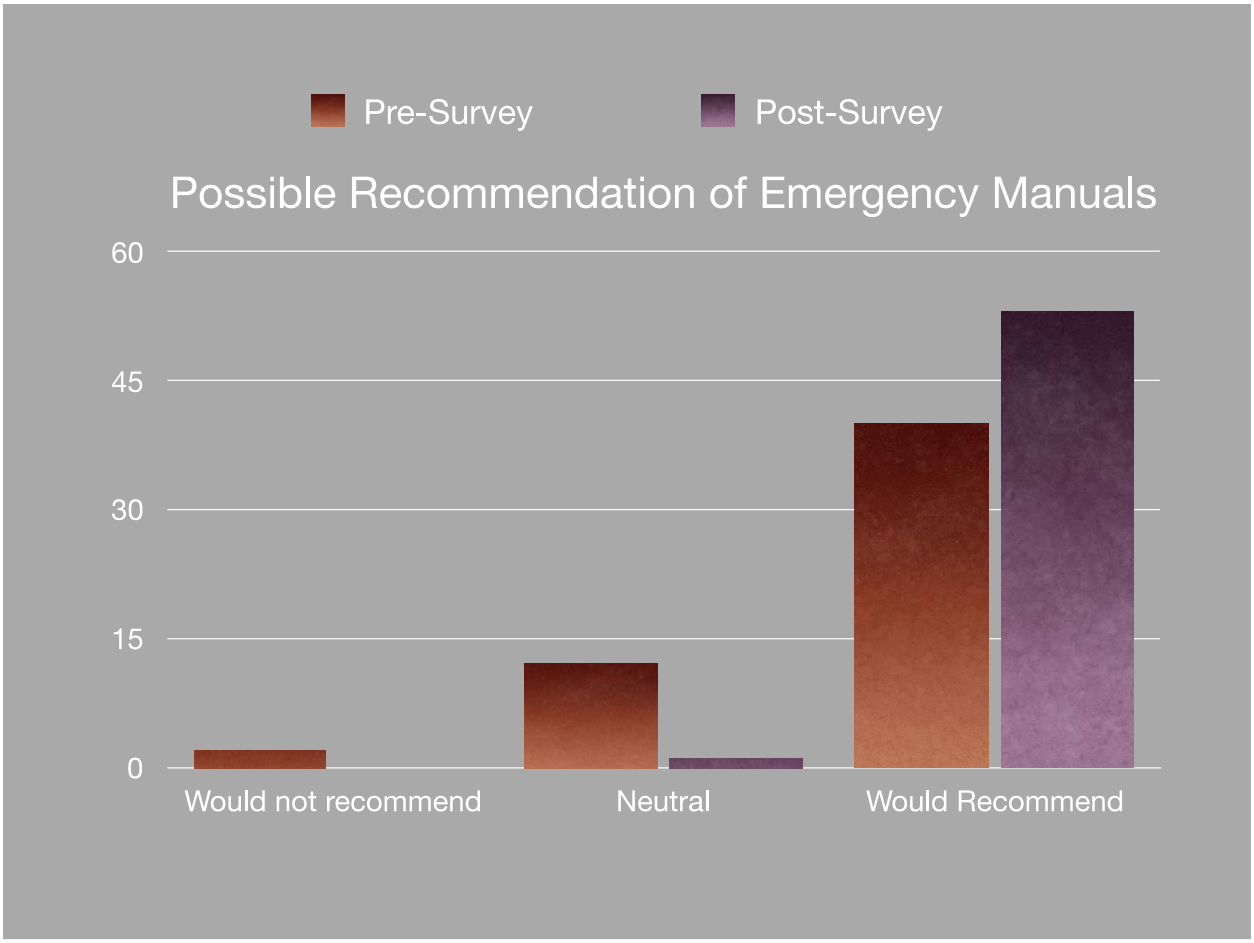
Appendix U

Consideration of Emergency Manual Utilization During a Crisis



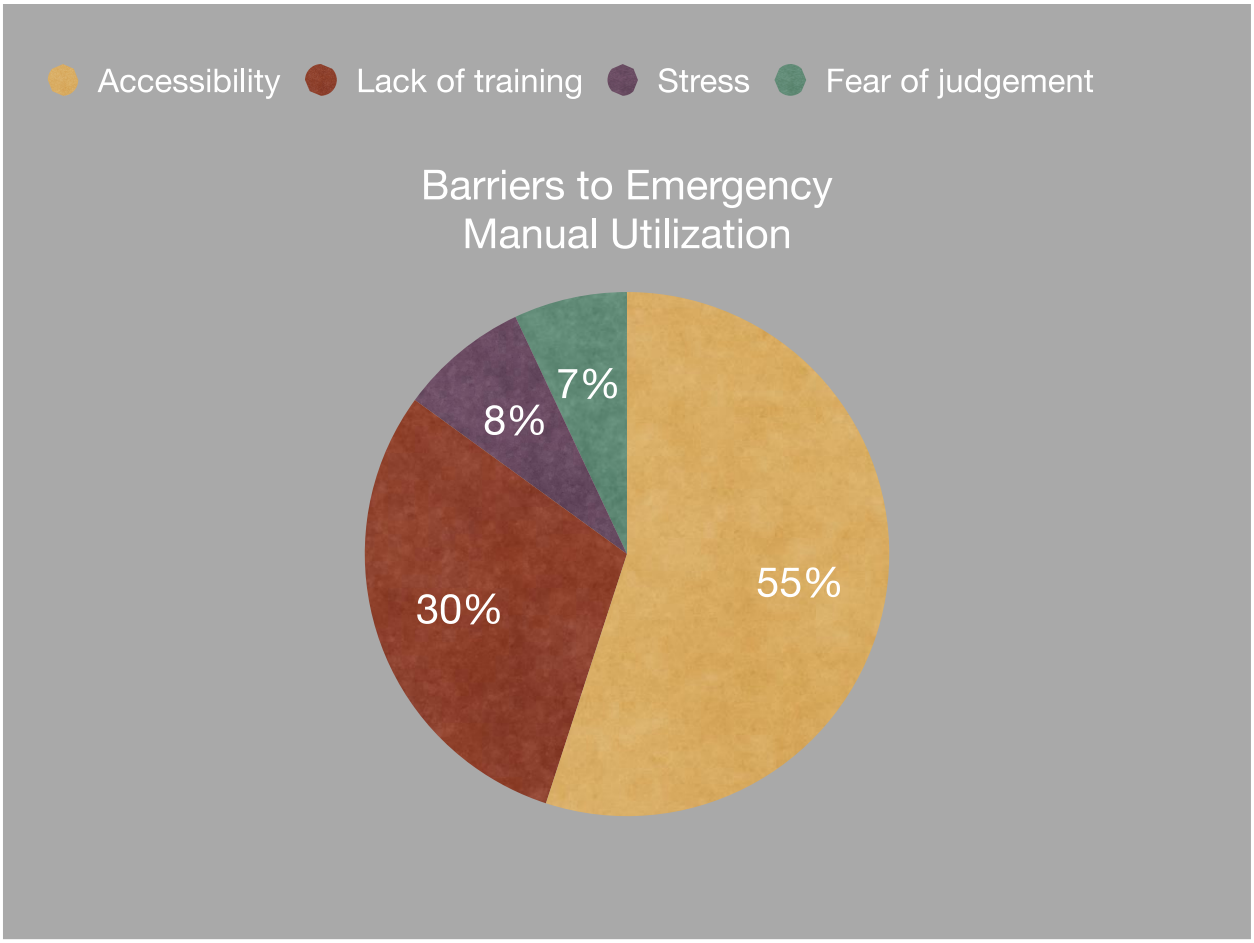
Appendix V

Possible Recommendation of Emergency Manuals



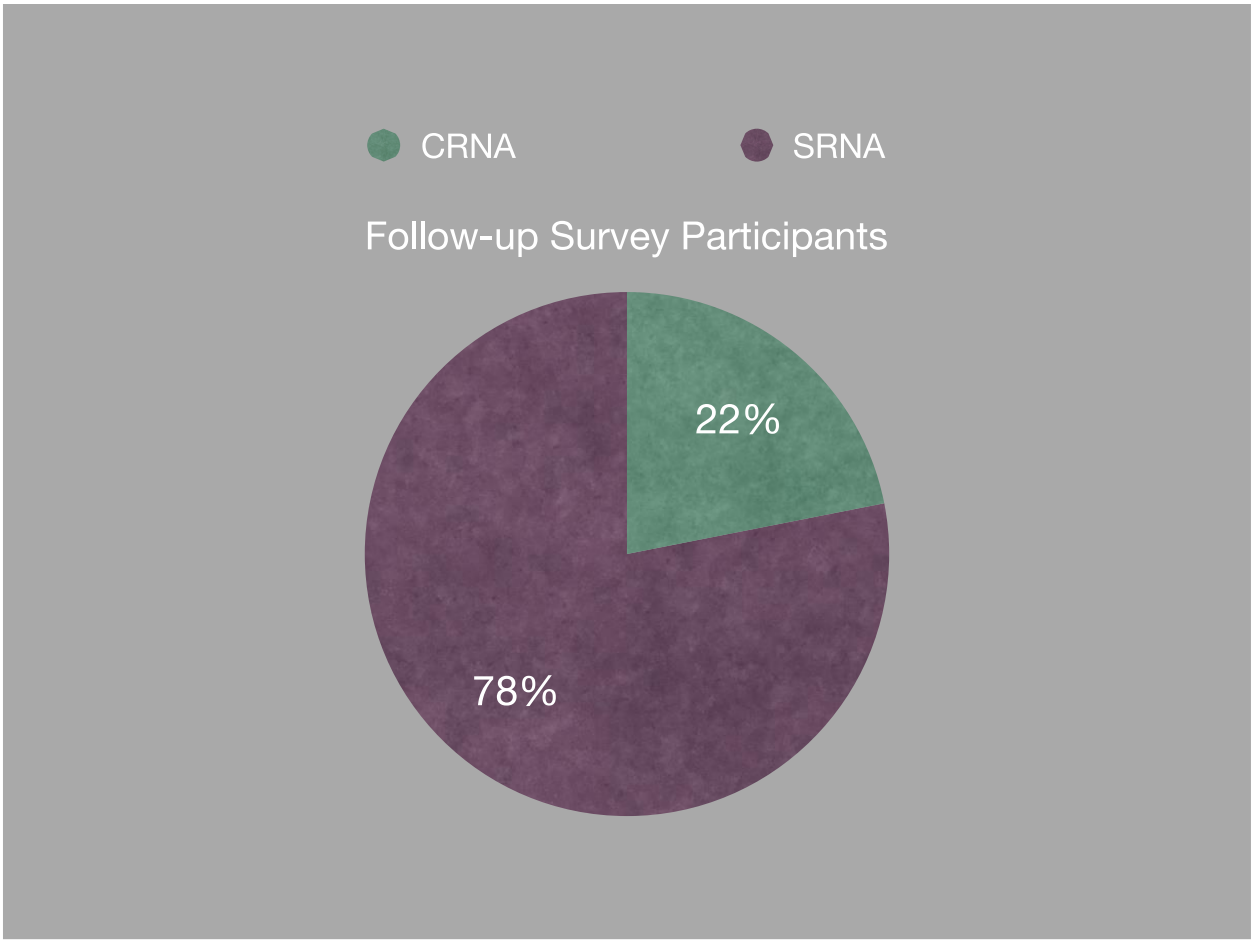
Appendix W

Barriers to Emergency Manual Utilization



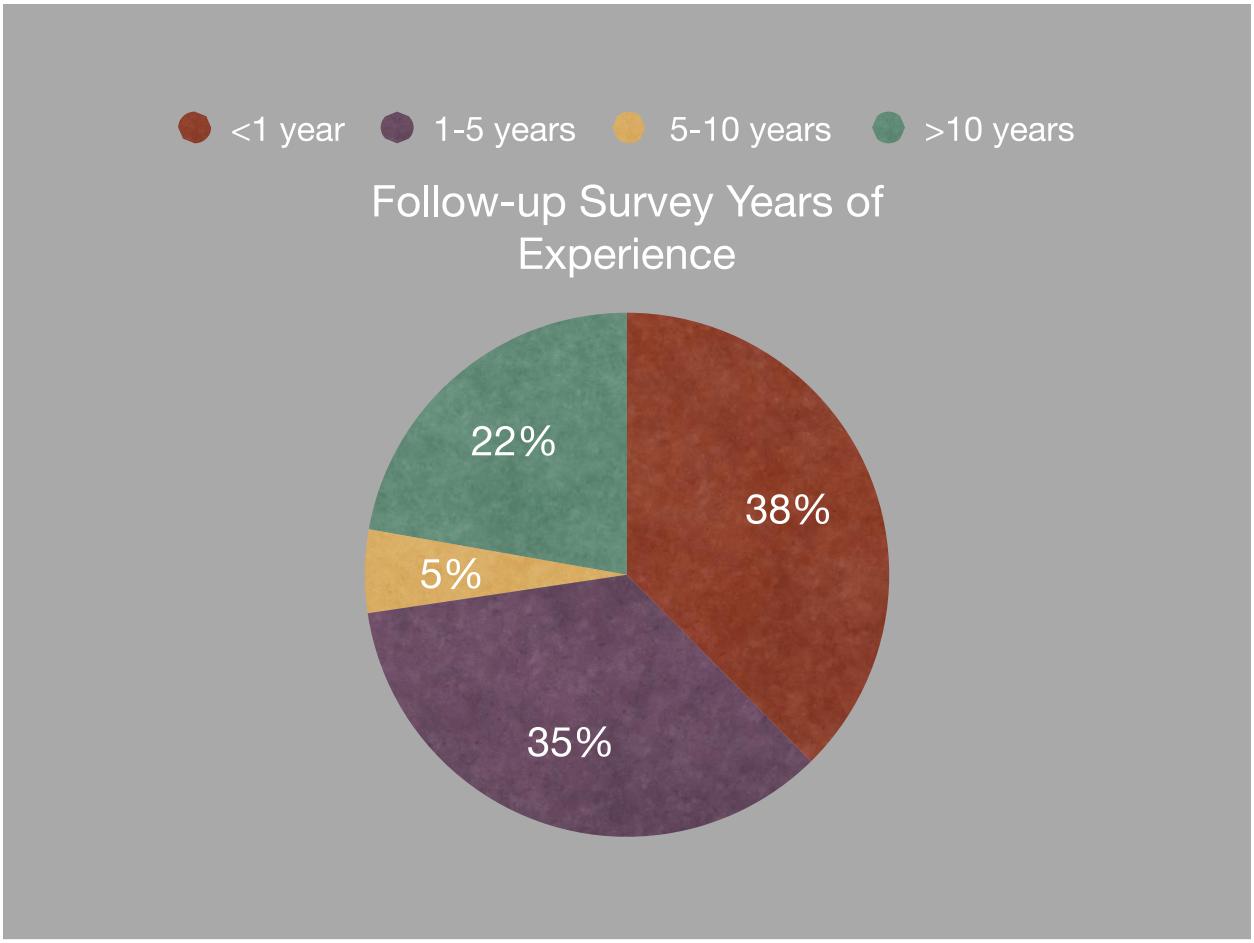
Appendix X

Follow Up Survey Participants



Appendix Y

Follow Up Survey Years of Experience



Appendix Z

Attested Recommendation & Discussion of Emergency Manuals