EVALUATION OF THE EFFECTS OF A SIMULATION-BASED TRAINING PROGRAM ON SITUATION AWARENESS IN STUDENT REGISTERED NURSE ANESTHETISTS

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By

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ABSTRACT

Situation awareness is a non-technical skill that has major implications in human behavior. Faults in situation awareness can increase chances for error to occur. In the field of nurse anesthesia, this is particularly relevant as decisions often have to be made rapidly in dynamic environments with an understanding of potential outcomes. In spite of this, standard methods to teach situation awareness to student registered nurse anesthetists (SRNAs) have not been established. The purpose of this pilot study was to evaluate the effects of a simulation-based training program on situation awareness in student registered nurse anesthetists.

A quasi-experimental design was used to demonstrate that a simulation-based training program including debriefing impacts situation awareness. The Anesthetists’ Non-Technical Skills (ANTS) System, a validated behavioral assessment tool, was applied to SRNAs in this study. SRNA perceptions of their situation awareness and the simulation-based training program were measured using questionnaires.

The results of the study yielded several statistically significant findings. First, SRNAs had increased understanding of the concept of situation awareness as it pertains to nurse anesthesia, from $M = 3.1 \ (SD = 0.9)$ to $M = 4.7 \ (SD = 0.5)$, $t(8) = 4.603, P = .002$. Second, SRNAs expressed increased ability to apply the non-technical skill of situation awareness to the intraoperative management of patients, from $M = 2.7 \ (SD = 0.7)$ to $M = 4.1 \ (SD = 0.9)$, $t(8) = 4.914, P = .001$. Third, there were statistically significant increases in ANTS scores for each element of situation awareness (Gathering Information, Recognizing and Understanding, and
Anticipating as well as in the total score. Total ANTS Scores increased from $M = 7.3$ ($SD = 1.8$) to $M = 10.3$ ($SD = 1.0$), $t(8) = 4.47$, $P = .0023$.

This study revealed that the simulation-based training program including debriefing improved situation awareness performance in SRNAs. Furthermore, the SRNAs perceived an improved understanding of situation awareness and its application to their practice. Future studies with larger sample sizes and control groups may help to strengthen the generalizability of the data which may benefit educators searching for ways to utilize simulation-based training to target non-technical skills in SRNAs.
The research and writing of this thesis is dedicated to everyone who helped me along the way. Thank you to Dr. Carrie Bowman-Dalley and Dr. Crystal O’Guin for your guidance and support with this project. Thank you to Dr. Alex Walker for your help with the design of this project. Thank you to Dr. Alexander Titus and Dr. Nancy Crowell for your help with the statistical analysis of this project. Thank you to the staff of the O’Neill Family Foundation Clinical Simulation Center for your assistance with the simulations. Thank you to all the volunteers who took the time to participate in this research study. Thank you to my friend Megan Ott for your participation in these simulations. And last but not least, thank you to my dear friend, Carter Gisriel, without whom, most of this would not have been possible.

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# TABLE OF CONTENTS

CHAPTER 1: Introduction ........................................................................................................ 1  
Introduction ........................................................................................................................... 1  
Problem Statement ............................................................................................................... 1  
Purpose of Study ................................................................................................................... 2  
Research Questions ............................................................................................................ 2  
Definitions ............................................................................................................................ 2  

CHAPTER 2: Literature Review ............................................................................................ 4  
Literature Review .................................................................................................................. 4  
Non-Technical Skills ............................................................................................................ 4  
Anesthetists’ Non-Technical Skills System (ANTS) ............................................................... 6  
Situation Awareness ............................................................................................................. 9  
Simulation Training ............................................................................................................. 13  
Standards for Simulation Development .............................................................................. 16  
Debriefing ............................................................................................................................ 18  
Conclusion ........................................................................................................................... 22  

CHAPTER 3: Methods .......................................................................................................... 24  
Methodology ......................................................................................................................... 24  
Research Design .................................................................................................................. 24  
Sample .................................................................................................................................. 24  
Instrumentation .................................................................................................................... 25  
Procedure .............................................................................................................................. 27  
Data Analysis ....................................................................................................................... 32  
Protection of Human Rights ............................................................................................... 32  

CHAPTER 4: Data .................................................................................................................. 33
LIST OF FIGURES

Figure 1. Question 12: Most Valuable Activity................................................................. 39
Figure 2. Gathering Information Scores ................................................................. 41
Figure 3. Recognizing and Understanding Scores.............................................. 42
Figure 4. Anticipating Scores............................................................................ 43
Figure 5. Total Scores......................................................................................... 44

LIST OF TABLES

Table 1. Demographic Data............................................................ 34
Table 2. Results from Pre-Simulation Training Questionnaire.................. 36
Table 3. Results from Post-Simulation Training Questionnaire................. 38
Table 4. Results of ANTS Scores Using Paired Samples $t$ Tests............... 44
CHAPTER 1: Introduction

Introduction

Situation Awareness is a non-technical skill that is critical to optimize patient care and safety in dynamic environments, such as the operating room. In high-reliability industries, such as healthcare, developing skills that are critical to patient safety such as situation awareness, is essential.\textsuperscript{1,2,3,4} For this reason, the development and assessment of situation awareness has become a subject of further investigation in the realm of anesthesia. A behavioral analysis tool, the Anesthetists’ Non-Technical Skills System, was empirically designed to assess skills relevant to anesthesia providers, such as situation awareness, and intended to be used in both clinical and simulated environments\textsuperscript{5,6}. Simulation-based training has become increasingly useful in healthcare to aid in developing skills like situation awareness for translation to practice.\textsuperscript{7,8,9,10} The incorporation of simulation-based training can be a useful addition to traditional didactic and clinical instruction which may ultimately enhance the skills and abilities of the healthcare provider.\textsuperscript{9,11,12} Furthermore, simulation-based training can be an exceptional opportunity for learning to occur in a manner that does not predispose patients to harm.\textsuperscript{13,14,15}

Problem Statement

While Student Registered Nurse Anesthetists (SRNAs) enter nurse anesthesia programs with previous clinical experience, considerable education and training must occur to acquire the technical and non-technical skills required to deliver safe and effective anesthesia care.\textsuperscript{16} Research has shown that non-technical skills such as situation awareness are critical for patient safety,\textsuperscript{1,2,3} and simulation-based training is a tool that is becoming increasingly used in healthcare to develop, assesses, and refine non-technical skills for translation to clinical practice in a safe and controlled environment.\textsuperscript{7,8,13} However, in spite of these details, formal integration
of a simulation-based training program to evaluate situation awareness in the SRNA has not been widely established in nurse anesthesia programs. This suggests a need for further research evaluating the impact of a simulation-based training program on situation awareness in student registered nurse anesthetists.

**Purpose of Study**

The purpose of this study is to design, implement, and measure the outcomes of a simulation-based training program to promote the non-technical skill of situation awareness in SRNAs in a Doctor of Nurse Anesthesia Practice program. The study will also investigate the SRNA’s perceptions of a simulation-based training program on situation awareness.

**Research Questions**

The questions that will guide this study are the following:

1. Does the implementation of a simulation-based training program including debriefing impact situation awareness in the SRNA?
2. What are SRNA perceptions of the simulation-based training program including debriefing on situation awareness?

**Definitions**

For the purpose of this study, the following terms and definitions were used.

**Conceptual definitions:**

1. Situation awareness: Situation awareness is defined as a perception of the components of a specific setting and time and an understanding of their implications within a greater context so that rational predictions of future events may occur.
2. Simulation-based training: Simulation-based training is defined as the process of performing actions for the development or assessment of skills in a safe and controlled environment with the purpose of translation to real-life contexts.

3. Debriefing: Debriefing is defined as a discussion, often between a trainer and trainee, that allows for reflection and evaluation of current events as well as suggestions for improving future endeavors.

4. Perception: Perception is defined as the SRNA’s views on the impact of a simulation-based training program with debriefing on situation awareness.

**Operational definitions:**

1. Situation awareness: Situation awareness will be measured using the Anesthetists’ Non-Technical Skills System which relates specific elements of situation awareness to the anesthetist’s ability to plan, prepare, prioritize, provide and maintain standards of situation awareness using a four-point scale.

2. Simulation-based training program: A pre- and post-training simulation experience will be completed for performance comparison analyzing situation awareness in the SRNA.

3. Debriefing: Debriefing will be completed in a formalized, systematic way using the Anesthetists’ Non-Technical Skills System to guide the instructor through the elements of situation awareness and the SRNA’s ability to plan, prepare, prioritize, provide, and maintain standards of situation awareness using a four-point scale to grade.

4. Perception: A survey using a Likert scale will be used to assess the SRNA’s perception of the simulation-based training program with debriefing on situation awareness.
CHAPTER 2: Literature Review

*Literature Review*

It is the goal of nurse anesthesia education to prepare the Registered Nurse to effectively transition into the Certified Registered Nurse Anesthetist role, capable of providing safe and effective anesthesia care.\(^{16}\) In high-reliability industries, such as the field of nurse anesthesia, non-technical skills such as situation awareness promote effective thought-processes that manifest as appropriate decision-making and actions that can optimize patient care and safety.\(^{1,2,4,16}\) The use of simulation-based training programs in the healthcare industry is an increasingly useful tool to develop non-technical skills like situation awareness. These programs have been shown to enhance learning\(^{17}\) and strengthen clinical performance\(^{18,19,20}\) in a safe and controlled environment.\(^{13,14}\) This literature review will examine the importance of situation awareness as a non-technical skill in the practice of nurse anesthesia, the application of a behavioral analysis tool to measure situation awareness in the anesthesia provider, the use of simulation-based training with debriefing in healthcare education, and the role of simulations in developing and evaluating situation awareness for translation to clinical practice.

*Non-Technical Skills*

The term “non-technical skills” describes the aspects of human behavior and thought processes that enable people to function in a given role.\(^{21}\) It has been defined as “the cognitive, social, and personal resource skills that complement technical skills, and contribute to safe and efficient task performance.”\(^{22}\) Clinicians utilize non-technical skills to analyze information, work as a team, formulate plans, and make decisions regarding patient care. Non-technical skills are influenced by many factors that include but are not limited to the nature of the situation (routine or emergent), the need to communicate with a team or make decisions independently, and level
of familiarity with the given scenario.\textsuperscript{21} When these skills are lacking or underdeveloped, there can be increased chances of error, which can result in adverse events and gaps in patient safety.\textsuperscript{21}

**Development of “Non-Technical Skills”**. The aviation industry was the first to focus on the importance of non-technical skills. The term “non-technical skills” was first incorporated into safety measurements by the European civil aviation regulator and was used to describe the behavior of pilots on the flight deck.\textsuperscript{21} Through studies of adverse outcomes in aviation, it became evident that cognitive and social skills (non-technical skills) directly impacted the quality and safety standards of flight operations.\textsuperscript{23} The industry incorporated non-technical skills development into standard flight crew training in order to analyze and improve human behaviors associated with accidents, allowing them to minimize the chance for human error.\textsuperscript{3} For this reason, non-technical skills training, formally developed as Crew Resource Management (CRM) training, became mandatory for flight crews.\textsuperscript{24}

The translation of non-technical skills development from aviation to other fields, such as anesthesia, began to occur due to recognition of the importance of non-technical cognitive and social skills in the prevention of patterns of human error.\textsuperscript{3} Gaba and colleagues at Stanford University were among the first anesthesiologists to adopt the CRM training techniques (non-technical skills-focused training) used in aviation for use in anesthesia. They believed that measuring both technical and non-technical skills was necessary for crisis management in medicine and thus they incorporated the CRM techniques into their crisis management simulation-training program.\textsuperscript{5,25} This allowed them to analyze how the management of cardiac arrest, for example, was influenced by technical decisions (chest compressions or defibrillation) and behavioral decisions (decision-making or teamwork), so they could identify areas for improvement.\textsuperscript{25}
Anesthetists’ Non-Technical Skills System (ANTS)

A taxonomy prototype and behavioral analysis tool titled the Anesthetists’ Non-Technical Skills System (ANTS) was designed to be a structured, reliable, and formalized method of evaluating non-technical skills in anesthetists. This was developed in response to the growing use of simulation-based training and emphasis on non-technical skills training among anesthesia providers. It has been widely adopted by anesthetists in the United Kingdom, various international countries, and has also been applied to the instruction of student nurse anesthetists in the United States.

Development of ANTS. ANTS was developed by a team of psychologists and anesthetists from the United Kingdom who designed a taxonomy prototype and behavioral analysis tool that divided non-technical skills into four main categories: situation awareness, decision-making, task management, and teamworking. The development of ANTS was based on a variety of different data collections. Literature reviews explored research of human factors in anesthesia and theoretical and applied knowledge of non-technical skills in anesthesia. The results from a study on anesthetists’ views on teamwork and safety were also considered. Observations of anesthetist behaviors in the operating room, interviews of anesthetists by psychologists, surveys of medical simulation centers utilizing CRM-style courses, and 200 incident analysis reports were also used. It was structured around the European taxonomy of pilots’ non-technical skills (NOTECHS) system, and intended to be used in clinical and simulated scenarios.

The NOTECHS system is a rating method used within CRM courses designed to train pilots in non-technical skills necessary for safe and effective flight procedures. The ANTS skills framework incorporates aspects of the NOTECHS framework, but the four non-technical
skills are customized for anesthetists. These four non-technical skills were determined by a two-step process which identified skills and related behaviors known to impact safe and effective performance by anesthetists. This data was then consolidated, refined, and organized into a taxonomy. This highlights the concept that though main skill categories may apply to many professions (decision-making or teamwork) the main components of each and what is considered a “good” or “poor” behavior needs to be evaluated in a specific task or role.

To further evaluate the categories that comprise the ANTS framework, there is a four-point behavior-rating scale that grades the identified behavioral elements of each category. For example, in situation awareness the behavioral elements for observation include (1) gathering information; (2) recognizing and understanding; and (3) anticipating. The four-point scale then rates each element as poor, marginal, acceptable, or good, from one to four, respectively. A section for “not observed” is also included. This scale is juxtaposed with descriptors for the points which describe performance levels as well as relevance to patient safety. Concepts relevant to patient safety involve planning and preparing, prioritizing, and providing and maintaining standards. This allows for a more comprehensive evaluation and description of the non-technical skill.

**ANTS and Situation Awareness.** Siu et al. performed a prospective observational study using ANTS to observe behaviors in anesthetists and identify how specific behaviors relate to intraoperative incidents. Twenty-nine observations were made of which three were “good behaviors” and 26 were “poor behaviors”. Twenty-five out of the 26 “poor behaviors” were associated with avoidable intraoperative incidents. Further analysis showed that non-technical skill failures were most responsible for avoidable incidents, with poor situation awareness the most observed failure (15 observations). This study concluded that avoidable incidents in the
operating room and contributing behaviors could be effectively evaluated in anesthetists by using a taxonomy such as ANTS. This suggests that using a system such as ANTS may be useful for training and assessing situation awareness in anesthetists.31

**ANTS in Nurse Anesthesia.** A quasi-experimental study by Wunder in 2016 explored whether a simulation-based non-technical skills intervention using the ANTS system for evaluation would improve the non-technical skills performance in a crisis simulation among first-year SRNAs. In this study, 33 SRNAs participated in three pretest and three posttest simulations involving crisis emergencies at induction, maintenance, and emergence. One week after the pretest simulations, the SRNAs underwent a three-hour educational instruction of non-technical skills through the ANTS system. They then practiced applying the ANTS system to review different vignettes and participated in group discussions to facilitate understanding of the skills and the tool. A 1-tailed, paired-sample t test was used to evaluate the hypothesis that mean posttest scores for nontechnical skills scores would be greater than mean pretest nontechnical skills scores. The results showed that mean scores for SRNAs who underwent the intervention improved significantly compared to those who did not. Not only did this study apply the ANTS system to a nurse anesthesia program, but it found that the ANTS system can indeed be a valuable tool to assess non-technical skills in SRNAs.16

This study’s limitations include a lack of interrater reliability testing and student familiarity, and uses a convenience sample from one university in the United States.16 This study does not expose SRNA perceptions about their non-technical skills before and after the testing or about the simulation experience itself. This study does not incorporate the use of debriefing methods to allow the opportunity for instructor-led feedback. This study does however, suggest that further exploration of the use of behavioral analysis tools, such as the
ANTS system, are important to furthering the clinical development of students in the field of nurse anesthesia. This warrants further investigation of the impact of ANTS in simulation-based training programs on situation awareness perception and performance in SRNAs, particularly as trainees in the clinical environment.

**Situation Awareness**

Situation awareness (SA) is defined as “the perception of elements of the environment within a volume of time and space, the comprehension of their meaning and the projections of their status in the near future”. It is used to describe the ability of one to be present and active in their current environment to the extent that they may also anticipate future transformations or events. Anesthetists depend on robust situation awareness to safely and effectively manage patients intraoperatively. It can greatly influence attention such that flaws in SA can increase chance for human error to occur. The concept of SA was first established in the aviation industry and the military, and comprehensively presented as a theoretical model by Endsley in the 1980s. This concept has subsequently been applied to the field of anesthesia where characteristics of aviation such as dynamism, complexity, high information load, variable workload, and risk are highly relevant. These implications are the reason for increasing research on how to design training modules and training equipment to enhance the development and application of SA for clinical practice.

**Theoretical Framework.** Endsley’s theoretical model has become the most universally accepted model of situation awareness in literature. It was constructed based on the assumption that situation awareness is an essential factor involved in decision-making and performance in a variety of dynamic systems. It also expands the definition of SA beyond an awareness of pertinent data, to include the ability to anticipate and formulate actions to achieve future goals.
The model divides SA into three levels, directly impacted by the state of the environment and the individual’s abilities, experience, and training. Level One (L1) involves the perception of elements in the current situation (perceiving an airway as difficult after examination), Level Two (L2) involves comprehension of the current situation (possible difficulty intubating or ventilating), and Level Three (L3) involves the projection of future status (unsecured airway causing failure to oxygenate). It is at the transition between L1 and L2 that novice operators may be insufficient, meaning that novice SRNAs for example, may be capable of determining an airway is difficult similarly to an expert anesthetist, but may not be able to extrapolate their findings to a more complete clinical situation (what that difficult airway means for their decisions and ultimate goals). L3 emphasizes the uniqueness of SA being more than assessing and understanding a situation, but also a true ability to formulate plans and alternative plans to yield decisions that are resilient in a complex and dynamic environment. It is regarded as the highest level of SA and it is where a person’s goals and expectations determine how attention is directed and how information is processed and projected.

Furthermore, it is also necessary to mention several other factors influencing SA which include integration of long-term memory, working memory capacity, limits in attention, confidence levels, automaticity of decision-making, and perceived stressors. Automaticity is of interest because it describes the ability of the nurse anesthetist to perform a task with little thought, which allows one to surmount certain limits in attention for a more robust SA. For this reason it has been called a defining characteristic of an expert and thus highlights how novice anesthesia providers may be more prone to faults in SA while training.

**Errors and Issues in SA.** Errors in SA exist at the point in each level where the clinician would be at risk of improperly perceiving, comprehending, or acting on given factors,
thus allowing for incorrect decisions or processes to occur. Error at L1 vary from simple obstruction of view (not looking over the drape to visualize blood loss on the surgical field) to failure of the system to provide necessary information (the blood pressure cuff not producing accurate measurements). L2 errors involve the lack of ability to analyze and process information, or improperly incorporating the information into a plan. This is a stage that must be stressed in the novice provider, as limitations in training and clinical comprehension may lead to increased susceptibility to error. L3 errors occur due to incomplete or incorrect incorporation of information making accurate projection of future events difficult or faulty. This can be influenced by a person’s innate lack of ability to mentally simulate events, or by limitations in memory or attention. It is reasonable to understand how a novice clinician would be more susceptible to errors at this level due to inexperience or lack of exposure to necessary knowledge and practice.

Lastly, issues arise surrounding one’s knowledge of their own errors in SA. Meaning, at times the clinician may not even be cognizant of the information they are lacking or of their own misperceptions or misinterpretations of the situation at hand; not knowing what they do not know. This is a factor of SA that leaves novice clinicians vulnerable to error and susceptible to downstream consequences of basic misinterpretation or cognitive limitations.

**Situation Awareness in Anesthesia.** Situation awareness has become an area of increasing interest in nurse anesthesia programs because flaws in SA are major factors when considering the human causes of error in the US healthcare system. A prospective observational study by Siu et al. in 2013 used behavioral analysis tools specific to surgeons, anesthetists, and operating room nurses to examine the mechanisms by which intraoperative incidents and adverse events occurred in 51 surgical procedures. The ANTS system was used to
observe behaviors in anesthetists. The results showed that poor situation awareness was the most observed non-technical failure in anesthetists. Furthermore, compared to surgeons and nurses, anesthetists were the most vulnerable to avoidable intraoperative incidents due to poor situation awareness behaviors. This is particularly relevant in an environment created by a multitude of dynamic data and prone to the unexpected, such as the operating room, where constant attention and situation awareness are critical.

A study by Wright et al. was published by the American Association of Nurse Anesthetists Journal in 2011 and used Endsley’s model to examine the relationships between memory, cognition, automaticity, and SA in SRNAs. The purpose of the study was to provide nurse anesthesia educators with a means to examine SA in the SRNA by analyzing those individual attributes. An exploratory, nonexperimental, correlational design was used and subjects included 71 SRNAs from three different US universities. They found that cognitive processes such as pattern matching, conscious analysis, story building and mental stimulation are used by the SRNA to develop SA. This was proven as a direct positive linear relationship between cognition and SA by computing a Pearson product moment correlation ($r$) and a correlation matrix output revealing an $r$ value of 0.442 ($P= .000$). This is relevant because knowledge of what can contribute to SA in SRNAs may assist educators in how to best utilize resources to facilitate its development. This is important for the training of SRNAs entering a field where obtaining skills like SA are important to avoid adverse outcomes such as patient morbidity or mortality.

Situation awareness is said to be a major component of effective problem solving, decision-making, and attention. It has been stated that it is possible to increase acquisition and quality of these skills by employing training that targets specific SA skills relevant to nurse
anesthesia, though continuing research is needed to support this process. Furthermore, research has shown that simulation-based training programs may be useful in providing the opportunity for experiences with real-time decision-making in scenarios with unfamiliar or unpredictable events. Additional exploration of SA using Endsley’s theoretical framework and simulation-based training programs may be useful in assessing the impact and development of SA in nurse anesthesia programs.

*Simulation Training*

Simulation training is described as a process by which actions are imitated and practiced in controlled environments with the intention of being applied to real-life scenarios. This practice began hundreds of years ago and has since become more commonplace in the realms of high-reliability organizations such as the aviation, nuclear power, and healthcare industries. The Institute of Medicine report, *To Err Is Human: Building a Safer Healthcare System*, recommended simulation-based training as a method of teaching clinicians to perform as effectively as possible to minimize errors that can result in morbidity or mortality. While simulation training in healthcare has largely been focused on the development of technical skills, there has been increased interest in developing nontechnical skills, such as situation awareness, to influence task performance, minimize chance for human error, and enhance patient safety.

**Benefits of Simulation.** Simulation training is increasingly useful in healthcare due to advances in technology and the ability to practice technical skills without risk to a patient. Simulation-based training provides a means of developing skills in a safe and controlled environment and also serves as an assessment tool for refining skills. This provides guidance and structure as one progresses from novice to expert. Furthermore, a systematic
review of qualitative and quantitative literature published between 2000 and 2016 by Alanazi et al. determined that the use of simulations in healthcare student education significantly improves knowledge, skills, and self-confidence.15

Simulations may also enhance students’ ability to transfer previous knowledge to new situations, compared to other methods of learning.11 This process of transferring knowledge from a controlled setting to a clinic or place where care is delivered is termed “translational science” by the medical community.8 The purpose of translational science is to use an educational tool like simulation-based training to target an individual or a team to improve knowledge, skills, attitudes, professionalism, and ultimately patient care and outcomes.8

A prospective, randomized, controlled trial by Mayo et al. designed and tested a program using a computer-controlled patient simulator to train medical interns and assess their competence in initial airway management skills during cardiac arrest. Fifty interns were included and divided into three groups. One group consisted of interns who were tested in phase one and immediately received training with a simulator (immediate training or IT group). Another group consisted of interns who were tested in phase one and received simulator training four weeks after (delayed training or DT group). The last group was neither tested nor trained initially (NTI group) in phase one, but instead during phase two, four weeks after the initial testing in phase one. The NTI group received simulator training immediately after testing in phase two of the study. There was no significant difference in scores before training between the IT and DT groups, however, more interns from the IT group attained perfect scores on the second test compared to the DT group (80% versus 0%, \( p < .001 \)).9 The interns in the NTI group received similarly low scores as the two other groups had before training. As follow up, the same attending physician that was part of the training program observed and scored 57 initial
airway management events performed by 41 different interns from the study 10 months following training. The interns were observed and scored on their ability to complete the appropriate clinical management steps developed in training such as attaching and turning on oxygen, standing at the head of the bed, or attaching suction to list a few. These management steps were enacted by all or nearly all of the interns (91% to 100%) and directly observed in real-life clinical scenarios. This study concluded that computer-controlled patient simulators are effective in improving emergency airway management skills and are useful in demonstrating competence in clinical skills. Furthermore, this study provides evidence that skills developed through simulation-based training are transferable to real clinical scenarios. 

This study also adds validation to the concept that simulation-based training may add a different though effective means of learning material for application to real-life, as compared to standard didactics alone. 

Simulation-based training provides a controlled environment to challenge the SRNA to think critically, reevaluate priorities, and understand the consequences of decisions, all of which are integral to maintaining SA. These simulations can be used to develop or assess skills, increase confidence levels in clinical practice, and facilitate the translation of knowledge from the place of obtainment (simulation lab) to the place of practical application (the operating room). A retrospective case-control study by Wayne et al. explored the impact of simulation-based education on team responses and the quality of care during cardiac arrest at an academic teaching hospital. All the residents received traditional ACLS (Advanced Cardiac Life Support) training and one group also received training on a simulator. Data on ACLS events that involved the residents was collected and reviewed. The results showed that simulator-trained residents applied correct American Heart Association (AHA) standards more compared to the
traditionally trained residents \( (p= 0.001, \text{ with odds ratio for appropriate ACLS response of 7.1, with 95\% confidence interval}) \). This study showed that simulation-based training can improve the quality of care delivered. It also showed how simulation-based training can be a useful supplement to traditional bedside and clinical teaching.\(^{12}\) These concepts have implications in improving patient safety and outcomes, and thus are the driving force for further research in simulation-based training.\(^{8,38}\)

**Standards for Simulation Development**

Simulation-based training is affected by numerous factors including the quality of the scenario, the instructor expertise, and the feedback process.\(^{40}\) For this reason, the International Nursing Association for Clinical Simulation and Learning (INACSL) published evidence-based guidelines as a standard of best practice for simulation design in 2016. The standard states that simulation-based experienced should be designed to meet identified objectives and optimize achievement of expected outcomes.\(^{41}\) The eleven listed criteria necessary to meet the standard established by the INACSL are the following: (1) perform a needs assessment to provide the foundational evidence of the need for a well-designed simulation-based experience; (2) construct measurable objectives; (3) structure the format of a simulation based on the purpose, theory, and modality for the simulation-based experience; (4) design a scenario or case to provide the context for the simulation-based experience; (5) use various types of fidelity to create the required perception of realism; (6) maintain a facilitative approach that is participant centered and driven by the objectives, participant’s knowledge or level of experience, and the expected outcomes; (7) begin simulation-based experiences with a predebriefing; (8) follow simulation-based experiences with a debriefing and/or feedback session; (9) include an evaluation of the participants, facilitators, the simulation-based experience, the facility, and the support team; (10)
provide preparation materials and resources to promote participants’ ability to meet identified objectives and achieve expected outcomes of the simulation-based experience; and (11) pilot test simulation-based experiences before full implementation. These criteria were developed based on validated theories of learning, further analysis of the subject, and clinical standards of care. The INACSL has stated that not adhering to the standards created for simulation development has the potential to result in ineffective assessment of the participants, inability of the participants to meet the goals, failure to yield the expected results, and improper utilization of resources.

It is also necessary to mention studies done by Jeffries with the National League for Nursing and Laerdal National Simulation Project Group. This work was used to establish a framework for designing, implementing, and evaluating simulations as teaching strategies in nursing that were referenced by the INACSL in the standard of best practice for simulation development. This work determined seven factors that create a well-developed simulation which include (1) clearly written objectives; (2) fidelity or realism that mimics real life situations; (3) building a level of complexity for the learner (4) providing cues for participants as the simulation progresses; and (5) debriefing. This further highlights the importance of considering the many factors that can influence the simulation development and experience.

**Fidelity and Integrated Simulators.** The concept of fidelity is ubiquitous in simulation development to describe the reality of the experience. The types of fidelity reviewed by Maran and Galvin and published in the *Medical Education* journal describe psychological or functional fidelity as a more important factor than engineering fidelity. This means the manner of use of the simulator and the environment created is more substantial than the state of the technology in increasing the overall fidelity. The reproduction of the setting and event must
be as similar as possible to the true clinicals situations and environment so that the learner is not exposed to inaccurate experiences.\textsuperscript{40,42} There are also appropriate simulators for levels of training and for specific skills (technical versus non-technical), suggesting that aspects of clinician experience and target skill must be considered when developing a simulation.\textsuperscript{45} For example, to assess situation awareness, it will be necessary to choose a technical skill or event that the learner is competent in otherwise there are added dimensions and factors such as unwarranted stress or technical challenges that will interfere with the target skill for assessment.\textsuperscript{40}

*Debriefing*

Debriefing is increasingly useful for examining technical skills as well as for allowing the learner to analyze their cognitive processes such as decision-making and situation awareness.\textsuperscript{46} Though it has been identified as the most important feature of simulation-based training, \textsuperscript{18,47} there have been few studies formally exploring its application in this area.\textsuperscript{48} Consequently, Gaba and colleagues completed a review to further analyze and expand on the concept of debriefing to establish new directions for its implementation and development in simulation-based training.\textsuperscript{48}

The concept of debriefing has roots in three areas: the military, emergency first responders, and experimental psychology.\textsuperscript{48} Debriefing in these fields was used to analyze experiences to strategize for future missions, develop a therapeutic outlet and team behavior by sharing experiences, and reduce stress and facilitate recovery after a critical incident.\textsuperscript{48} In healthcare, debriefing is considered the supreme component of the simulation experience because it allows for critical dialogue to occur on how to improve the performance of an individual or team which can ultimately impact patient care.\textsuperscript{18,19}
Objectives in Debriefing. Debriefing has been defined as “a conversation between two or more people to review an event in which participants analyze their actions and reflect on the roles of thought processes, psychomotor skills, and emotional states to improve or sustain performance in the future.” Fanning and Gaba completed an extensive review about debriefing in simulation-based learning, focusing on the process of its development. They highlighted how debriefing sessions made to explore a specific factor (i.e. situation awareness) allow the facilitator to examine the performance of the individual and assess areas of strength or areas where improvement is needed. It is said that debriefing is conducted by instructors to facilitate the educational development of practitioners and is highly dependent on their ability to create a “supportive climate”. Such a climate must be formed at the beginning of the session by establishing trust by ensuring the participants feel valued, respected, and free to learn and candidly share their experiences. The setting for debriefing is also important and should take place in an area that is comfortable, private, intimate and separate from the simulation room to allow for diffusion of tension. Finally, the elements of “good” debriefing sessions included using open-ended questions, positive reinforcement, cognitive aids, audiovisuals, and self-debriefing, whereas “poor” sessions involved closed questions, ridicule, criticism, and focusing on errors.

Elements of Debriefing. The INACSL referenced Lederman’s comprehensive review and analysis of the debriefing process and effective strategies for its use in simulation development. There are many different ways to debrief but there are seven structural elements identified by Lederman that are common to most forms. These elements are the debriefer, the participants to debrief, the experience (simulation), the impact of the experience, recollection, report, and time. The impact of the experience as a structural element is important because it is
known through the widely accepted work of Malcolm Knowles, and his published theory of andragogy, that adult learners must view an experience as important and meaningful in their everyday lives in order for it to make an impact and have worth. Gaba et al. presented the element of time as important because it can affect the way the debriefing is viewed, depending on how soon or how long after the experience occurs.

**Value of Debriefing.** Debriefing has been considered to be the “heart and soul” of the simulation experience because of its ability to strengthen clinical performance to improve patient safety. One study by Shinnick et al. used an experimental design to examine the impact of a hands-on simulation with and without debriefing to determine where greatest knowledge gains occur. They divided a group of nursing students (n=162) into an experimental and control group and assessed clinical knowledge of heart failure. The experimental group was given a baseline pretest before hands-on simulation, then a test following hands-on simulation only (posttest 1). This group underwent a debriefing session after posttest 1 and was then given posttest 2 (after both hands-on and debriefing). The control group took the same pretest, then took posttest 1 within one hour (prior to simulation). They then underwent the hands-on simulation experience with debriefing and took posttest 2. The experimental group had higher scores than the control group on posttest 1, and continued to have higher scores on posttest 2 scores compared with the control group’s posttest 1 scores ($p=.009$). The results also showed a decrease in scores from the pretest to posttest 1 ($M=-5.63, SD=3.89; p<.001$), whereas there was a dramatic improvement in scores from the pretest to posttest 2 ($M=+6.75, SD=4.32; p<.001$). There was also a significant difference found between the pretest and posttest 2 scores for both groups ($M=6.75, SD=4.32$). From this, they concluded that the greatest knowledge gains occurred after
debriefing, suggesting further emphasis be placed on incorporating debriefing into simulation learning experiences.\textsuperscript{17}

Another study by Savoldelli et al. in 2006 used the ANTS system to explore the value of debriefing following simulation training in anesthesia. The aim was to identify if an advantage existed between debriefing using video-assisted oral feedback or oral feedback alone versus no debriefing. This study examined anesthesia residents (n=42) and analyzed the impact of the type of debriefing (video-assisted oral feedback or only oral feedback) versus no debriefing on the development of their non-technical skills. It found that there was no improvement in non-technical skills in the group of residents that did not receive any type of debriefing (control group= -1\%), whereas there was a significant improvement in non-technical skills in the group that received debriefing ($p < 0.005$). No significant difference was found between using video replay and oral discourse. This study concluded that an exposure to a simulation without a debriefing by instructors is less beneficial to trainees. Further research has validated that there is no significant difference in type of debriefing method, though one should be employed in simulation-based training.\textsuperscript{46,52}

Debriefing allows the learner to reflect, analyze, understand, and synthesize thoughts and feelings to improve future performance with structure and guidance.\textsuperscript{53} This may be a valuable tool for surmounting the error in SA that results from one being unaware of information they are lacking or of their misperceptions or misinterpretations of a given situation.\textsuperscript{4} Offering an opportunity for instructor-led debriefing within this training program can allow useful dialogue and reflection to occur which can ultimately equip the Student Registered Nurse Anesthetist with an experience that may impact their situation awareness in clinical practice.\textsuperscript{53} Therefore,
debriefing as a component of a simulation based-training program to assess SA in the SRNA should be explored.

Conclusion

It is the goal of nurse anesthesia education to prepare the Registered Nurse to effectively transition into the Certified Registered Nurse Anesthetist role. This may involve using simulations to develop technical and non-technical skills in an attempt to optimize patient safety and delivery of quality anesthesia care. The use of simulation-based training is growing in the healthcare industry as a useful tool to develop both technical and non-technical skills in a controlled and safe environment. The concept of debriefing as part of simulation-based training program has increasingly been recognized as a way to optimize learning, strengthen clinical performance, and improve patient safety.

In high-reliability industries, such as the field of anesthesia, it is understood that the non-technical skill of situation awareness allows for better perception, comprehension, and projection of factors which ultimately creates more effective thought-processes. Such thought-processes manifest through appropriate actions and decisions. Errors in SA leave novice clinicians vulnerable to mistakes and susceptible to the downstream consequences of their basic misinterpretations or cognitive limitations. They are also the leading causes of avoidable intraoperative incidents created by anesthetists.

This literature review reveals situation awareness as a critical factor in patient safety and simulation-based training as a tool that can be used to develop, assesses, and refine situation awareness in a controlled environment for translation to clinical practice. In spite of these details, no formal integration of a simulation-based training program to influence situation awareness exists in nurse anesthesia programs. This strengthens the need for further research.
evaluating the impact of a simulation-based training program on situation awareness in nurse anesthesia programs.
CHAPTER 3: Methods

Methodology

This chapter will provide the methodology that was used to answer the research questions that guided this study. These questions were (1) Does the implementation of a simulation-based training program including debriefing impact situation awareness in the SRNA? (2) What are SRNA perceptions of the simulation-based training program including debriefing on situation awareness? This chapter will also provide the research design, sample, instrumentation, procedure, data analysis, and protection of human subjects.

Research Design

This study was conducted using a quasi-experimental design. This research design was used to evaluate the effects of a simulation-based training program on situation awareness in Student Registered Nurse Anesthetists. This research also explored SRNA perceptions of the simulation-based training experience on situation awareness.

After obtaining informed consent, this study was completed in five steps: (1) initial pre-simulation training questionnaire, (2) first simulation involving assessment of situation awareness skills, (3) an intervention involving a standardized didactic lesson on situation awareness and a structured debriefing session, (4) a post-intervention second simulation involving reassessment of situation awareness skills, and (5) completion with another structured debriefing session and post-simulation training questionnaire.

Sample

Subjects were obtained through convenience sampling of student registered nurse anesthetists from an accredited Doctor of Nurse Anesthesia Practice Program (DNAP) at a university in the United States. These subjects volunteered to participate in this study. Inclusion
criteria consisted of enrollment in the selected accredited Doctor of Nurse Anesthesia Practice Program as a second-year SRNA. Exclusion criteria included any SRNA that had already undergone their second year of DNAP education or had already accomplished more than one month of clinical training in the operating room as a SRNA. The sample size was calculated using the Raosoft Sample Size Calculator with a 5% margin of error, a 90% confidence interval, a population size of 25, and a 50% response distribution. The minimum recommended sample size for this study to meet these criteria is 23 subjects (Appendix A).

Instrumentation

Three data collection tools were used in this study. Each data collection tool was linked together via a randomly chosen number from an envelope with numbers one through 10 inscribed on individual pieces of paper. The subject was asked to discretely write their randomly chosen number on the back of all of their tools to maintain anonymity. Each subject also wrote their name and corresponding number on a master list that was kept private and sealed in an envelope. This allows each subject to retrieve their data at any point in time should they request to do so. Each subject was also provided with a folder to keep all tools together and hidden throughout the study.

The first data collection tool was the pre-simulation training questionnaire (Appendix B). This questionnaire was completed by the subject prior to the initial simulation experience. This tool was used to gather anonymous descriptive data on the subjects and gauge SRNA perceptions of situation awareness using a Likert scale. This was used to evaluate SRNA perceptions of situation awareness and the simulation-based learning experience before and after the simulations and intervention.
The second tool was the Anesthetists’ Non-Technical Skills System (ANTS) behavioral analysis tool and four-point rating scale for situation awareness combined with simulation-specific tasks. As a combined entity, this tool was called the “Annotated ANTS Assessment Tool” (Appendix C). The ANTS behavioral analysis tool with the four-point rating scale was developed by experts in anesthesiology and psychology. This tool was developed as a means for observing and grading non-technical skills, such as situation awareness, in anesthetists. This tool is validated and available for use by clinical professionals and intended to be used in both clinical and simulated scenarios. The Annotated ANTS Assessment Tool was used to record observable skills during the simulation as well as to make evident any skills that are not appreciated so that performance can be scored and discussed with structured debriefing. Furthermore, this allowed the researcher to evaluate the effectiveness of the simulation-based training program through comparison of pre- and post-intervention scores.

The third tool was a post-simulation training questionnaire (Appendix J). This questionnaire was administered to the SRNAs upon completion of the debriefing and didactic intervention and the second simulation. This questionnaire was developed using a Likert scale for assessment of the SRNA’s experience with the simulation-based training program and their perception of its impact on situation awareness. This tool also allowed the researcher to compare results to the pre-simulation training questionnaire values to evaluate whether or not the SRNAs perceived an impact on their situation awareness after undergoing the simulation-based training program.

Five expert reviewers were selected to review these data collection tools. It must be noted that Appendix C depicts the Annotated ANTS System Tool. The original ANTS Tool and corresponding rating scale have been reviewed and expertly validated. Experts reviewed the
tool in conjunction with the simulation-specific actions that were added for this study. The first expert reviewer was a Certified Registered Nurse Anesthetist (CRNA) with a PhD and extensive experience in clinical and didactic education. The second expert reviewer was a CRNA with a Doctorate of Nursing Practice (DNP) and extensive experience in clinical and didactic education. The third expert reviewer was a CRNA with a Doctorate of Nurse Anesthesia Practice (DNAP) and experience training SRNAs in a hospital setting. The fourth expert reviewer was a CRNA with a DNP and extensive experience in clinical and didactic education. Finally, the fifth expert reviewer was a PhD with a background in the development of training and assessment tools that address cognitive, perceptual, and human factor-related concepts as well as medical training simulations.

Procedure

Participants were recruited through the accredited DNAP program at the university selected for this study after approval from the Institutional Review Board. The recruitment was done via electronic mail with specific information and instructions about the study and the letter of consent attached. This allowed ample time for the subjects to review the study implications and prepare questions. This was then followed by the lead researcher attending a class meeting at a later date where all eligible subjects were present to discuss information about the study and its purpose, and to answer any questions. At this meeting the subjects were informed of an electronic sign-up sheet that was made available for them to sign up for a one-hour time slot that was most convenient for them. They were given two different dates to participate in the 55-minute study for their convenience. They were instructed to only sign up for one time slot on one of the days listed. The subjects in this study were recruited on a voluntary basis. The simulations, interventions, and data collections were completed on the same day.
Permission was obtained to utilize the simulation lab at the university selected for this study. This study utilized a high-fidelity integrated simulator consisting of a whole body manikin, the Human Patient Simulator (HPS), designed and manufactured by CAE Healthcare. The HPS was controlled by a lab technician using a software system called Muse. This lab contains a Datex-Ohmeda Anesthesia workstation, which the students have obtained experience using in technical skills training labs as part of the DNAP curriculum. In order to minimize variability, the manikin was preprogrammed for each simulation and the lab technician had a manuscript to regulate and monitor the manikin through various responses as the simulation progressed. In addition, the lead researcher and the same selected grading assistant were used for each subject, for each simulation, and for each day of the study to optimize grading consistency.

The assistant grader was an individual with clinical experience in anesthesia and simulation-based learning. The assistant grader was given instruction on situation awareness as it is described by the ANTS system, on the Annotated ANTS tool that was used to observe and score the subjects (Appendix C), and on the manuscripts that were used during the simulation for reference (Appendices E & I).

The simulation environment is designed to replicate an operating room (OR) milieu. An actor representing a CRNA was also present in the simulated OR. In this simulation lab there was a double-sided mirror that separated the simulated OR from the control room where the lead researcher, the grading assistant, and the lab technician completed their duties. This allowed the lead researcher and the grading assistant to utilize the Annotated ANTS Tool (Appendix C) to privately observe and assess actions of the SRNA during the scenario. The lab technician was present to follow the manuscript in order to regulate and monitor the simulation as needed.
This study was completed in multiple steps with multiple data collection tools. Each step will be explained in the following paragraphs.

**Step 1: Initiation.** After obtaining informed consent from each subject, five minutes were allotted for each subject to complete the pre-simulation training questionnaire (Appendix B). After completion of this form, the subjects began the first simulation.

**Step 2: First Simulation.** The purpose of this initial simulation was to establish a baseline performance for each subject. The initial simulation involved each subject entering the simulation lab with the following instructions: (1) to treat this simulated environment and patient as if it were the real operating room and a living human being; (2) to vocalize all thoughts and actions as thoroughly as possible; and (3) to not discuss the simulation with other students. The subject was given a paper that had the clinically relevant information about the simulated patient to review for three minutes before entering the simulation (Appendix D). Each simulation was limited to ten minutes. The lead researcher and the same selected grading assistant were present behind the double-sided mirror. They had the Annotated ANTS System Tool to guide their observations and rate performance (Appendix C). A lab technician with training on how to operate the simulation and the manikin helped run the first simulation following a manuscript (Appendix E) to maximize consistency and accuracy for each subject. This manuscript was also available to the lead researcher and assistant grader for review and reference throughout the simulation. An actor with training in nurse anesthesia practice was present as a CRNA so that the SRNA could interact with the CRNA, much like in a real-life scenario.

The simulation involved a patient presenting to the operating room and undergoing general anesthesia for a surgical procedure (Appendix D). A hypotensive predicament occurred to gauge the subject’s ability to demonstrate the three elements of situation awareness per the
ANTS System. The lead researcher and the same grading assistant then recorded observations and assigned a score using the Annotated ANTS System Tool (Appendix C).

**Step 3: Intervention.** Immediately following the first simulation, the subjects underwent the intervention. This involved a didactic course on the ANTS system, its implications for situation awareness, and its relevance to the practice of nurse anesthesia (Appendix F). This course was presented via a booklet created by the author of the study. The subject had 10 minutes to review the booklet. After the subject completed reviewing the booklet, they were allowed to ask any questions that occurred to them. They then underwent a five minute period of instructor-led debriefing. This was done by the lead researcher using the Annotated ANTS System Tool and a script to follow (Appendices C & G, respectively). The objectives for the debriefing session were to provide specific examples from the subject’s performance in the simulation which adequately (or inadequately) reflected the elements of situation awareness as well as to provide a numeric value for rating and comparing future performance.

**Step 4: Second Simulation.** Upon completion of the intervention phase, members from each group re-entered the simulation lab and underwent a second simulation. This was conducted by the same lead researcher and the same assistant grader as the first simulation. The student was again given a paper that had the clinically relevant information about the simulated patient (Appendix H) to review for three minutes before entering the simulation. Each simulation was limited to ten minutes. The lead researcher and the same selected grading assistant were present behind the double-sided mirror. They had the Annotated ANTS System Tool to guide their observations and rate performance (Appendix C). A lab technician with training on how to operate the simulation and the manikin helped to run this second simulation following a manuscript (Appendix I) to maximize consistency and accuracy for each subject.
This manuscript was available to the lead researcher and assistant grader for review and reference throughout the simulation. An actor with training in nurse anesthesia practice was present as a CRNA so that the SRNA could interact with the CRNA, much like in a real-life scenario.

This simulation again involved a patient presenting to the operating room and undergoing general anesthesia for a surgical procedure. This time, a hypertensive predicament occurred to gauge the subject’s ability to demonstrate the three elements of situation awareness per the ANTS System. The lead researcher and the same grading assistant then recorded observations and a numerical rating using the Annotated ANTS System Tool (Appendix C). These observations and scores were used to compare performance pre- and post-intervention.

**Step 5: Completion.** Immediately following the second simulation each subject again underwent structured debriefing lasting five minutes. This debriefing was done using the Annotated ANTS System Tool (Appendix C). It again followed the script presented in Appendix G. The objectives for the debriefing session were again to provide specific examples from the subject’s performance in the simulation which adequately (or inadequately) reflect the elements of situation awareness, as well as to provide a numeric rating to compare to previous performance.

Finally, a post-simulation training questionnaire (Appendix J) was given to each student to complete and anonymously submit in a private folder to be placed in a locked box for protection. The subject was allowed as much time as they desired to complete this questionnaire. This document was also numerically coded and the student was reminded that it would be kept anonymous. This document was used to obtain SRNA perceptions of situation awareness and
the simulation-based training program. Completion of this questionnaire marked the conclusion of the simulation-based training experience.

Data Analysis

The results of this pilot study were primarily qualitatively analyzed using Microsoft Excel due to the nature of a small sample size. However, paired samples $t$ tests through SPSS were able to achieve statistically significant results in certain data sets. The largest possible sample size would have had 24 subjects, however, only nine subjects volunteered to participate.

Protection of Human Rights

An Informed Consent document was provided to each individual who volunteered to participate in this study. This document described the study and its purpose. It informed the subject that all information obtained from the data collection tools would be kept anonymous and confidential. It notified the subjects of securement of data collection tools in password-locked computers and/or a locked box, only accessible by researchers involved. Furthermore, all the researchers involved underwent a course on the protection of human subjects by the National Institute of Health (Appendix K). In acknowledgement of the fact that the researcher attended the same university as the subjects, a point was made to assure the subjects that their performance would not be discussed or shared with any individual, including program faculty. They were informed that by no means would participation or lack of participation in this study directly impact their grades in this DNAP program. This document also informed the subject of their right to withdraw from the study at any time without consequences. Finally, approval by the Institutional Review Board at Georgetown University was obtained prior to initiation of this study.
CHAPTER 4: Data

Sample

Demographic Data. Of the nine subjects, four were male (44%) and five were female (55%). The average age of the subjects was 29.5 years. Nationally, 41% of CRNAs are male, and this convenient sample also reflects that statistic.\(^{54}\)

Clinical Characteristics. Each subject was eligible to participate in the study if they were enrolled as a first year SRNA at the university where this study took place. In this program, each subject is required to have at least two years of critical care experience.

Each subject was asked for a range of two years that best reflected their time spent as a Registered Nurse (RN). Two subjects spent one to two years as RNs. The remaining seven subjects had at least three years of experience as RNs. Three of those remaining subjects spent three to four years as RNs. The other three spent five to six years as RNs, and one subject spent nine or more years as a RN. The subjects were asked to further specify how many of those years were spent as ICU RNs. The average number of years the subjects spent as ICU nurses was 3.7 years. Nationally, the average number of years spent as an ICU RN upon entering a nurse anesthesia program is 2.9 years.\(^{54}\)

The subjects were also asked to select the types of ICUs they obtained experience working in. Three of the subjects worked in two or more types of ICUs, while the other six worked in only one ICU. One subject also included experience working as part of a rapid response team. The most notable ICUs where the subjects previously worked were the Cardiac ICU (six subjects), the Surgical ICU (four subjects), the Medical ICU (three subjects), and the Trauma/Burn ICU (three subjects). None of the subjects worked in a Neonatal or Pediatric ICU.
Table 1. Demographic Data.

<table>
<thead>
<tr>
<th>Demographic Data</th>
<th>Sample (n=9)</th>
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</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
</tr>
<tr>
<td>Male (n)</td>
<td>4 (44%)</td>
</tr>
<tr>
<td>Female (n)</td>
<td>5 (55%)</td>
</tr>
<tr>
<td><strong>Age (mean ± SD)</strong></td>
<td>29.5 ± 3.2 years</td>
</tr>
<tr>
<td><strong>RN Experience (mean + SD)</strong></td>
<td>4.3 ± 2.3 years</td>
</tr>
<tr>
<td><strong>ICU Experience (mean + SD)</strong></td>
<td>3.7 ± 2.0 years</td>
</tr>
<tr>
<td><strong>Previous ICU Experience</strong></td>
<td></td>
</tr>
<tr>
<td>Cardiac ICU (n)</td>
<td>6 (66%)</td>
</tr>
<tr>
<td>Medical ICU (n)</td>
<td>3 (33%)</td>
</tr>
<tr>
<td>Neurosurgical ICU (n)</td>
<td>1 (11%)</td>
</tr>
<tr>
<td>Trauma/Burn ICU (n)</td>
<td>3 (33%)</td>
</tr>
<tr>
<td>Surgical ICU (n)</td>
<td>4 (44%)</td>
</tr>
<tr>
<td>Other- Rapid Response (n)</td>
<td>1 (11%)</td>
</tr>
</tbody>
</table>

Findings

The results of this pilot study were measured by 1) the Pre-Simulation Training Questionnaire, 2) the Post-Simulation Training Questionnaire, and 3) the Annotated ANTS Assessment Tool scores.

Analysis of the Pre-Simulation Training Questionnaire. The Pre-Simulation Questionnaire was designed using a Likert Scale with the numbers one through five. The answers associated with each number are as follows: 1- “strongly disagree”, 2- “disagree”, 3- “neutral”, 4- “agree”, and 5- “strongly agree”. The first four questions in the Pre-Simulation Training Questionnaire are identical to the first four questions in the Post-Simulation Training Questionnaire for comparison. For this reason, the same questions will be marked with “a” if they are from the Pre-Simulation Questionnaire, and “b” if they are from the Post-Simulation Training Questionnaire in each respective data table (see Table 2 and Table 3).
The first question (1a) asked whether the subject understood “the concept of situation awareness as it pertains to nurse anesthesia.” The average numerical response was 3.1 ($SD=0.9$), representing overall neutrality in regard to an understanding of the concept and its application to their practice. The second question (2a) asked if the SRNA felt they “can properly apply the non-technical skill of situation awareness to the intraoperative management of a patient.” The average number response was 2.6 ($SD=0.7$), meaning the subjects disagreed or were neutral about being able to apply this skill intraoperatively. The third question (3a) asked if “situation awareness is an essential non-technical skill that should be taught to SRNAs.” The average number response was 4.4 ($SD=0.7$), which represents overall agreement amongst the subject pool that this skill is essential and should be taught. The fourth question (4a) asked if “a simulation-based training program on situation awareness should be formally incorporated into the DNAP curriculum.” The average number response was also 4.4 ($SD=0.7$), again expressing overall agreement amongst the subjects that such a training program should indeed be formally incorporated into the curriculum. The last question (labeled Pre-Sim) asked whether the subject had “received prior training or instruction on situation awareness.” The average number response was 2.7 ($SD=1.3$), meaning overall the subjects disagreed or remained neutral on having received prior training or instruction on this non-technical skill.
Table 2. Results from Pre-Simulation Training Questionnaire.

<table>
<thead>
<tr>
<th>Subject</th>
<th>Question 1a</th>
<th>Question 2a</th>
<th>Question 3a</th>
<th>Question 4a</th>
<th>Question Pre-Sim</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>2</td>
<td>5</td>
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<td>3</td>
<td>3</td>
<td>5</td>
<td>5</td>
<td>1</td>
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</table>

**Question Pre-Sim:** “I have received prior training or instruction on situation awareness.”

Likert scale responses recorded: 1= strongly disagree, 2= disagree, 3= neutral, 4= agree, and 5= strongly agree.

### Analysis of the Post-Simulation Training Questionnaire

The Post-Simulation Questionnaire was also designed using a Likert Scale with the numbers one through five. It was administered after the intervention and second simulation. The first four questions in the Post-Simulation Training Questionnaire were identical to the first four questions in the Pre-Simulation Questionnaire and will be marked with a “b” for convenience. This was done for the purpose of comparing pre and post-intervention average scores.

Question 1b again asked whether the subject understood “the concept of situation awareness as it pertains to nurse anesthesia.” This time, the average was 4.6 (SD=0.5), which is higher than the 3.1 average from the Pre-Simulation Training Questionnaire. This number also expresses overall agreement that the subjects understand the concept and its pertinence to the practice. Question 2b asked the subject if the SRNA felt they “can properly apply the non-technical skill of situation awareness to the intraoperative management of a patient.” The average number response was 4.1 (SD=0.9), an increase from 2.6 in the Pre-Simulation Training
Questionnaire. This value correlates to an agreement amongst the subjects on their ability to apply situation awareness to their intraoperative management of patients. Question 3b asked the subject if “situation awareness is an essential non-technical skill that should be taught to SRNAs.” The average number response was 4.8 ($SD=0.3$), an increase from 4.4 in the Pre-Simulation Training Questionnaire. This represents a consistently strong agreement that this skill is viewed as essential and should be taught. Question 4b asked the subject if “a simulation-based training program on situation awareness should be formally incorporated into the DNAP curriculum.” The average number response was also 4.8 ($SD=0.3$), an increase from 4.4 in the Pre-Simulation Training Questionnaire. This demonstrates stronger agreement that such a program should be formally incorporated into curriculum. Finally, the last question (labeled Post-Sim) differed, and instead asked the subjects if the simulation-based training program was an effective method for teaching situation awareness in SRNAs. The average number response was 5, meaning all nine subjects strongly agreed that this program was an effective teaching method.
Table 3. Results from Post-Simulation Training Questionnaire.

<table>
<thead>
<tr>
<th>Subject</th>
<th>Question 1b</th>
<th>Question 2b</th>
<th>Question 3b</th>
<th>Question 4b</th>
<th>Question Post-Sim</th>
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<td>5</td>
<td>4</td>
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<td>6</td>
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<td>7</td>
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<tr>
<td>8</td>
<td>4</td>
<td>2</td>
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<tr>
<td>9</td>
<td>4</td>
<td>5</td>
<td>5</td>
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<td>5</td>
</tr>
<tr>
<td>Avg</td>
<td>4.6 (SD = 0.5)</td>
<td>4.1 (SD = 0.9)</td>
<td>4.8 (SD = 0.3)</td>
<td>4.8 (SD = 0.3)</td>
<td>5 (SD = 0)</td>
</tr>
</tbody>
</table>

**Question 1b:** “I understand the concept and factors of situation awareness as it pertains to nurse anesthesia practice.” **Question 2b:** “As a SRNA, I feel that I can properly apply the non-technical skill of situation awareness to the intraoperative management of a patient.” **Question 3b:** “Situation awareness is an essential non-technical skill that should be taught to SRNAs.” **Question 4b:** “I would like a simulation-based training program on situation awareness to be formally incorporated into the DNAP curriculum.” **Question Post-Sim:** “The simulation-based training program was an effective method for teaching situation awareness in SRNAs.”

Likert scale responses recorded: 1= strongly disagree, 2= disagree, 3= neutral, 4= agree, and 5= strongly agree.

Pre- and post-simulation results were compared using paired samples t tests. For Question 1, there was a statistically significant increase in the participants’ perception of their understanding of situation awareness as it pertains to nurse anesthesia, from $M = 3.1$ (SD = 0.9) to $M = 4.7$ (SD = 0.5), $t(8) = 4.603$, $P = .002$. For Question 2, there was a statistically significant increase in the participants’ perception that they could apply the non-technical skill of situation awareness to the intraoperative management of a patient, from $M = 2.7$ (SD = 0.7) to $M = 4.1$ (SD = 0.9), $t(8) = 4.914$, $P = .001$.

There were no significant differences from pre to post in Question 3 or Question 4.

There were two additional questions asked on the Post-Simulation Training Questionnaire. **Question 11** asked the subject “Which of the following activities did you find most valuable?” and asked the subject to circle each listed activity that applied. The activities were listed as such: 1- the presentation on situation awareness as a non-technical skill, 2- the first simulation, 3- the second simulation, and 4- the debriefing. Seven out of nine subjects (77%)
found each activity to be valuable. All nine subjects (100%) found the second simulation and the debriefing valuable.

Question 12 further asked the subject “Which of the four activities listed did you find the most valuable?” and asked the subject to list only one activity. Interestingly, four out of nine subjects (44%) found the most valuable activity to be the debriefing. Three of the nine subjects (33%) found the first simulation to be the most valuable, and the remaining two subjects (22%) found the presentation on situation awareness to be the most valuable. No subject singled out the second simulation, even though it had been listed by all nine subjects as being valuable.

![Figure 1. Question 12: Most Valuable Activity. Subjects were asked, “Which of the four activities listed did you find the most valuable?”](image)

**Analysis of The Annotated ANTS Assessment Tool Scores.** The lead researcher and a one grading assistant use the Annotated ANTS Assessment Tool (Appendix C) to evaluate the performances of each subject. The three elements of situation awareness (1- Gathering Information, 2- Recognizing and Understanding, and 3- Anticipating) were observed and evaluated individually and as composite score. Scores for each section are based on a scale of one to four with one corresponding to a “poor performance” and four corresponding to a “good” performance”. Appendix C shows the ANTS grading scale that was used to determine the
numerical value associated with subject performance. Interrater reliability using the ANTS Tool has previously been validated, allowing for the scores for each element from the lead researcher and the grading assistant to be averaged and compared pre- and post-intervention. Evaluation using the ANTS tool was completed during the first simulation (pre-intervention) and again during the second simulation (post-intervention). Results from the paired samples t test on the ANTS Assessment Tool Scores are discussed below and summarized in Table 4.

**Gathering Information Scores.** Each subject was observed for case specific actions that reflected behavioral markers for Gathering Information per the ANTS System. Such actions included, but were not limited to the following: asking questions during handoff from the CRNA, visually scanning the anesthesia work area and surgical site, verbally acknowledging faulty equipment/monitors, and removing decoy equipment from blocking monitors. Each subject achieved a score that reflected at least an equal score (if not a higher score) between the first and second simulation, with six of those nine subjects (66%) improving their score. The average score pre-intervention was 2.8 ($SD=0.6$). The average score post-intervention increased to 3.8 ($SD=0.4$). The score of 2 corresponds to a marginal performance, meaning performance indicated cause for concern, considerable improvement is needed. The score of 3 corresponds to acceptable performance, meaning of a satisfactory standard but could be improved. A score of 4 corresponds to a good performance, meaning a consistently high standard, enhancing patient safety; it could be used as a positive example for others. (Please see Figure 2). It was also interesting to note that post-intervention, seven of the nine subjects received maximum performances scores of 4. This indicates that those subjects better performed observable behaviors that proved they could more aptly gather information about the situation and the patient.
Figure 2. Gathering Information Scores. Average scores for Gathering Information are listed for each subject pre-intervention and post-intervention from the Annotated ANTS Assessment Tool.

Recognizing and Understanding Scores. Each subject was observed for case specific actions that reflected behavioral markers for Recognizing an Understanding per the ANTS System. Such actions included, but were not limited to the following: correcting faulty monitoring equipment, acknowledging changes in vital signs and prompting a treatment, and vocalizing changes in patient status and potential reasons, causes, or solutions. While one subject scored lower (4 versus 3.25) in the second simulation (post-intervention), seven other subjects improved their scores (77%), and one subject’s scores remained the same. The average score pre-intervention was 2.3 (SD= 0.8). The average score post-intervention was 3.2 (SD= 0.3). The score of 2 corresponds to a marginal performance, meaning performance indicated cause for concern, considerable improvement is needed. The score of 3 corresponds to acceptable performance, meaning of a satisfactory standard but could be improved. (Please see Figure 3).
Figure 3. Recognizing and Understanding Scores. Scores for Recognizing and Understanding are listed for each subject preintervention and post intervention from the Annotated ANTS Assessment Tool.

**Anticipating Scores.** Each subject was observed for case specific actions that reflected behavioral markers for Anticipating per the ANTS System. Such actions included, but were not limited to the following: vocalizing administration of drugs/fluid or decision not to, treatment with appropriate drugs, manipulation of volatile anesthetic, increasing monitoring of vital signs, and calling for assistance. In this section, all nine subjects (100%) had better scores in the second simulation, post-intervention. The average score pre-intervention was 2.2 ($SD = 0.7$). The average score post-intervention was 3.3 ($SD = 0.5$). The score of 2 corresponds to a “marginal performance”, meaning performance indicated cause for concern, considerable improvement is needed. The score of 3 corresponds to “acceptable performance”, meaning performance was of a satisfactory standard but could be improved (please see Figure 4).
Figure 4. Anticipating Scores. Scores for Anticipating are listed for each subject pre-intervention and post-intervention from the Annotated ANTS Assessment Tool.

**Total Scores.** Observations by the lead researcher the grading assistant yielded improved total scores in Situation Awareness overall in the second simulation (post-intervention) compared to the first simulation in all nine subjects (100%). Interestingly, subjects that had the lowest pre-intervention scores (seven or less) showed the greatest increase in scores post-intervention. (Please see Figure 5).
There were statistically significant increases in ANTS scores for Gathering Information, Recognizing and Understanding, and Anticipating, as well as in the total score. Results of the paired samples $t$ tests are displayed in Table 4 below.

**Table 4. Results of ANTS Scores using Paired Samples $t$ Tests.**

<table>
<thead>
<tr>
<th></th>
<th>Pre $M (SD)$</th>
<th>Post $M (SD)$</th>
<th>$t(8)$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gathering Information</td>
<td>2.8 (0.6)</td>
<td>3.8 (0.4)</td>
<td>3.51</td>
<td>.008</td>
</tr>
<tr>
<td>Recognizing &amp; Understanding</td>
<td>2.3 (0.8)</td>
<td>3.2 (0.3)</td>
<td>2.95</td>
<td>.018</td>
</tr>
<tr>
<td>Anticipating</td>
<td>2.2 (0.7)</td>
<td>3.3 (0.5)</td>
<td>5.72</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Total ANTS</td>
<td>7.3 (1.8)</td>
<td>10.3 (1.0)</td>
<td>4.47</td>
<td>.0023</td>
</tr>
</tbody>
</table>
Summary

In summary, the major findings of this pilot study demonstrate that a simulation-based training program that includes a didactic and debriefing session does impact situation awareness in the SRNA. Furthermore, SRNAs perceive the simulation-based training program to be an effective way to influence their situation awareness, a skill they deem to be of essential value, by enhancing their understanding of and comfort in applying this non-technical skill to their nurse anesthesia practice.
CHAPTER 5: Discussion

Discussion

This study explored the impact of a simulation-based training program and its impact on the non-technical skill of situation awareness in student registered nurse anesthetists. The study also explored the SRNA’s perceptions of situation awareness before and after the simulation-based training program. This study utilized simulations, a validated assessment tool, a didactic presentation, surveys, and structured debriefing to accomplish this goal. The study findings are consistent with similar studies in the literature and further contribute to the understanding of situation awareness and its importance to nurse anesthesia education. The findings also suggest that utilization of simulation-based learning is an effective method to enhance this skill in the student registered nurse anesthetist.

The first research question used to guide this study asked, “does the implementation of a simulation-based training program including debriefing impact situation awareness in the SRNA?” This question was explored and evaluated using two simulations that were assessed using the Annotated Anesthetists’ Non-Technical Skills Tool for pre- and post-intervention comparison. The simulation-based training program proved to be an effective tool to impact situation awareness in SRNAs as evidenced by the differences between pre- and post-intervention ANTS scores. It was found that all nine subjects (100%) scored higher in the second simulation (post-intervention) compared to the first. The subjects with the lowest total ANTS scores (seven or less) pre-intervention, showed the greatest improvement (see Figure 5 and Table 4). Another interesting finding was that the element of anticipating had the lowest average pre-intervention score but had the highest point increase (1.2) of all the elements in the post-intervention average score. These results suggest that a simulation-based training program
including debriefing may increase situation awareness in the SRNA, implying that situation awareness can be taught and that this method may be an effective way of doing so.

These results are consistent with a 2016 study by Wunder which applied the ANTS system to the non-technical skills training of 33 SRNAs in simulation at a university in the southeastern United States. Wunder’s study validated the ANTS system as a useful tool to assess non-technical skills in the SRNA, and also found that non-technical skills are not solely acquired through experience, but also through instruction. This is relevant because formal, focused education of non-technical skills is presently not included in most nurse anesthesia curriculums, even though these skills are crucial to patient safety. The results from the current study and Wunder’s study support the theory that non-technical skills can be taught, and suggest simulation with debriefing can be an effective method to increase non-technical skills acquisition, such as situation awareness, in nurse anesthesia programs. Furthermore, these studies were conducted at different nurse anesthesia programs and in geographical regions, suggesting the findings may be applicable to SRNAs in general.

Simulation as a means to teach the non-technical skill of situation awareness appears to be effective in fields beyond nurse anesthesia. For example, Savoldelli et al. applied the ANTS system to anesthesia residents in simulation and also found it to be useful to review and score performances of the residents. Chang et al. found that simulation-based training improved situation awareness in critical care fellows on the Situation Awareness Global Assessment Technique (SAGAT) scale. They found that simulation-based training is a superior method to teaching situation awareness compared to lecture-based training alone. The results from these prior studies in conjunction with the current study suggest that simulation may be useful to teach
non-technical skills such as situation awareness across medical and nursing disciplines and that it can be used to influence these skills at different levels of training.\textsuperscript{16,55}

Situation awareness is a non-technical skill that influences clinician performance and can impact patient care and patient safety.\textsuperscript{1,2,16} Therefore, researchers have been interested in exploring strategies to effectively teach it to clinicians from different specialties, at different stages of training. The current study, along with prior studies, suggests that non-technical skills, such as situation awareness can indeed be effectively taught through low-risk simulation-based teaching programs, possibly more effectively than by traditional didactics alone. Several lines of evidence suggest that simulation-based training effectively translates into improved clinical performance in real-life scenarios.\textsuperscript{7,8,11} However, it is important to note that the results from the current study only reflect performance in simulation and do not confirm if this educational intervention improves clinical performance in real-life settings. Therefore, a future randomized controlled, multi-site study evaluating situation awareness in clinical settings before and after a simulation-based training program should be conducted. Furthermore, continued studies looking at the various behavioral marker tools such as the ANTS tool or SAGAT tool and how they impact teaching and acquisition of situation awareness in the SRNA will be needed to establish evidence-based guidelines for simulation application and development.

The second research question used to guide this study asked, “What are SRNA perceptions of the simulation-based training program including debriefing on situation awareness?” This question was explored and evaluated by the Pre-Simulation Training Questionnaire and the Post-Simulation Training Questionnaire using Likert Scale methodology. The findings from the Post-Simulation Training Questionnaire reflect overall enhancement in the SRNA’s understanding of the importance of situation awareness and an increase in their
perception of the value of the simulation-based training program to teach this non-technical skill. For example, post-intervention, SRNA respondents were more likely to agree that situation awareness is an essential skill that should be formally taught to them, and the simulation-based training program was an effective method of doing so. The intervention appeared to enhance the SRNA’s comfort in application of this skill to the intraoperative management of patients based off of comparisons between Pre- and Post-Simulation Training Questionnaire responses (see Table 2 and Table 3). This is consistent with a systematic review of qualitative and quantitative literature spanning 16 years by Alanazi et al. which determined that the use of simulations in healthcare student education significantly improves knowledge, skills, and self-confidence.15

While simulation has been typically used to train anesthesia providers in the technical aspects of anesthesia care, the current study found that a simulation-based training program was able to increase the value the SRNAs placed on situation awareness, as well as their understanding of this skill and its relevance to their nurse anesthesia practice. These findings reveal that the simulation-based training program may be an effective method for presenting, educating, and impacting non-technical skills such as situation awareness in the SRNA in a safe and controlled environment.

It is more difficult to find studies that evaluate subject perceptions of an educational intervention to teach clinical skills. This may be a meaningful aspect to further explore because if a learner feels an intervention helps them obtain information, this indicates they value that intervention as part of their education. The current study, for example, revealed that SRNAs perceived an increased understanding of situation awareness and its relevance to their nurse anesthesia practice, as well as comfort in applying it to their intraoperative management of patients (see Table 2 and 3) after the intervention. The subjects perceived this simulation-based
training program as effective and they felt they gained knowledge of and appreciation for a skill they did not fully understand prior to the study. However, this does not necessarily mean this skill will be demonstrated properly in real-life clinical scenarios. For this reason, studies that examine how perceptions of an intervention in a simulation-based training program correlate to performance in a real-world setting are warranted.

The *Journal of Critical Care Medicine* published a small survey of anesthesia and intensive care residents that aimed to gather their perceptions of simulation-based training. They found that these residents favored the use of simulator-based teaching, even though none of the residents had actually participated in it. These findings, along with the findings from the current study show that simulation-based training is viewed positively by trainees across different specialties, though further research is needed to determine best practices for its application to various specialties for various skills.

Another study by Henrichs et al. qualitatively explored the perceptions of SRNAs using a simulator in their educational training. They have several important findings worth noting. The study found that the SRNAs reported perceived improvement in critical thinking and decision-making, increased confidence levels, increased motivation to learn more about specific topics, and increased ability to evaluate cognitive skills. Furthermore, the SRNAs felt the simulator to be a vital part of nurse anesthesia education. While this study is somewhat dated (it was published in 2002) and used a convenience sample from one nurse anesthesia program, the findings are consistent with those of the current study. Taken together in the context of other simulation research, the findings strongly suggest SRNAs perceive simulation-based learning to be effective and worth incorporating into nurse anesthesia education. In spite of these findings, formal integration of simulation-based learning to teach non-technical skills such as situation
 awareness have not been consistently incorporated into nurse anesthesia curriculums. For these reasons, more research that strengthens the data showing simulation-based teaching programs as an effective and meaningful way to teach skills such as situation awareness to the SRNA are warranted.

While all aspects of this training program (first simulation, didactic presentation, debriefing, and second simulation) were selected as valuable, debriefing was selected as most valuable by four of the nine subjects, the first simulation was selected by three of the nine, the presentation was selected by two of the nine, and no subject selected the second presentation (see Figure 1). This study shows debriefing was singled out more than any other aspect, though a larger sample size would help determine the generalizability of this finding. Other studies have found value in debriefing as part of simulation-based learning which is why debriefing was specifically included as an aspect to further explore in this study. A study by Shinnick et al. concluded that greatest knowledge gains in simulation-training occurred after debriefing17 and another study by Savoldelli et al. found that simulations without instructor-led debriefing were less beneficial to trainees.46 The findings from the current study and the prior studies support debriefing as a valuable aspect of simulation-based teaching programs.

Another valuable finding from these responses is that even though four of the nine subjects singled out debriefing as most important, two of the nine still preferred a more traditional didactic approach. This suggests that a combination of teaching methods may meet the needs of a group of students with diverse learning styles. It is also worth acknowledging that the first simulation with the didactic presentation and the debriefing are resource intensive and a repeat simulation may not be as critical as the other components in this type of teaching program.
Therefore, this study should be repeated with a larger sample size to validate these findings and determine if the second simulation is worth the investment of simulation facility and faculty resources. No activity was found to have no value, therefore, additional research exploring which of the activities consistently holds the most value utilizing a larger, more diverse sample may help guide educators as they develop simulation-based training programs.

In conclusion, the encouraging findings from this pilot study suggest that future studies with larger sample sizes are warranted. The sample should include multiple nurse anesthesia programs in various parts of the country and a control group. This study and future research in this area may benefit educators searching for ways to utilize simulation-based training to target non-technical skills, such as situation awareness in student registered nurse anesthetists. Sufficient knowledge and research exists regarding situation awareness and how crucial this non-technical skill can be in dynamic environments, such as the operating room.1,2,4,16,21,31,33,34,37 This study helps to increase appreciation for the perceived value of situation awareness to student registered nurse anesthetists and especially how its value increases after an educational intervention. This study also presents more evidence that a simulation-based teaching program that includes debriefing may be an effective method for teaching non-technical skills such as situation awareness to student registered nurse anesthetists.

**Limitations**

This study presented several limitations. The sample size was inadequate to meet the desired $n$ of 25 (Appendix A). Furthermore, the convenience sample represents only a subset of one nurse anesthesia program in the eastern United States. Further studies would be useful to diversify the sample and strengthen the generalizability of the data.
Another limitation is that peers were used to grade SRNA performance in the simulation as well as provide feedback during debriefing. Although the peers used to grade were in different cohort years, with the graders being more senior with a year of clinical experience, none of the people involved in the direct execution of the study are Certified Registered Nurse Anesthetists. This could also potentially allow for more leniency in grading as the peers grading may not be able to fully appreciate “good” and “bad” behaviors because of their own clinical practice limitations as trainees.

Another limitation includes lack of personnel to increase simulation fidelity. An entire surgical team (surgeon, scrub technician, and operating room nurse, for example) would have been useful to create a more realistic environment where the subject would have had more cues and opportunities to interact with other personnel. However, these simulations did utilize a high-fidelity manikin and software and used the same operating room environment that the subjects were familiar with from previous simulation experiences.

Finally, a control group was not created and instead the Annotated ANTS Assessment Tool Scores were used for a pre- and post-intervention comparison. Therefore, further research on this topic using a control group would be useful to reduce the potential influence of confounding factors such as programmatic educational methods on the results.
**APPENDIX A: Raosoft**

<table>
<thead>
<tr>
<th>What margin of error can you accept?</th>
<th>5%</th>
<th>The margin of error is the amount of error that you can tolerate. If 90% of respondents answer yes, while 10% answer no, you may be able to tolerate a larger amount of error than if the respondents are split 50-50 or 45-55. Lower margin of error requires a larger sample size.</th>
</tr>
</thead>
<tbody>
<tr>
<td>What confidence level do you need?</td>
<td>90%</td>
<td>The confidence level is the amount of uncertainty you can tolerate. Suppose that you have 20 yes-no questions in your survey. With a confidence level of 95%, you would expect that for one of the questions (1 in 20), the percentage of people who answer yes would be more than the margin of error away from the true answer. The true answer is the percentage you would get if you exhaustively interviewed everyone. Higher confidence level requires a larger sample size.</td>
</tr>
<tr>
<td>Typically choices are 90%, 95%, or 99%</td>
<td>50%</td>
<td>For each question, what do you expect the results will be? If the sample is skewed highly one way or the other, the population probably is, too. If you don't know, use 50%, which gives the largest sample size. See below under More Information if this is confusing.</td>
</tr>
<tr>
<td>What is the population size?</td>
<td>25</td>
<td>How many people are there to choose your random sample from? The sample size doesn't change much for populations larger than 20,000.</td>
</tr>
<tr>
<td>If you don't know, use 20000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>What is the response distribution?</td>
<td></td>
<td>For each question, what do you expect the results will be? If the sample is skewed highly one way or the other, the population probably is, too. If you don't know, use 50%, which gives the largest sample size. See below under More Information if this is confusing.</td>
</tr>
<tr>
<td>Leave this as 50%</td>
<td>23</td>
<td>This is the minimum recommended size of your survey. If you create a sample of this many people and get responses from everyone, you're more likely to get a correct answer than you would from a large sample where only a small percentage of the sample responds to your survey.</td>
</tr>
</tbody>
</table>
APPENDIX B: Pre-Simulation Training Questionnaire

This research tool is designed to gather demographic data and evaluate situation awareness in Student Registered Nurse Anesthetists (SRNAs) undergoing a simulation-based training program.

Please refer to the instructions in each section for any questions. Please answer the following questions as accurately as possible. Please do not disclose personal or identifying information. The information obtained from this questionnaire will remain anonymous.

**Pre-Simulation Training Questionnaire**

Please circle the option that most accurately describes you and your professional nursing experience:

1) Gender
   a. Male
   b. Female

2) What is your age in years?
   _____ years

3) How long have you been a licensed Registered Nurse?
   a. 1-2 years
   b. 3-4 years
   c. 5-6 years
   d. 7-8 years
   e. 9 or more years

4) How long did you work in the Intensive Care Unit setting as a Registered Nurse? Please list the number of years and months as accurately as possible.
   _____ years _____ months

5) What type of intensive care unit did you work in as a Registered Nurse? (please select all that apply).
   a. Cardiac Intensive Care
   b. Medical Intensive Care
   c. Neurosurgical Intensive Care
   d. Neonatal Intensive Care
   e. Trauma/Burn Intensive Care
   f. Pediatric Intensive Care
   g. Surgical Intensive Care
   h. Other (please specify): ____________________________
Please read the statements below and circle the response that most accurately represents your opinion. Please do not disclose any identifying information when completing this form. Thank you for your participation.

1. I understand the concept of situation awareness as it relates to Nurse Anesthesia practice.

   Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree
   1  2  3  4  5

2. As a SRNA, I feel that I can properly apply the non-technical skill of situation awareness to the intraoperative management of a patient.

   Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree
   1  2  3  4  5

3. Situation awareness is an essential non-technical skill that should be taught to Student Registered Nurse Anesthetists.

   Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree
   1  2  3  4  5

4. I would like a simulation-based training program on situation awareness to be formally incorporated into the DNAP curriculum.

   Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree
   1  2  3  4  5

5. I have received prior training or instruction on situation awareness.

   Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree
   1  2  3  4  5

56
Annotated Anesthetists’ Non-Technical Skills System (ANTS) Tool (for Situation Awareness)

**Situation Awareness:** Skills for developing and maintaining an overall awareness of the work setting based on observing all relevant aspects of the operating environment (patient, team, time, displays, equipment); understanding what they mean, and thinking ahead about what could happen next. It has three skill elements: gathering information; recognizing and understanding; anticipating.

<table>
<thead>
<tr>
<th>Skill Element</th>
<th>Behavioral Markers for Good Practice</th>
<th>Behavioral Markers for Poor Practice</th>
<th>Case Specific Actions (for debriefing)</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gathering Information</strong></td>
<td>o Obtains/documents patient information pre-operatively</td>
<td>o Reduced level of monitoring because of distractions</td>
<td>□ Asks a minimum of one question or clarification during handoff from the CRNA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>o Conducts frequent scan of the environment</td>
<td>o Responds to individual cues without confirmation</td>
<td>□ Visually scans the anesthesia work area, OR environment, drugs, surgical site, other providers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>o Collects information from the team to identify the problem</td>
<td>o Does not alter physical layout of workspace to improve data visibility</td>
<td>□ Verbally Acknowledges low pulse oximetry reading</td>
<td></td>
</tr>
<tr>
<td></td>
<td>o Watches surgical procedure, verifying status when required</td>
<td>o Does not ask questions to orient self to situation during hand-over</td>
<td>□ Removes decoy equipment away from monitor it is blocking</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>□ Asks surgeon about surgical bleeding</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>□ Recycles BP cuff more than what is set (every 2 mins)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>□ Other:</td>
<td></td>
</tr>
<tr>
<td>Skill Element</td>
<td>Behavioral Markers for Good Practice</td>
<td>Behavioral Markers for Poor Practice</td>
<td>Case Specific Actions (for debriefing)</td>
<td>Score</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>-------------------------------------</td>
<td>-------------------------------------</td>
<td>---------------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>Recognizing and Understanding</td>
<td></td>
<td></td>
<td>□ Corrects pulse oximetry probe position on patient finger</td>
<td></td>
</tr>
<tr>
<td>Interpreting</td>
<td>o Increases frequency of monitoring in response to patient condition</td>
<td>o Does not respond to changes in patient state</td>
<td>□ Acknowledges sound of increasing suction and prompts one treatment (does this prompt them to further inquire?)</td>
<td></td>
</tr>
<tr>
<td>information collected form the environment (with respect to existing knowledge) to identify the match or mis-match between the situation and the expected state, and to update one’s current mental picture.</td>
<td>o Informs others of seriousness of situation</td>
<td>o Carries out inappropriate course of action</td>
<td>□ Vocalization of change in patient status and potential reasons</td>
<td></td>
</tr>
<tr>
<td>o Describes pattern of cues and their meaning to other team members</td>
<td>o Silences alarm without investigation</td>
<td>o Verbalizes potential causes and solutions for the predicament</td>
<td>□ Other:</td>
<td></td>
</tr>
<tr>
<td>Anticipating</td>
<td>o Keeps ahead of the situation by giving fluids/drugs</td>
<td>o Does not consider potential problems associated with case</td>
<td>□ Vocalizes administration of fluid (or vocalizes choice not to)</td>
<td></td>
</tr>
<tr>
<td>Asking “what if” questions and thinking ahead about potential outcomes and consequences of actions, intervention, non-intervention, etc.; running projections of current situation to produce what might happen in the near future.</td>
<td>o Reviews the effects of an intervention</td>
<td>o Fails to increase level of monitoring in keeping with patient condition</td>
<td>□ Treats with an appropriate drug</td>
<td></td>
</tr>
<tr>
<td></td>
<td>o Sets and communicates intervention threshold</td>
<td>o Is caught unaware by surgical actions</td>
<td>□ Decreases volatile anesthetic</td>
<td></td>
</tr>
<tr>
<td></td>
<td>o Takes action to avoid or mitigate potential problems</td>
<td>o Does not foresee undesirable drug interactions</td>
<td>□ Increases monitoring (cycles BP cuff more frequently)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>□ Continues to observe surgical field</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>□ Continues to ask surgeon clinical questions</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>□ Calls for assistance</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>□ Other:</td>
<td></td>
</tr>
</tbody>
</table>
Rating Anesthetists’ Non-Technical Skills

The scale below can be used for rating non-technical skills based on observed behavior. If it is not relevant for a particular element to be demonstrated in a situation, the “not observed” rating should be used.

<table>
<thead>
<tr>
<th>Rating Label</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 – Good</td>
<td>Performance was of a consistently high standard, enhancing patient safety; it could be used as a positive example for others</td>
</tr>
<tr>
<td>3 – Acceptable</td>
<td>Performance was of a satisfactory standard but could be improved</td>
</tr>
<tr>
<td>2 – Marginal</td>
<td>Performance indicated cause for concern, considerable improvement is needed</td>
</tr>
<tr>
<td>1 – Poor</td>
<td>Performance endangered or potentially endangered patient safety, serious remediation is required</td>
</tr>
<tr>
<td>N – Not observed</td>
<td>Skill could not be observed in this situation</td>
</tr>
</tbody>
</table>
Information for Case #1: John Doe

Background:
John Doe is a 58 year-old male who presented to the hospital for a bilateral axillary lymph node biopsies for suspected lymphoma. His current stay was complicated by increasing dyspnea and diminished breath sounds on the upper right side. Further diagnostic testing revealed a right-sided chylothorax (a type of pleural effusion caused by chyle leakage from the lymphatic system into the pleural space). Mr. Doe was taken to the OR in the afternoon for evacuation of the chylothorax with insertion of a chest tube and bilateral axillary lymph node biopsies. He was placed under general anesthesia with an endotracheal tube.

Significant Medical History:
- End-Stage Renal Disease (dialysis 3x per week)
- Anemia
- Peripheral Vascular Disease

Day-of-Surgery Labs:

<table>
<thead>
<tr>
<th></th>
<th>Na+</th>
<th>Hgb</th>
<th>Platelets</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>137</td>
<td>7.2</td>
<td>150</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>K+</th>
<th>Hct</th>
<th>Glucose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4.7</td>
<td>21%</td>
<td>80</td>
</tr>
</tbody>
</table>

Medication List:
- Midodrine
- Erythropoietin
- Iron

Situation: You are the SRNA assigned to take over this case after induction and initial incision. Receive hand-off of care from the CRNA in the OR and proceed with managing this patient as you would in a real-world setting.

Please:
1. Treat this simulated environment and patient as if it were the real OR and a living human being.
2. Vocalize all thoughts and actions as thoroughly as possible.
3. Do not discuss the simulation with other students.

You will have 10 minutes to complete this simulation. Thank you for your participation!
**Pretest Simulation Manuscript: Hypotensive Event**

**Location:** Operating Room

**Monitors:** EKG, Pulse Oximetry, Non-Invasive Blood Pressure, End-Tidal CO2

**Props/Equipment:**
- Human Patient Simulator (HPS)
- Datex-Ohmeda Anesthesia Workstation
- Surgical drape
- Anesthesia Cart Drugs (Phenylephrine, Ephedrine, Glycopyrrolate, Fentanyl, Propofol, Atropine, Hydralazine, Labetalol, Esmolol, Epinephrine, Dopamine, Metoprolol, Vasopressin)
- 1 Liter IV bag of 0.9% Normal Saline Solution

**Personnel:** Surgeon, CRNA

**Initial Setup:** The HPS will be under general anesthesia with an endotracheal tube in place.

<table>
<thead>
<tr>
<th><strong>EKG</strong></th>
<th>Normal Sinus rhythm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- Heart rate between 70-80 beats per minute</td>
</tr>
<tr>
<td><strong>Pulse Oximetry</strong></td>
<td>Flattened waveform with one asterisk (*)</td>
</tr>
<tr>
<td></td>
<td>- 87%</td>
</tr>
<tr>
<td><strong>Blood Pressure</strong></td>
<td>Cycle every 5 minutes</td>
</tr>
<tr>
<td>(Non-Invasive)</td>
<td>- Systolic 110-125 mmHg</td>
</tr>
<tr>
<td></td>
<td>- Diastolic 50-65 mmHg</td>
</tr>
<tr>
<td><strong>ETCO2</strong></td>
<td>Normal waveform</td>
</tr>
<tr>
<td></td>
<td>- 32-35 mmHg</td>
</tr>
</tbody>
</table>

**Temperature**

36.5 degrees Celsius

**Ventilator Settings**

Pressure Control Ventilation
TV: 500mL
RR: 12 breaths per minute
I:E: 1:2

**Volatile Anesthetic**

2% Sevoflurane at 1 MAC
Subject will receive hand-off of care from CRNA (or paper hand-off) for 1 minute.

  a. Observe for questioning that shows the SRNA is thinking about the patient’s diagnosis and potential issues with medical management.

<table>
<thead>
<tr>
<th>CRNA Hand-off</th>
<th>Examples of Good Behaviors to Observe For</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. “The patient was an easy mask and intubation.”</td>
<td>• What grade view? (grade 1)</td>
</tr>
<tr>
<td>2. “The patient was induced and had an episode of hypotension following induction but has since been stable”</td>
<td>• How low was the patient’s BP?</td>
</tr>
<tr>
<td>3. “The patient has been sinus rhythm in the 70s, systolic between 110-125”</td>
<td>(About 88 systolic, and 50 diastolic)</td>
</tr>
<tr>
<td>4. “He is on pressure control ventilation with no issues, Sats are 100%, lungs are clear.”</td>
<td>• What agent was used to treat it?</td>
</tr>
<tr>
<td>5. “Everything has been going well, he has access on the right forearm when you need to give anything else”</td>
<td>How much? (100 mcg of phenylephrine)</td>
</tr>
<tr>
<td>6. “He also has a bag of Normal Saline running in now”</td>
<td>• What is their baseline BP?</td>
</tr>
<tr>
<td>7. “Do you have any questions?”</td>
<td>(115/60)</td>
</tr>
<tr>
<td></td>
<td>• What is the IV access gauge? (20 g)</td>
</tr>
<tr>
<td></td>
<td>• How much fluid has the patient received? (less than 100cc)</td>
</tr>
<tr>
<td></td>
<td>• When did they last have dialysis?</td>
</tr>
<tr>
<td></td>
<td>(yesterday)</td>
</tr>
<tr>
<td></td>
<td>• What was their potassium level?</td>
</tr>
<tr>
<td></td>
<td>(4.7)</td>
</tr>
</tbody>
</table>

Subject will then enter OR. Wait 30 seconds for student to orient self to situation.

  a. Observe for:
    i. Movement of decoy equipment away from monitor it is blocking
    ii. Reattachment of pulse ox
    iii. Vocalization of vitals, meds, situation, environment
  b. Observe for:
    i. Subject peering over drape, analyzing suction
    ii. Conversation with surgeon on potential blood loss
  c. Alteration data on HPS and Datex-Ohmeda machine to simulate acute hypotension.
# Hypotensive Event Setup

<table>
<thead>
<tr>
<th>EKG</th>
<th>Normal Sinus rhythm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Heart rate between 90-100 beats per minute</td>
</tr>
<tr>
<td>Pulse Oximetry</td>
<td>Flat waveform with 1 asterisk (*) [IF NOT CORRECTED BY SUBJECT]</td>
</tr>
<tr>
<td></td>
<td>• 87%</td>
</tr>
<tr>
<td></td>
<td>-or-</td>
</tr>
<tr>
<td></td>
<td>Normal waveform with 3 asterisks (*** [IF CORRECTED])</td>
</tr>
<tr>
<td></td>
<td>• 100%</td>
</tr>
<tr>
<td>Blood Pressure</td>
<td>Cycle every five minutes:</td>
</tr>
<tr>
<td>(Non-Invasive)</td>
<td>• Systolic 80, 77, 62 mmHg</td>
</tr>
<tr>
<td></td>
<td>• Diastolic 52, 49, 40 mmHg</td>
</tr>
<tr>
<td></td>
<td>*If treated with vasopressor:</td>
</tr>
<tr>
<td></td>
<td>• Phenylephrine: increase SBP by 10 mmHg and DBP by 10 mmHg, and decrease HR by 10 beats per minute</td>
</tr>
<tr>
<td></td>
<td>• Ephedrine: increase SBP by 10 mmHg and DBP by 10 mmHg, and increase HR by 10 beats per minute</td>
</tr>
<tr>
<td>ETCO2</td>
<td>Normal waveform</td>
</tr>
<tr>
<td></td>
<td>• 27-29 mmHg (fluctuate)</td>
</tr>
<tr>
<td>Temperature</td>
<td>36.5 degrees Celsius</td>
</tr>
<tr>
<td>Ventilator</td>
<td>Pressure Control Ventilation</td>
</tr>
<tr>
<td>Settings</td>
<td>TV: 500mL</td>
</tr>
<tr>
<td></td>
<td>RR: 12 breaths per minute</td>
</tr>
<tr>
<td></td>
<td>I:E: 1:2</td>
</tr>
<tr>
<td>Volatile</td>
<td>2% Sevoflurane at 1 MAC</td>
</tr>
<tr>
<td>Anesthetic</td>
<td></td>
</tr>
</tbody>
</table>

- Observe for gathering of information, recognizing and understanding, and anticipating future events:
  a. Active treatment:
     i. Opening fluids or vocalization of choice to give or not give fluids
     ii. Administration of a vasopressor with rationale
     iii. Decreasing volatile anesthetic
  b. Vocalization of altered ETCO2 value
     i. Changing ventilator immediately vs fetching more information to rule out clinical causes (further investigating)
  c. Acquisition of valuable information
     i. More frequent recycling of cuff
     ii. Conversation with surgeon about blood loss
     iii. Observance over drape
     iv. Observance of suction or field
APPENDIX F: Presentation on Situation Awareness

Situation Awareness
A Non-Technical Skill for Nurse Anesthetists

Objectives
- Understand the concept of Situation Awareness as it pertains to the practice of Nurse Anesthesia
- Understand the relevance of Situation Awareness to my practice as a Student Registered Nurse Anesthetist
- Provide the learner with a foundation for their development of Situation Awareness

What is Situation Awareness?
- Situation awareness (SA) is defined as "the perception of elements of the environment within a volume of time and space, the comprehension of their meaning and the projections of their status in the near future".

Relevance to me as a SRNA
- Errors in Situation Awareness can have clinicians vulnerable to mistakes and downstream consequences
- Developing situation awareness can help minimize the chance for human error to occur, especially in environments prone to (emergencies and environmental) overload
- Being aware of one’s cognitive limitations (“not knowing what you do not know”)
- Being prepared for the unexpected AND unexpected
- Being vigilant
- Studies have shown that faults in Situation Awareness in Anesthetists are highly responsible for AVOIDABLE Intraoperative incidents

Anesthetists’ Non-Technical Skills System (ANTS)
- A system developed by Anesthetists and Psychologists in the UK to identify and refine essential non-technical skills for anesthesia providers
- Designed following best practices in aviation
- Aviation is also a high-reliability industry, where even small errors can yield catastrophic consequences
- Much research and development has been done to measure safety and quality in this industry
- Aviation and Anesthesia share similar characteristics:
  - Dynamic, complex, high-information load, complex teamwork, and risk

ANTS & Situation Awareness
- Developed the concept of Situation Awareness as it pertains to Anesthesia
- 3 main elements of Situation Awareness identified:
  1. Generating Information
  2. Recognizing and Understanding
  3. Anticipating
- Established behavioral markers for good and bad practice
1. Gathering Information

- Actively collects data
- Continuously observes the whole environment
- Monitors all available data sources and cues
- Verifies data to confirm reliability

2. Recognizing and Understanding

- Interprets information collected from the environment
- Applies this new information to existing knowledge of the situation
- Identifies the match or mismatch between the situation and the expected state
- Updates one's current mental picture to support and manage the new state

3. Anticipating

- Asking "what if" questions
- Thinking ahead about potential outcomes
- Thinking ahead about consequences of actions, interventions, non-interventions
- Running projections of current situation to produce what might happen in the future

Take-Aways

- Situation awareness is said to be a major component of:
  - Effective problem solving
  - Decision-making
  - Attention
- It also allows for better perception, comprehension, and projection of factors which ultimately creates a more effective thought processes
- This results in appropriate actions and decisions regarding patient management
- In the OR, you can develop your Situation Awareness by thinking about and demonstrating the 3 elements regularly

References

Debriefing Scripts

ANTS Observational Tool and Rating Scale Script:

1. An example of the student’s actual actions in the simulation will be explicitly stated as it pertains to each element of Situation Awareness.
   a. If the element does not apply to the specific scenario, the “N” for not observed will be used and the element need not be discussed.
2. Each element will be scored per the ANTS System Rating Options scale and the description will be read as provided

Example:

   In the simulation you asked if there was increasing blood loss due to increased suction usage. Therefore, you received a 4, meaning your “performance was of a consistently high standard, enhancing patient safety; it could be used as a positive example for others”.

   OR

   In the simulation you did not ask for further information regarding increased suction usage. Therefore you received a 2, meaning your “performance indicated cause for concern, considerable improvement is needed”.

APPENDIX H: Information for Case #2

Information for Case #2: Jane Doe

Background:
Jane Doe is a 74 year-old female who presented to the hospital following a fall two days ago, resulting in a fractured femur. She has underlying coronary artery disease and hypertension that is well controlled. She has good exercise tolerance.

Ms. Doe was taken to the OR in the morning for an open reduction and internal fixation of her fractured femur. She was placed under general anesthesia with an endotracheal tube.

Significant Medical History:
- Coronary Artery Disease
- Hypertension
- Atherosclerosis

Day-of-Surgery Labs:

<table>
<thead>
<tr>
<th>Na+</th>
<th>138</th>
<th>Hgb</th>
<th>11</th>
<th>Platelets</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>K+</td>
<td>4.0</td>
<td>Hct</td>
<td>33%</td>
<td>Glucose</td>
<td>87</td>
</tr>
</tbody>
</table>

Medication List:
- Metoprolol
- Lisinopril
- Atorvastatin
- Multivitamin

Situation: You are the SRNA assigned to take over this case after induction and initial incision. Receive hand-off of care from the CRNA in the OR and proceed with managing this patient as you would in a real-world setting.

Please:
4. Treat this simulated environment and patient as if it were the real OR and a living human being.
5. Vocalize all thoughts and actions as thoroughly as possible.
6. Do not discuss the simulation with other students.

You will have 10 minutes to complete this simulation. Thank you for your participation!
APPENDIX I: Posttest Simulation Manuscript

**Posttest Simulation Manuscript: Hypertensive Event**

**Location:** Operating Room

**Monitors:** EKG, Pulse Oximetry, Non-Invasive Blood Pressure, End-Tidal CO2

**Props/Equipment:**
- Human Patient Simulator (HPS)
- Datex-Ohmeda Anesthesia Workstation
- Surgical drape
- Anesthesia Cart Drugs (Phenylephrine, Ephedrine, Glycopyrrolate, Fentanyl, Hydromorphone, Midazolam, Propofol, Atropine, Hydralazine, Labetalol, Esmolol, Epinephrine, Dopamine, Metoprolol, Vasopressin)
- 1 Liter IV bag of Lactated Ringers Solution

**Personnel:** Surgeon, CRNA

**Initial Setup:** The HPS will be under general anesthesia with an endotracheal tube in place.

<table>
<thead>
<tr>
<th>EKG</th>
<th>Normal Sinus rhythm/ Sinus Bradycardia</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- Heart rate between 55-65 beats per minute</td>
</tr>
<tr>
<td>Pulse Oximetry</td>
<td>Normal waveform with 3 asterisks</td>
</tr>
<tr>
<td></td>
<td>- 100%</td>
</tr>
<tr>
<td>Blood Pressure (Non-Invasive)</td>
<td>Cycle every five minutes.</td>
</tr>
<tr>
<td></td>
<td>- Systolic 120-130 mmHg</td>
</tr>
<tr>
<td></td>
<td>- Diastolic 60-75 mmHg</td>
</tr>
<tr>
<td>ETCO2</td>
<td>Normal waveform</td>
</tr>
<tr>
<td></td>
<td>- 32-35 mmHg</td>
</tr>
<tr>
<td>Temperature</td>
<td>36.7 degrees Celsius</td>
</tr>
<tr>
<td>Ventilator Settings</td>
<td>Pressure Control Ventilation- Volume Guarantee</td>
</tr>
<tr>
<td></td>
<td>TV: 400 mL</td>
</tr>
<tr>
<td></td>
<td>RR: 11 breaths per minute</td>
</tr>
<tr>
<td></td>
<td>I:E: 1:2</td>
</tr>
<tr>
<td>Volatile Anesthetic</td>
<td>2% Sevoflurane at 1 MAC</td>
</tr>
</tbody>
</table>
Subject will receive hand-off of care from CRNA for 1 minute.
   a. Observe for questioning that shows the SRNA is thinking about the patient’s diagnosis and potential issues with medical management.

<table>
<thead>
<tr>
<th>CRNA Hand-off</th>
<th>Examples of Good Behaviors to Observe For</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. “The patient was an easy mask after using an oral airway. We needed two direct laryngoscopy attempts for successful intubation.”</td>
<td>1. What made the laryngoscopy more difficult? (anterior airway)</td>
</tr>
<tr>
<td>2. “The patient was induced and had an episode of hypertension during laryngoscopy but has since been relatively stable.”</td>
<td>2. How high was the patient’s BP? (SBP was 190)</td>
</tr>
<tr>
<td>3. “The patient has been sinus rhythm/sinus bradycardia in the 50s-60s with systolics around 130”</td>
<td>3. What agent was used to treat it? How much? (increased Sevo and gave 20mg of Esmolol)</td>
</tr>
<tr>
<td>4. “She is on pressure control ventilation- volume guarantee with no issues, sats are 100%, lungs are clear.”</td>
<td>4. What is their baseline BP? (133/75)</td>
</tr>
<tr>
<td>5. “Everything has been going well. She has had a couple episodes of hypertension but responds appropriately.”</td>
<td>5. What is the IV access gauge? (20 in right hand)</td>
</tr>
<tr>
<td>6. She has access on the right hand when you need to give anything else.”</td>
<td>6. How much fluid has the patient received? (This is the first liter)</td>
</tr>
<tr>
<td>7. “She also has a bag of Lactated Ringers running in now.”</td>
<td>7. Has the patient received their beta blocker or ACE Inhibitor today?</td>
</tr>
<tr>
<td>8. “Do you have any questions?”</td>
<td></td>
</tr>
</tbody>
</table>

Subject will then enter OR. Wait 30 seconds for subject to orient self to situation.
   a. Observe for:
      i. Movement of equipment away from monitor it is blocking
      ii. Vocalization of vitals, meds, situation, environment

Alteration data on HPS and Datex-Ohmeda machine to simulate acute hypertension.
**Hypertensive Event Setup**

| **EKG**          | Normal Sinus rhythm/ Sinus Bradycardia  
|                 | - Heart rate 60 beats per minute       |
| **Pulse Oximetry** | Normal waveform with 3 asterisks (***))  
|                 | - 100%                                 |
| **Blood Pressure (Non-Invasive)** | Cycle every five minutes:                  
|                 | - Systolic 150, 175, 190 mmHg        
|                 | - Diastolic 78, 95, 115 mmHg         |

- IF treated with vasodilator:
  - Hydralazine: 10 minute onset.
  - Propofol: reduce SBP and DBP by 20 mmHg for every 20 mg
  - Any Beta Blocker: acute bradycardia (continue downtrend from 60, 55, 47, 35, 30, 20) necessitating atropine administration
  - Nitroglycerine/Nitroprusside: Reduce SBP and DBP by 30 mmHg or place within normal range (130/70)

- IF treated with Volatile Anesthetic (increased %):
  - Decrease SBP/DBP by 20 mmHg

- IF treated with Opioid Analgesic:
  - Fentanyl, Hydromorphone, or other, decrease SBP and DBP by 20 mmHg.

- ***BP will only normalize after 2 minutes regardless of agents used. The subject will need to express ability to:
  - Call for help
  - Observe field, ask surgeon clinical questions
  - Continue to treat the patient

| **Temperature** | 36.7 degrees Celsius                           |
| **Ventilator Settings** | Pressure Control Ventilation- Volume Guarantee 
|                 | TV: 400 mL                                   
|                 | RR: 11 breaths per minute                    
|                 | I:E: 1:2                                     |
| **Volatile Anesthetic** | 2% Sevoflurane at 1 MAC                        |

- Observe for gathering of information, recognizing and understanding, and anticipating future events:
  - Active treatment:
    - Closing fluids
    - Administration of a vasodilator with rationale
    - Increasing volatile anesthetic with rationale
    - Administration of opioid analgesic with rationale
b. Acquisition of valuable information
   i. More frequent recycling of cuff
   ii. Conversation with surgeon about stimulation, acute hypertension, possibly pausing stimulation
   iii. Observance over drape
APPENDIX J: Post-Simulation Training Questionnaire

Post-Simulation Training Questionnaire
Please read the statements below and circle the response that most accurately represents your opinion. Please do not disclose any identifying information when completing this form. Thank you for your participation.

1. I understand the concept and factors of situation awareness as they pertain to Nurse Anesthesia practice.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

2. As a SRNA, I feel that I can properly apply the non-technical skill of situation awareness to the intraoperative management of a patient.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

3. Situation awareness is an essential non-technical skill that should be taught to Student Registered Nurse Anesthetists.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

4. I would like a simulation-based training program on situation awareness to be formally incorporated into the DNAP curriculum.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

5. This simulation-based training program was an effective method for teaching situation awareness in Student Registered Nurse Anesthetists.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

6. Which of the following activities did you find valuable (select all that apply):
   a. The presentation on situation awareness as a Non-Technical Skill
   b. The FIRST simulation
   c. The SECOND simulation
   d. The debriefing

7. Which of the activities listed above did you find the most valuable? Please list only one.

______________________________________________________________________________
APPENDIX K: CITI Certificate

This is to certify that:

Annie Camacho

Has completed the following CITI Program course:

Human Research
Group 2. Social and behavioral research investigators and key personnel,
1. Basic Course

Under requirements set by:

Georgetown University

Verify at www.citiprogram.org/verify?tw6e962ad5-8a6f-48f6-8f7e-ac52777da344-28573449


