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An Evidence-Based Strategy for the Use of Simulation to Assess Situation Awareness in Applicants to Nurse Anesthesia Programs

Angela Lee
lee11@otterbein.edu

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Angela M. Lee, BSN, RN

Department of Nursing, Otterbein University

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DNP Final Scholarly Project Team:

Dr. Kacy Ballard, DNP, CRNA, Project Team Leader

Dr. Chai Sribanditmongkol, PhD, RN, IBCLC, CNS, Project Team Member

Dr. Amy Bishop, DNP, AGCNS, Project Team Member

Abstract

Medical errors are considered one of the top causes of patient death. Closed claims analysis reveals an estimated 50% of claims are associated with preventable events by the anesthesia provider. Errors in anesthesia leading to critical incidents are associated with errors in situation awareness (SA). Identification of human factor variables, such as SA, provides an analysis of observable behavior and intuition necessary to guide crisis management, maintain clinical performance, and mitigate errors in patient safety. The human factor components of human error and SA play critical roles in patient safety and overall clinical anesthesia practice. The viability of simulation assessment delivers a consistent evaluation of learner progression and identifies areas of improvement to provide safe clinical practice and minimize adverse outcomes during patient interaction. Incorporating high-fidelity simulation into a multimodal admissions process for nurse anesthesia programs may provide a vital assessment of candidate SA in managing stressful scenarios and predict overall program progression and success. The evidence-based project serves to evaluate current literature for evidence-based strategies to provide a direct assessment of SA on prospective applicants during applicant interviews to nurse anesthesia programs.

Keywords: situation awareness, anesthesia, non-technical skills, cognitive skills

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In the report, *To Err is Human*, the Institute of Medicine (IOM) defined medical errors as "the failure of a planned action to be completed as intended or the use of a wrong plan to achieve an aim" (Kohn et al., 1999, p. 4). The report discussed the significance of preventable medical errors and the implications of medical mismanagement (Kohn et al., 1999). The IOM brought attention to the overall quality of the U.S. healthcare system and addressed the need for systemic changes to improve upon accidental injury (Kohn et al., 1999). The report revealed several divisions of the hospital associated with the most significant risk of error including the emergency medicine units, intensive care units, and operating rooms (Kohn et al., 1999). During the period of the report, an average of 96,000 people died per year from preventable medical errors at an estimated cost of $17 to $29 billion per year, which included care associated with medical errors, disability, and loss in productivity (Kohn et al., 1999). Current data projects an average of 400,000 patients associated with medical errors per year at an estimated cost of $20 billion per year (Rodziewicz et al., 2021).

In the companion report, *Crossing the Quality Chasm*, the IOM discussed the need to establish systems to improve upon quality and delivery of patient care to mitigate medical errors (Institute of Medicine, 2001). Death related to medical error is currently estimated to be the third leading cause of death in the United States and remains to be a phenomenon that is less appreciated in other countries (Makary & Daniel, 2016). Although the IOM report provided awareness of preventable situations influencing patient safety and emphasized the priority of establishing safety measures, precise morbidity and mortality statistics remain unmeasured due to hospital confidentiality processes and root cause analysis (Makary & Daniel, 2016). The average medical error is associated with system inefficiencies with limited safety checks leading to human and structure failure (Rodziewicz et al., 2021). Establishing safety measures such as medication safeguards, handoff communication checklists, electronic medical data entry, infection prevention, enhanced interdisciplinary communication, and patient safety guidelines may mitigate additional human error (Rodziewicz et al., 2021).

Background

The operating room is a complex and dynamic setting in which human factors and high cognitive demand play a role in maintaining clinical performance, expected outcomes, and patient safety. The environment creates an experience of high sensory overload, resulting in distracting events and interruptions in concentration (Mackenzie & Foran, 2020). The stressors in the environment contribute to disruptions in communication, surgical care, and patient safety (Mackenzie & Foran, 2020). Reduction of distractions and enhancement of situation awareness in anesthesia are vital components in supporting effective patient care and safety and minimizing risks in communication and outcomes (Mackenzie & Foran, 2020).

Endsley (1988) introduced the term *situation awareness* to the field of aviation to describe the ability to consider environmental factors and develop a sensitivity based on an awareness established by the senses and the physical environment. A separate concept compared to the processes of decision-making and performance, situation awareness incorporates perception as the underpinning of the mental model and involves the active involvement of cognition and sensation (Endsley, 1988). While Endsley's discussion of situation awareness focused on the discipline of aviation and the human factors associated with pilot performance, the components of Endsley's situation awareness model may apply to the safe operation of anesthesia and maintenance of patient safety. In Endsley's mental model, situation awareness comprises of three phases or levels: perception, comprehension, and projection, respectively (Endsley, 1988; Endsley, 1995). In relation to the delivery of anesthesia, “perception” describes objective data collection of the clinical scenario and active communication of the findings (Endsley, 1988; Endsley, 1995). “Comprehension” describes the ongoing assessment of the collected patient data and the development of inferences about the patient's status (Endsley, 1988; Endsley, 1995). “Perception” describes the analysis of the patterns of the current situation, the prediction of patient needs, and the creation of a plan (Endsley, 1988; Endsley, 1995).

Gaba (1995) introduced the concept of situation awareness into the field of anesthesia to describe the effects of the mental workload, human factor variables, complexity, and risk associated with clinical performance in the operating room. Gaba’s mental model comprises of five levels: “abstract level” (abstract reasoning and analysis of data), “procedural level” (problem recognition and reasoning), “sensory/motor level” (action/implementation), “supervisory control level” (prioritization and scheduling of actions), and “resource management level” (utilization of resources and communication with the team) (Gaba et al., 1995).

Fletcher et al. (2003) introduced the topic of human factors and non-technical skills to anesthesia through the discussion and development of a behavior marker system. Similar to the high-reliability disciplines of the aviation and military industries, anesthesia requires high proficiency in technical skills and cognitive demand to guide clinical performance and maintain expected outcomes (Fletcher et al., 2003). The high-risk industry of anesthesia relies on the essential abilities of incorporating objective methods of assessing cognitive and non-technical behaviors in clinical training to evaluate and guide crisis management and debrief on observable behavior performance (Fletcher et al., 2003). Using tools reliable for assessing behavioral markers provides a framework for clinical performance evaluation traditionally executed by intuition (Fletcher et al., 2003). Succeeding the introduction of human factors in anesthesia, awareness of non-technical skills is more prevalent in hospital systems, and provider training incorporates the use of the aviation Crew Resource Management (CRM) training tailored to medicine (Fletcher et al., 2003).

Problem Statement

The human factor components of human error and situation awareness play critical roles in patient safety and overall clinical anesthesia practice. On the individual level, non-technical skills are vital to maintaining clinical performance and minimizing barriers to unexpected outcomes (Jones et al., 2018). A monograph released by the World Health Organization (WHO, 2016), acknowledges patient safety related to human factor variables as a universal problem. The monograph necessitates practical systems which consider human variables in providing safe patient care and reducing errors (World Health Organization, 2016). In a case-control study in a 700-bed hospital, Bates et al. (1997) connected two out of 100 patients to adverse events with an estimated annual hospital cost of $2.8 million. Glavin (2010) reported the incidence of medical errors in anesthesia to be an estimated one in every 133 persons given anesthetic. Nanji et al. (2016) completed a prospective observational study and identified about one in every twenty perioperative medications as adverse drug events or medical errors. Understanding and recognition of human factor variables in anesthesia are essential in the evaluation and improvement of behavior assessments, crisis management, and clinical performance (Jones et al., 2018).

Currently in the anesthesia specialty, certified registered nurse anesthetists (CRNAs) constitute more than 50% of the profession (AANA, 2022; U.S. Bureau of Labor Statistics, 2021). Education requirements for preparation as a CRNA include a minimum of a year of critical care nursing experience, an extension of the curriculum vitae, and a GPA requirement set by the individual program (AANA, 2022). Admission into a nurse anesthesia program is contingent following an interview process analyzing clinical reasoning, critical thinking, aptitude, and personality (AANA, 2022). Providing education on situation awareness using high-fidelity simulation to nurse anesthesia program applicants as a core component of the applicant interview process will assess heightened awareness and prioritization and provide additional evaluation for cognitive and non-cognitive qualities.

Significance to the Profession

The high-reliability profession of anesthesia is similar to the aviation and military disciplines (Fletcher et al., 2003). The thorough assessment of both cognitive and non-technical performance provides vital information on the management and evaluation of anesthesia training (Fletcher et al., 2003). Identification of human factor variables provides an analysis of observable behavior and intuition executed to guide crisis management, maintain clinical performance, and mitigate errors in patient safety (Fletcher et al., 2003).

In the AANA Foundation Closed Claims Database, 50.2% of the closed claims are preventable events and involve either a certified registered nurse anesthetist (CRNA) or a student registered nurse anesthetist (Kremer et al., 2019). Analysis of the claims provided consistency in the causation of errors: communication failure, violation of standards of practice, and error in judgment (Kremer et al., 2019). Judgment errors involve cognitive biases influenced by heuristics, vigilance, and situation awareness (Kremer et al., 2019). In another closed claims analysis, 74% of adverse anesthesia events are due to situation awareness and lack of vigilance (Schulz et al., 2017). Factors affecting conscious situation awareness and vigilance include distractions and fatigue (Kremer et al., 2019). Situation awareness and vigilance are essential components of safe anesthesia delivery (Kremer et a., 2019). The act of awareness incorporates training, education, skills, and prior experiences (Kremer et a., 2019). Experience is a major contributing factor to developing expectations and predicting outcomes for clinical events and may complement the use of high-fidelity simulation to increase clinical experience (Kremer et al., 2019).

High-fidelity simulation has been an assessment and training tool associated with the aviation and military disciplines since the 1900s (Ryall et al., 2016). The complexity of high-fidelity simulators has since been incorporated into the medical field as a viable process to present clinical scenarios and evaluate learners (Ryall et al., 2016). Using simulation in anesthesia training provides preparation for challenging clinical scenarios and exercises cognitive and noncognitive skills before patient interaction to improve clinical outcomes and patient safety (Ryall et al., 2016). Simulation training before clinical placement helps predict clinical performance and provides a more standardized method of assessing clinical competence and readiness (Ryall et al., 2016). The viability of simulation assessment delivers a consistent evaluation of learner progression and identifies areas of improvement to provide safe clinical practice and minimize adverse outcomes during patient interaction (Ryall et al., 2016).

The competitive admissions process into nurse anesthesia programs involves using a multimodal assessment method incorporating personal interviews, written essays, and interpersonal interactions to determine program success and clinical performance (Penprase et al., 2012). In addition to candidate interviews, using high-fidelity simulations during the candidate admissions process as a tool provides a simultaneous assessment of cognitive and noncognitive behaviors (Penprase et al., 2012). Using high-fidelity simulation, evaluators observe candidate assessment of critical care scenarios and candidate ability to manage stressful situations, self-awareness, accountability, communication, and leadership (Ziv et al., 2008). Incorporating high-fidelity simulation into the admissions process may provide a complete assessment of noncognitive behaviors not traditionally observed in personal interviews (Ziv et al., 2008).

Considering the noncognitive behaviors affecting clinical performance and patient outcomes, incorporating high-fidelity simulation into the admissions process for nurse anesthesia programs may provide a vital assessment of candidate situation awareness in managing stressful scenarios. The evaluation provided by simulation may offer a complete analysis of candidate quality and serve as a foundation to determine candidate selection and clinical performance. The complex and dynamic setting of anesthesia requires cognitive vigilance and active awareness to provide quick judgment and decision-making to support patient safety. Using a multimodal admissions process including high-fidelity simulation may thoroughly identify candidate clinical competency and predict overall program progression and success.

PICO(T)

In applicants for nurse anesthesia programs (P), how does a high-fidelity simulation in the applicant interview process (I) compared to the traditional interview process (C) affect situation awareness and clinical preparedness (O) during the program (T)?

Project Objectives

The following objectives are identified for the project:

1. Obtain an understanding of situation awareness and the effect of situation awareness on clinical performance and patient outcomes through a literature review.
2. Develop a comprehensive plan to create an evidence-based simulation to assess situation awareness to implement during the applicant interview process in nurse anesthesia programs.

3. Develop a comprehensive plan to monitor and evaluate situation awareness during the applicant interview process.
4. Develop a comprehensive plan to adjust the guidelines based on outcomes.

Literature Review

A literature search was completed for the assessment of common themes associated with the use of high-fidelity simulations in anesthesia and the resulting influences on non-technical skills and clinical preparedness of anesthesia providers. The databases utilized for the literature search include the Cumulative Index of Nursing and Allied Health Literature (CINAHL) PubMed, and ProQuest.

The initial literature search utilized the keywords "situation awareness," "anesthesia," and "non-technical skill." The Boolean operator "AND" and "OR" were used during the search. The findings were limited to peer-reviewed publications, full-text availability, and publication in the English language. Seminal articles with relevance to the assessment of situation awareness in anesthesia were included in the resulted findings.

The final literature search utilized the keywords "simulation," "situation awareness," and "anesthesia." The keywords included "situation awareness," "surgery," "anesthesia," "students," and "anesthes*". The Boolean operators "AND" and "OR" were used during the search. Exclusion of articles was completed through evaluation of title, abstract, and text. Articles were excluded based on studies evaluating patient awareness in the operating room, studies evaluating multidiscipline situation awareness (i.e., team situation awareness versus individual situation awareness), studies evaluating the use of handoff tools to improve situation awareness, and studies evaluating the use of technology in affecting situation awareness (i.e., usage of eye tracking technology). A selection of 12 articles were isolated for rapid critical appraisal.

Complications in Anesthesia

Safe and effective delivery of anesthesia commands a high cognitive demand and an aptitude for situation awareness (SA) to minimize patient safety compromise and error in clinical judgement. Efficient clinical performance requires the skillset of both technical and non-technical skills, which include SA and human error (Jones et al., 2018). Active SA plays a role in acknowledging human error development and the effect of human factors on non-technical skills on the individual level (Schulz et al., 2016; Jones et al., 2018). SA is divided into three components: “perception” (the lowest level of SA involving information collection), “comprehension” (information processing), and “projection” (the highest level of SA involving the anticipation of future events) (Jones et al., 2018; Schulz et al., 2016; Schulz et al., 2017; Lee Chang et al., 2017).

In closed claims analysis of errors in anesthesia by a single anesthesia provider resulting in critical events, 81.5% of critical incidents were associated with errors in SA, specifically with the area of perception affecting 38% of the surgical cases (Schulz et al., 2016). Error resulting from the combination of comprehension and projection affected 43.5% of the surgical cases (Schulz et al., 2016). Another closed claims analysis of brain death or damage resulting from anesthesia management of a single anesthesia provider showed 74% of malpractice claims associated with SA (Schulz et al., 2017). The highest cause of SA error was associated with perception at 42%, while comprehension and projection errors were combined at 58% (Schulz et al., 2017). In closed claims analysis of morbidity and mortality prevention by a certified registered nurse anesthetist (CRNA), 50.2% of the cases were associated with preventable events, such as anoxic brain injury, and 65% of the isolated claims involved errors in judgement, such as inappropriate delivery of anesthesia and lack of situation awareness (Kremer et al., 2019). In the SA taxonomy, error in the lower levels will presumably translate to the higher levels of SA, which results in errors in clinical judgement and patient safety compromise (Schulz et al., 2016). Errors in judgement involve the lack of SA resulting from active decision making without conscious awareness and vigilance (Kremer et al., 2019). Factors contributing to judgement errors include distractions (i.e., provider fatigue and environmental components), performance pressure, cognitive biases (Kremer et al., 2019). Loss of SA and failure of active vigilance lead to delayed responses to clinical management and provides the foundation for adverse events (Kremer et al., 2019).

SA Evaluation and the Situation Awareness Global Assessment Technique (SAGAT)

Measurement of SA may be completed using either direct or indirect assessment tools. The direct method of measurement directly assesses individual SA and incorporates the use of both objective and subjective analysis (Orique & Despins, 2018). A valid and reliable tool used to directly measure SA is the Situation Awareness Global Assessment Technique (SAGAT) Scale (Orique & Despins, 2018).

Originally developed for use in the military and aviation industry to assess pilot SA and analyze accidents in flight, the SAGAT provides a direct method to assess the three levels of SA in simulation (Orique & Despins, 2018; Lee Chang et al., 2017; Dishman et al., 2022). In assessments involving the SAGAT, Goal-Direct Task Analysis (GDTA) is developed through the delivery of questions to simulation participants in randomized succession to encourage rapid response, active memory, and goal maintenance (Orique & Despins, 2018; Dishman et al., 2022). Results from a mixed-methods study demonstrated the relationship between clinical competency and performance and SA utilizing the SAGAT (Dishman et al., 2022). Also operating with the SAGAT, a randomized control trial led by Lee Chang et al. (2017) demonstrated the significance of using simulation training to provide improved individual SA. Compared to other methods of SA measurement, the SAGAT is proven to provide a more thorough understanding of an individual's SA concurrent to a critical event (Orique & Despins, 2018).

Non-Technical Skill and the Anesthetists Non-Technical Skill (ANTS) Framework

The analysis of non-technical skills originated from research associated with flight accidents in the aviation industry (Wunder, 2016). Data gathered from the aviation research identified non-technical skills as the source of critical safety events (Wunder, 2016). Non-technical skills are considered social and cognitive skills that are essential components to effective performance and are the counterparts to technical skills and knowledge (Flynn et al., 2022; Wunder, 2016). Assessment of non-technical skills and effective maintenance of non-technical skills in anesthesia are vital in mitigating clinical error and improving patient outcomes (Flynn et al., 2022).

The indirect method of measuring SA involves the analysis of behavior markers to provide critical reflection and feedback on the SA of an individual (Flynn et al., 2022). Indirect measurement of SA provides an inference on an individual based on cognition, clinical performance, and behavior (Orique & Despins, 2018). A valid and reliable tool used to indirectly measure SA is the Anesthetists Non-Technical Skill (ANTS) framework (Wunder, 2016; Flynn et al., 2022). The ANTS framework is designed specifically for the assessment of SA in anesthesia (Wunder, 2016). The ANTS framework assesses an individual's situation awareness, decision making, teamwork, and task management based on a scoring system (Wunder, 2016). Data gathered from a pre-test/post-test quasi-experimental study displayed the significance of formalized training on individual situation awareness (Wunder, 2016). Post-test scores were recorded to be higher than pre-test scores and indicated that non-technical skills are more pronounced following SA education (Wunder, 2016).

Other studies utilized a modified version of the ANTS framework to assess for SA (Flynn et al., 2017; Flynn et al., 2022). The modified framework, Nurse Anesthetists' Non-Technical Skills-Norway (NANTS-no), was proven to be a valid and reliable measurement of SA is utilized in the assessment of Norwegian delivery of anesthesia (Flynn et al., 2017; Flynn et al., 2022).

SA and Simulation Training

Effective SA is an integral component of clinical decision making and is translated into clinical performance and patient outcomes (Schulz et al., 2013). Provision of formative training and education in SA will provide the anesthesia provider the sensitivity to identify situations compromising SA and focused knowledge to maintain vigilance in the clinical setting (Schulz et al., 2013). The use of high-fidelity simulation is proven to be an effective method to SA training in anesthesia that is goal directed (Wright & Fallacaro, 2011; Schulz et al., 2013; Lee Chang et al., 2017). A correlation design study led by Wright and Fallacaro (2011) demonstrated the ability to predict SA through predictor variables. The results displayed a direct positive linear correlation between cognition and situation awareness using high-fidelity simulation (Wright & Fallacaro, 2011). A randomized control trial led by Lee Chang et al. (2017) demonstrated the significant difference in SA education and training using high-fidelity simulation compared to the use of lecture-based training. Using high-fidelity simulation provided improvements to individual perception scores, which implicates improved clinical decision making with higher levels of perception (Lee Chang et al., 2017).

Analogous to flight simulators utilized in the military and aviation industries, high-fidelity simulations in anesthesia training are effective training tools to provide concurrent analysis and feedback of clinical management (Schulz et al., 2013; Lee Chang et al., 2017). Concomitant use of a direct SA measurement tool with high-fidelity simulation provides focused training of SA and allows for the use of debriefing procedures to fine tune clinical performance (Schulz et al., 2013).

Limitations

The concept of SA is a relatively new term associated with anesthesia. While the concept is widely known in the military and aviation industries, SA in relation to anesthesia remains to be novel area of study. Key concepts on SA in other disciplines were included in the literature review to provide a foundation on the understanding of SA and performance outcomes. Further research into SA within the anesthesia setting may provide better analysis on anesthesia management and clinical performance.

Evidence-Based Practice Model

The evidence-based practice model used to guide the project is the John Hopkins Nursing Evidence-Based Practice (JHNEBP) Model. The JHNEBP Model delivers a systemized method for active clinical governance and analysis and provides a design ensuring the implementation of evidence-based research into clinical practice (Dang et al., 2022). The key components of the model focus on inquiry, best practices, and practice improvements (Dang et al., 2022). The idea of “inquiry” focuses on the formation of a clinical question impacting future clinical practice (Dang et al., 2022). The development of the “inquiry” is supported through defining situation awareness and assessing the perception of the topic by applicants to nurse anesthesia programs. The idea of “best practices” focuses on the identification of current and relevant evidence-based data supporting the clinical question (Dang et al., 2022). Data obtained from an extensive literature review provide the foundation of “best practices”. The idea of “practice improvements” involves the implementation of supportive data into future clinical practice to provide advancements to patient care (Dang et al., 2022). Due to the timeframe of the project, implementation and analysis of the project will not be executed.

Recommendations

Development

The project will involve the collection of qualitative and quantitative data to assess for candidate perception of situation awareness and evaluate the effects of high-fidelity simulation on prospective candidates for the nurse anesthesia program. Data gathered through an anonymous open-ended pre- and post-training questionnaires involving the topics of candidate opinion regarding simulation training and situation awareness will provide qualitative data. The use of an open-ended questionnaire aids in identifying barriers to the execution of the simulation and addresses potential changes that could be implemented to tailor to future candidate application interviews. Data gathered through the SAGAT will provide quantitative data on candidate situation awareness. The use of the SAGAT involves objective data collection, as opposed to retrospective subjective behavior inference, which mitigates bias during the evaluation and summarization of data (Endsley, 2000).

Pre-Simulation Questionnaire

An open-ended survey utilizing a Likert scale will be distributed to candidates to assess their perception of situation awareness prior to the start of the simulation (Appendix A). Data from the questionnaire will be collected verbatim to provide an analysis of candidate perception of situation awareness prior to the simulation.

Post-Simulation Questionnaire

A questionnaire will be distributed to candidates following the simulation (Appendix B). The questionnaire is developed using a Likert scale to provide an assessment of candidate perception of situation awareness before and after the simulation experience of candidates. The questionnaire will provide information on the perceived effects of situation awareness. Data collected from the questionnaire will offer a direct comparison of candidate perception for analysis.

Situation Awareness Global Assessment Technique (SAGAT)

The SAGAT, a valid and reliable assessment tool, will be used to directly measure the situation awareness of candidates (Appendix C). Originally developed by Endsley (1988; 2000) for the military and aviation industry, the SAGAT is the only valid and reliable qualitative measurement tool that provides a direct assessment of situation awareness. As a direct assessment tool, the SAGAT employs the use of assessment at selected or frozen moments of operation and the use of queries or a series of questions to assess current candidate perception of the surrounding environment (Endsley, 2000). The queries will involve questions aiming to assess the three levels of situation awareness: level 1 (data perception), level 2 (meaning comprehension), and level 3 (future projection) (Endsley, 2000). The unique assessment process of the SAGAT provides the direct assessment of instantaneous candidate perception as opposed to behavior inference, which is an indirect assessment (Endsley, 2000). Using the SAGAT to provide direct objective assessment eliminates the use of subject or objective judgment associated with subjective analysis (Endsley, 2000). The use of a direct measurement tool for situation awareness provides immediate and more reliable data collection for assessment and mitigates the possibility of bias in candidate response and retrospective data analysis (Endsley, 2000). The SAGAT will allow for effective analysis of candidate situation awareness before and after the intervention.

The use of the SAGAT in the project will involve the identification of cognitive functioning and external environment features (Endsley, 2000). The use of the SAGAT will also involve the development of questions relating to the simulation that addresses all three levels of situation awareness. In the project, the system is defined as the life-sized adult SimMan utilized in the simulation, and the environment is defined as objective findings associated with the simulation (ex. vital signs, patient status, blood loss). The questions utilized during the project will be framed after goal-directed task analysis, which is a form of cognitive task analysis involving defined goals, secondary goals, and decisions associated with the achievement of the goals (Endsley, 2000). The questions given to the candidates must be delivered in a method that is “cognitively compatible” with the thought processes of the candidates (Endsley, 2000). The phrasing of the questions should not involve additional external suggestions or decision-making of the candidates. The goal-directed task analysis provides a defined framework of situation awareness that is expected with cognitive operations to reach the established goals. For the data collection, candidates will be assessed as either meeting or not meeting the criteria for the three levels of situation awareness.

Implementation

Timeline

The project will begin October 2022 following the prospective candidate selection for admission interviews to the nurse anesthesia program. The project will involve all prospective candidates selected for candidate interviews. Application criteria to the nurse anesthesia program include a baccalaureate nursing degree, a minimum undergraduate cumulative GPA of 3.0, a minimum undergraduate science GPA of 3.0, a current and valid nursing license, a one-year minimum of critical care nursing experience, and current Advanced Cardiovascular Life Support (ACLS) and adult CCRN (adult critical care specialty certification) recognition. Details related to the project and a consent form will be sent via electronic mail two weeks prior to applicant interviews. The voluntary nature of the project will be addressed. Voluntary consent to the project will address participation in the simulation without penalty to the prospective application process. Candidates will be permitted to exit from any portion of the project at the time of their discretion. Candidates will be given the opportunity to review the details, relay questions related to the project, and determine participation in the project. All portions of the project will be completed on the same day.

Data collection for the project will begin October 2022 following the selection of interview candidates. The project will be integrated into the current applicant interview process at the Nurse Anesthesia program in the simulation laboratory utilizing a computer-generated life-sized adult SimMan manikin and Laerdal Learning Application (LLEAP) Software. The simulation will be controlled by two CRNAs (experts in the field of anesthesia) and a trained simulator coordinator (an individual trained in running high-fidelity simulations). The individuals running the simulation will be tasked with assessing candidate performance during the simulation. The SimMan manikin will be preprogrammed to follow simulation manuscripts to allow for the progression of the simulation and anticipated responses and events (Appendix D). The manuscript will be available to review and reference during the simulation to guide and respond to events. The CRNAs and simulator coordinator will be briefed prior to the start of the simulation on the topic of situation awareness and the assessment through the SAGAT.

The simulation and simulation lab will be designed to replicate an intensive care unit (ICU) environment, which candidates have familiarity with prior to the application process. The simulation lab will include standard patient monitors with audio and visual, a nurse workstation, and a standard crash cart with equipment. The simulation lab will also include a double-sided mirror to allow for direct visualization of the lab from the control room. Microphones will only be used in the simulation lab to amplify the verbal communication of the candidates. Recording via audio and visual will not be utilized.

Following candidate selection for the applicant interviews and the formal interview process, the simulation will begin. De-identification of candidates will be implemented through the provision of anonymity and random assignment to a number. Candidates will be randomly assigned numbers through closed envelopes. Individuals will rotate to be either in the simulation or waiting to be entered in the simulation. Prior to the start of the simulation, all candidates will complete a pre-training questionnaire to assess the pre-simulation perception of situation awareness.

High-Fidelity Simulation

The simulation will be limited to five minutes. Prior to the start of the simulation, the candidates will be briefed on the process of the simulation and given a patient report (Appendix E). The candidates will be notified of questions asked during the simulation at any given time. Prior to entering the simulation lab, each candidate will be briefed with the following instructions: 1) visualize the simulation and the environment as a real patient scenario in the intensive care unit, 2) audibly vocalize any actions or thoughts, and 3) refrain from discussion of the simulation with other candidates following the simulation. During the simulation, the CRNAs and simulation coordinator will pause the simulation at the five-minute mark and lead the candidates through a series of questions about the simulation. At the time of questioning, the monitor screens will be turned off. Following the questions, the simulation will end and the candidates will receive a debrief session and a post-simulation questionnaire.

The simulation will involve a hypotensive scenario in the ICU following a surgical procedure in the operating room (OR) (Appendix D). A hypotensive procedure is chosen for the simulation as the candidates will have prior familiarity with the procedure in their respective ICU settings. The scripted hypotensive simulation will allow for the assessment of candidate situation awareness at all three levels (perception, comprehension, and projection). All data points will be collected via the SAGAT by the CRNAs and trained simulation coordinator (Appendix C).

Completion

Each simulation will be followed by a debriefing session for each individual candidate to discuss the case scenario. The debriefing will be led by the CRNAs and follow a manuscript addressing the three levels of situation awareness observed or not observed throughout the simulation (Appendix F). Following the debriefing session, a post-simulation questionnaire will be given to the candidates to assess candidate perception of situation awareness. The questionnaire will be numerically coded to remain anonymous. The questionnaires will be submitted in a closed envelope to maintain anonymity.

Data Evaluation

The evaluation and summarization of data will begin during the spring semester of 2023. Data will be averaged and analyzed through Statistical Package for the Social Sciences (SPSS software) to assess for trends in situation awareness. The data collected through the open-ended questionnaires may be summarized for common themes. Evidenced-based strategies for assessing and improving situation awareness will be selected for presentation at the end of the spring semester of 2023.

Budget

The greatest expenditure associated with the project will be the time commitment of the primary investigator. With the plan to implement the project within the confines of the formal candidate interview process, hiring additional staff to assist with the project will not be necessary. The staff currently involved with the interview process will support the primary investigator with running and collecting data from the simulation. Training of the staff will require a maximum of one hour per staff member. Staff will be trained on assessing situation awareness and running the high-fidelity simulation under the guidance of a pre-scripted manuscript.

The proposed incorporation of high-fidelity simulation-based assessment strategies will involve a nurse anesthesia program already utilizing the SimMan simulation and associated LLEAP Software and thus, will not require an additional cost. Updates to the LLEAP Software connected to the SimMan are completed automatically and do not require additional cost. Maintenance to the SimMan is dependent on the type of maintenance required and cannot be calculated at this time. The SPSS Software estimated to be utilized for three years is averaged to cost $219. Additional financial implications are associated with paper and ink usage involved with the physical printouts of the pre- and post-simulation questionnaires, case study briefs, debriefing manuscript, and simulation manuscript. Utilizing a standard black and white printer, the cost per printed page of black ink is 5.5 cents (Cartridge World, 2022). The cost of a standard black and white printer averages $100-300 (Cartridge World, 2022). The cost of a standard black ink cartridge will cost an average of $150 annually depending on usage (Cartridge World, 2022).

Anticipated Barriers

Barriers to the implementation of the project include the task burden on the current staff to support an additional method of candidate assessment during the application process. Other notable barriers include the limited participation of the candidates relating to voluntary participation and concerns relating to cognitive and emotional burden and stress. Mitigation of the barriers will include staffing support to assist with the application interviews. Other methods to reduce the impact of potential barriers include the use of shortened re-assessment simulations to lessen the cognitive and emotional burden of the participants.

Data Analysis

Monitoring Outcomes

A primary measure of successful situation awareness performance is the overall evaluation of clinical training. Candidates will be evaluated over the course of the three years of the anesthesia program through the clinical setting and a portion of the evaluation will discuss the level of situation awareness maintained by the candidates. The observation of the trending improvements throughout the course of the three years will be outside the time constraints given for the project. Improvements to situation awareness will be indicated by overall performance in the clinical setting.

An additional measure of success would be indicated by trending improvements to situation awareness assessed through the SAGAT with repeated simulations: once during the junior year of the Nurse Anesthesia program and once during the senior year of the Nurse Anesthesia program. The subsequently repeated simulations will be tailored to correspond to the level of learning and training the candidates receive in each additional year of the nurse anesthesia program (i.e., the simulation will reflect the operating room and a clinical anesthesia case scenario). To assess for success and address additional changes to the delivery process of the simulation, comparisons of the clinical evaluations and the SAGAT will be made year to year to improve upon the situation awareness and cognitive capacity of candidates throughout the trajectory of the Nurse Anesthesia program. The data from the SAGAT scores will be averaged and analyzed through SPSS software to assess and evaluate for trends in situation awareness. The data collected through the open-ended questionnaires may be summarized for common themes.

Optimizing Outcomes

The primary barrier to success in the assessment of situation awareness is fatigue. Candidates may be overburdened by the demands of the program during certain intervals and may not provide optimal revelation of situation awareness on assessment. To mitigate the participation burden of the simulation, the repeated simulations will be delivered within a shortened time frame following a day of lecture in class.

Conclusion

The field of anesthesia relies on high cognitive demand with a small margin of error. Situation awareness is a necessary component of the cognitive process to help with patient safety and maintain clinical performance. Literature suggests the use of a formative discussion on situation awareness to provide improvements to the clinical setting. Providing structured teaching and assessment on situation awareness to prospective candidates for the nurse anesthesia program will allow for the effective assessment of overall candidate performance and success throughout the trajectory of the program.

Currently, there is no distinguishable valid, and reliable tool to assess for situation awareness in the field of anesthesia. However, the SAGAT is an established valid, and reliable tool used for the direct assessment of situation awareness in high cognitive demand settings similar to the OR. Utilizing the SAGAT will provide a direct assessment of the level of situation awareness of candidates and may provide data that could be addressed to improve upon the demands of the Nurse Anesthesia program.

Current data suggests the valid and reliable use of the SAGAT in the field of anesthesia, but an additional exploration into the assessment of situation awareness is needed to generate more conclusive findings for the application to anesthesia.

The proposed strategy is modeled after evidence-based strategies of disciplines similar to anesthesia and follows a theoretical approach for implementation. The project dissemination will occur during the summer of 2023.

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Appendix A:

Pre-Simulation Questionnaire

The purpose of this questionnaire is to gather your level of understanding on the topic of ***situation awareness***. Do not write any information that may be used identify you. Please answer to the best of your ability.

Please write your answer to the questions below.

What is *situation awareness*?

What is the relationship between *situation awareness* and the field of nurse anesthesia?

Please circle your response to the questions below.

	Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
1. I have been given formal education on the topic of situation awareness before today.	**5**	**4**	**3**	**2**	**1**
2. Situation awareness plays a role in the practice of nurse anesthesia.	**5**	**4**	**3**	**2**	**1**
3. I can incorporate situation awareness into my daily clinical practice as a nurse anesthesia student in the future.	**5**	**4**	**3**	**2**	**1**
4. Nurse anesthesia programs should include the topic of situation awareness into the didactic portion of the curriculum.	**5**	**4**	**3**	**2**	**1**
5. I have used high-fidelity manikin simulations in the past for training and educational purposes.	**5**	**4**	**3**	**2**	**1**
6. High-fidelity simulation is an effective training tool for the future practice of nurse anesthesia.	**5**	**4**	**3**	**2**	**1**

Appendix B:

Post-Simulation Questionnaire

The purpose of this questionnaire is to gather your level of understanding on the topic of ***situation awareness*** after the simulation. Do not write any information that may be used identify you. Please answer to the best of your ability.

Please write your answer to the questions below.

What is *situation awareness*?

What is the relationship between *situation awareness* and the field of nurse anesthesia?

Please circle your response to the questions below.

	Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
1. I understand the topic of situation awareness.	**5**	**4**	**3**	**2**	**1**
2. Situation awareness plays a role in the practice of nurse anesthesia.	**5**	**4**	**3**	**2**	**1**
7. I can incorporate situation awareness into my daily clinical practice as a nurse anesthesia student in the future.	**5**	**4**	**3**	**2**	**1**
3. Nurse anesthesia programs should include the topic of situation awareness into the didactic portion of the curriculum.	**5**	**4**	**3**	**2**	**1**
4. The high-fidelity manikin simulation was an effective training method for teaching the topic of situation awareness.	**5**	**4**	**3**	**2**	**1**
8. High-fidelity simulation is an effective training tool for the future practice of nurse anesthesia.	**5**	**4**	**3**	**2**	**1**

Appendix C:

SAGAT questions for the simulation:

Situation Awareness Level 1: Perception

Question:

☐ What is the current HR?
-Values within 5% of the actual value will be accepted
☐ What is the current BP?
-Values within 5% of the actual value will be accepted
☐ What is the current SpO2?
-Values within 5% of the actual value will be accepted

Situation Awareness Level 2: Comprehension

Question:

☐ Why did the vital signs change?
- Active bleed
-Hypovolemic
-Compression of vessels
-Too much sedation
☐ Is the patient receiving adequate blood flow?
-No

Situation Awareness Level 3: Projection

Question:

☐ If the patient's status is not addressed, what will happen to the vital signs?
- The BP will continue to drop
-The HR will continue to increase
-The patient's mental status will worsen
☐ What other assessments should be completed?
-Palpate the abdomen to assess rigidity
-Assess for other sites of bleeding
-Reposition the patient to Trendelenburg position
☐ What other interventions may be necessary?
-Administration of vasopressors or fluids
-Notify surgeon of patient status for return to OR

Appendix D:

ICU Setup for the simulation:

Monitoring Equipment:

- 5-lead EKG
- Pulse oximetry
- Invasive arterial BP monitoring
- Temperature monitoring device

Props/Room Equipment:

- Adult SimMan Manikin
- Nurse server
- Ventilator
- 1 L Lactated Ringers
- 2 Jackson-Pratt drains
- Room phone

Staff:
Resident physician, ICU nurse (the candidate), Respiratory therapist

Manikin Setup: The adult SimMan will be intubated and connected to the ventilator.

EKG	Normal Sinus Rhythm • Heart rate between 80-90 bpm
Pulse Oximetry	99%
Respiratory Rate	12
Blood Pressure Invasive	Cycled every 2 minutes • Systolic 130-145mmHg; Diastolic 70-80mmHg
Temperature	36.2 C
Ventilator Settings	Volume Control Ventilation • TV: 550 mL • RR: 12 • I:E 1:2
Blood Glucose	155

The candidate receives report from the surgical and anesthesia team. Wait for candidate to familiarize with the setting, then begin the simulation.

Respiratory therapist sets up the ventilator and completes ETT care and ICU Resident physician asks if the RN needs anything and then leaves the room.

2 minutes into the simulation change the vital signs:
HR 97, BP 94/53, RR 14, SpO2 99%

4 minutes into the simulation change the vital signs:
HR 112, BP 77/49, RR 16, SpO2 97%

5 minutes into the simulation, pause the simulation and turn all monitors off. Ask the series of questions.

Appendix E:

Simulation: Billy Doe

The patient is admitted to your ICU after surgery for closer monitoring. You are the RN admitting the patient. This is the report you receive from the surgical and anesthesia team.

Handoff Report:

Billy Doe is a 56-year-old who presented to the hospital with complaints of abdominal pain, tenderness, and fever. Further assessment and testing revealed absent bowel sounds, leukocytosis, and bowel distension. He was taken to the OR after a bowel prep for a 4-hr exploratory laparotomy for a small bowel obstruction.

Medical/Surgical History:

- Anemia
- Type 2 Diabetes Mellitus

Current Medications:

- Iron
- Metformin
- Multivitamins

Admission Labs:

Na 140	**BUN** 14	**Glucose** 140	**Hct** 30%
K 4.3	**Cr** 1.3	**Hgb** 10.7	**Plt** 148

I/Os:

- Fluids: 2.5L LR
- Urine Output: 800cc
- EBL: 2L

Surgical Events:

- Multiple boluses of phenylephrine, ephedrine, and vasopressin given
- 2u PRBCs given

Key Points:

- Treat this simulation as a real-life scenario.
- Speak loudly and please vocalize all thoughts and actions.
- Do not discuss this simulation with other candidates.
- You will be informed when the simulation is completed.
- A short debriefing will follow the simulation.

Appendix F:

Simulation Debriefing:

The purpose of this simulation was to assess for ***situation awareness***, a vital component in anesthesia necessary to help manage critical situations and maintain patient safety. We will discuss your actions and how they are related to the three different levels of situation awareness.

Read the actions completed by the candidate with the situation awareness level to which the action is related (e.g., the candidate correctly states the actual blood pressure of the patient. The action corresponds to perception: the first level of situation awareness).

Appendix G:

Literature Table

Citation **(Author, Year, Title, etc.)**	**Conceptual Framework** **(Theoretical basis for study)**	**Design/Method**	**Sample/Setting** **(Number, Characteristics, Exclusions, Criteria, Attrition, etc.)**	**Major Variables; Definitions** **(Independent variables; Dependent variables)**	**Outcome Measurement** **(What scales used - reliability information - alphas)**	**Data Analysis** **(What stats used)**	**Findings** **(Statistical findings or qualitative findings)**	**Level of Evidence** **(Level =)**	**Quality of Evidence** **(Strength, Limitations, Risks, Feasibility)**
Article 1: Human Factors in Preventing Complications in Anaesthesia: A Systematic Review									
Jones, C., Fawker-Corbett, J., Groom, P., Morton, B., Lister, C., & Mercer, S. J. (2018). Human factors in preventing complications in anaesthesia: a systematic review. *Anaesthesia*, *73*(1), 12–24. https://doi.org/10.1111/anae.14136	Explorative Research	Systematic Review	74 articles included in the literature review from the databases Medline and CINAHL Exclusion criteria: duplicate publications, publications not associated with human factors, and irrelevance to anesthesia	Independent variables: non-technical skills (task management, teamworking, situation awareness, and decision making) Dependent variables: human factors varying from overconfidence, patient safety scenarios and assessment, management, and medication errors	Human factors identification by the Anesthetists Non-Technical Skill (ANTS) framework	Search strategy and protocol with PROSPERO	Studies demonstrated the significance in acknowledging human factor variables in anesthetic practice to minimize human error Improvements to management of anesthesia following acknowledgement of human factors	Level I	Strength: systematic review of literature and high level of evidence Limitations: utilization of a different measurement tool
Article 2: Experiences Using an instrument for Non-Technical Skills in the Operating room									
Flynn, F. M., Valeberg, B. T., Bing-Jonsson, P. C., Lyberg, A. M., & Tønnessen, S. (2022). Experiences using an instrument for non-technical skills in nurse anaesthesia education: a focus group study. *BMC Medical Education*, *22*(1), 243. https://doi.org/10.1186/s12909-022-03322-w	Explorative Research	Qualitative Study	Interviews completed with four focus groups from two different cohorts at a two-year	Independent variables: self-awareness, decision making, communication,	Non-technical skills identification by the Anesthetists Non-	Analysis and transcription utilized Graneheim and	Utilization of a structured assessment tool provides insight into clinical practice	Level VI	Strength: Limitations: utilization of a different

Citation (Author, Year, Title, etc.)	Conceptual Framework (Theoretical basis for study)	Design/Method	Sample/Setting (Number, Characteristics, Exclusions, Criteria, Attrition, etc.)	Major Variables; Definitions (Independent variables; Dependent variables)	Outcome Measurement (What scales used - reliability information - alphas)	Data Analysis (What stats used)	Findings (Statistical findings or qualitative findings)	Level of Evidence (Level =)	Quality of Evidence (Strength, Limitations, Risks, Feasibility)
			nurse anesthesia master's program	situation awareness Dependent variables: clinical proficiency and excellence	Technical Skill (ANTS) framework and the Nurse Anaesthetists' Non-Technical Skills-Norway (NANTS-no)	Lundman's qualitative content analysis	Utilization of an assessment tool provides active feedback on the development of non-technical skills and the improvements to patient safety and clinical practice Improvements to management of anesthesia in clinical practice and patient safety		assessment tool
Article 3: Frequency and Type of Situation Awareness Errors Contributing to Death and Brain Damage: A Closed Claims Analysis									
Schulz, C. M., Burden, A., Posner, K. L., Mincer, S. L., Steadman, R., Wagner, K. J., & Domino, K. B. (2017). Frequency and type of situation awareness errors contributing to death and brain damage: A closed claims analysis. *Anesthesiology*, *127*(2), 326–337. https://doi.org/10.1097/ALN.0000000000001661	Explorative Research	Closed Claims Analysis/ Literature Review	390 cases met inclusion criteria for review Inclusion criteria included surgical or procedural anesthesia care, phase of anesthesia, damaging events leading to injury, sole anesthesia provider, and cases that occurred between the years 2002 to 2013	Independent variables: level of situation awareness (i.e., perception, comprehension, and projection) Dependent variables: damaging events (e.g., respiratory, cardiovascular, medications, equipment, regional, or other)	N/A	Utilized SPSS 22 for statistical analysis and inter-rater reliability	74% of the closed claims in involved an error in situation awareness by the anesthesia provider Situation awareness is an integral component of safe anesthesia decision-making and delivery In the closed claims involving anesthesia errors, 42% involved errors in perception, 29%	Level VII	Strengths: literature review on cases associated with errors in anesthesia

Citation (Author, Year, Title, etc.)	Conceptual Framework (Theoretical basis for study)	Design/Method	Sample/Setting (Number, Characteristics, Exclusions, Criteria, Attrition, etc.)	Major Variables; Definitions (Independent variables; Dependent variables)	Outcome Measurement (What scales used - reliability information - alphas)	Data Analysis (What stats used)	Findings (Statistical findings or qualitative findings)	Level of Evidence (Level =)	Quality of Evidence (Strength, Limitations, Risks, Feasibility)
							involved errors in comprehension, and 29% involved errors in projection		
Article 4: Situation awareness in anesthesia: concept and research									
Schulz, C. M., Endsley, M. R., Kochs, E. F., Gelb, A. W., & Wagner, K. J. (2013). Situation awareness in anesthesia: concept and research. *Anesthesiology*, *118*(3), 729–742. https://doi.org/10.1097/ALN.0b013e318280a40f	Explorative Research	Literature Review	N/A	N/A	N/A	N/A	Focused training on situation awareness will provide improved clinical performance by decreasing cognitive workload and anesthesia maintenance and delivery errors Effective development of situation awareness is involved in critical decision-making and affects patient safety and clinical performance Identification of factors impacting situation awareness in relation to anesthesia is important to develop necessary training programs	Level VII	Strengths: Limitations: expert opinion and low level of evidence

Citation **(Author, Year, Title, etc.)**	**Conceptual Framework** **(Theoretical basis for study)**	**Design/Method**	**Sample/Setting** **(Number, Characteristics, Exclusions, Criteria, Attrition, etc.)**	**Major Variables; Definitions** **(Independent variables; Dependent variables)**	**Outcome Measurement** **(What scales used - reliability information - alphas)**	**Data Analysis** **(What stats used)**	**Findings** **(Statistical findings or qualitative findings)**	**Level of Evidence** **(Level =)**	**Quality of Evidence** **(Strength, Limitations, Risks, Feasibility)**
Article 5: Situation awareness errors in anesthesia and critical care in 200 cases of a critical incident reporting system									
Schulz, C. M., Krautheim, V., Hackemann, A., Kreuzer, M., Kochs, E. F., & Wagner, K. J. (2016). Situation awareness errors in anesthesia and critical care in 200 cases of a critical incident reporting system. *BMC Anesthesiology*, 16(4), 1–10. https://doi.org/10.1186/s12871-016-0172-7	Explorative Research	Literature Review	200 cases met inclusion criteria for review Inclusion criteria included relevance to anesthesia or critical care and occurrence in a hospital setting	Independent variables: level of situation awareness (i.e., perception, comprehension, and projection) Dependent variables: critical clinical actions (e.g., drug administration or management of a clinical problem)	N/A	Utilized IBM SPSS Statistics Version 22.0 for statistical analysis Chi-square test or Fisher's exact test provided exploratory analysis of correlation Cohen's kappa calculated reliability	183 cases (81.5%) associated with situation awareness In the cases involving situation awareness, 38% involved errors in perception, 31.5% involved errors in comprehension, and 12% involved errors in projection Utilization of the situation awareness framework provides an overview on the causation of human error in anesthesia	Level VII	Strengths: literature review on cases associated with errors in anesthesia Limitations: expert opinion and low level of evidence
Article 6: Preventable Closed Claims in the AANA Foundation Closed Malpractice Claims Database									
Kremer, M. J., Hirsch, M., Geisz-Everson, M., Wilbanks, B., Clayton, B., Boust, R., & Jordan, L. (2019). Preventable closed claims in the AANA Foundation closed malpractice claims database. *AANA Journal*, *87*(6), 468–476. https://www.aana.com/docs/default-source/aana-journal-web-	Explorative Research	Closed Claims Analysis/ Literature Review	123 cases met inclusion criteria for review	N/A	N/A	Utilized SPSS 19 for statistical analysis	Common themes included failure in communication violation of standards of care,	Level VII	Strengths: literature review on cases associated

Citation (Author, Year, Title, etc.)	Conceptual Framework (Theoretical basis for study)	Design/Method	Sample/Setting (Number, Characteristics, Exclusions, Criteria, Attrition, etc.)	Major Variables; Definitions (Independent variables; Dependent variables)	Outcome Measurement (What scales used - reliability information - alphas)	Data Analysis (What stats used)	Findings (Statistical findings or qualitative findings)	Level of Evidence (Level =)	Quality of Evidence (Strength, Limitations, Risks, Feasibility)
documents-1/preventable-closed-claims-in-the-aana-foundation-closed-malpractice-claims-database-december-2019.pdf?sfvrsn=66d4b937_6			Inclusion criteria included cases associated preventable errors by the anesthesia provider			Inter-rater reliability of a κ value of 0.8	and error in judgement (includes situation awareness) 50.2% of the closed claims were associated to preventable events by the anesthesia provider >65% of the cases were associate with errors in judgement (i.e., lack of situation awareness, mismanagement of anesthesia care, lack of preparedness and vigilance, and performance pressure) Situation awareness depends on vigilance, which is associated with continuous monitoring and assessment of a given situation		with errors in anesthesia Limitations: low level of evidence
Article 7: Aiming for excellence – A simulation-based study on adapting and testing an instrument for developing non-technical skills in Norwegian student nurse anaesthetists									

Citation **(Author, Year, Title, etc.)**	**Conceptual Framework** **(Theoretical basis for study)**	**Design/Method**	**Sample/Setting** **(Number, Characteristics, Exclusions, Criteria, Attrition, etc.)**	**Major Variables; Definitions** **(Independent variables; Dependent variables)**	**Outcome Measurement** **(What scales used - reliability information - alphas)**	**Data Analysis** **(What stats used)**	**Findings** **(Statistical findings or qualitative findings)**	**Level of Evidence** **(Level =)**	**Quality of Evidence** **(Strength, Limitations, Risks, Feasibility)**
Flynn, F. M., Sandaker, K., & Ballangrud, R. (2017). Aiming for excellence – A simulation-based study on adapting and testing an instrument for developing non-technical skills in Norwegian student nurse anaesthetists. *Nurse Education in Practice*, *22*, 37–46. https://doi.org/10.1016/j.nepr.2016.11.008	Explorative Research	Qualitative Study	14 student nurse anesthetists participated in the study over the course of a 10-week period Qualifications for participation included a minimum of two years of nursing experiences and completion of six out of eighteen months of nurse anesthesia program training at a university college	Independent variables: no control utilized for the study Dependent variables: assessment of patient safety and variability in human factors	Assessment of non-technical skills by the Nurse Anesthetists' Non-Technical Skills-Norway (NANTS-no)	Utilized SPSS 22 for statistical analysis Utilized Pearson's *r* to calculate the effect size of the findings Utilized a post-hoc Wilcoxon signed ranks test with a Bonferroni correction for comparison of scores and assessment of changes in non-technical skills Utilized Mann-Whitney *U* tests to assess for the effect of age, nursing experience, or level on non-technical skills	Study demonstrated improvement to participant non-technical skills following completion of the simulations with the highest significance in the sessions involving training NATS-no displayed high reliability in the assessment of non-technical skills Simulation is an effective tool for the assessment and training of non-technical skills	Level VI	Strengths: validity and reliability of assessment tool Limitations: small sample size and recruitment method based on convenience

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Article 8: Effect of a Nontechnical Skills Intervention on First-Year Student Registered Nurse Anesthetists' Skills During Crisis Simulation									
Wunder, L. L. (2016). Effect of a nontechnical skills intervention on first-year student registered nurse anesthetists' skills during crisis simulation. *AANA Journal*, *84*(1), 46–51. https://www.aana.com/docs/default-source/aana-journal-web-documents-1/effect-of-nontechnical-skills-0216-pp46-51.pdf?sfvrsn=bdd448b1_6	Explorative Research	Quasi-Experimental Study	Thirty-two first-year nurse anesthetist students from a southeastern U.S. university participated in the study Inclusion criteria included participation in simulation training during the nurse anesthesia program	Independent variables: non-technical skills (i.e., situation awareness, decision making, teamwork, and task management) Dependent variable: posttest scores	Non-technical skills identification by the Anesthetists Non-Technical Skill (ANTS) framework	Utilized a 1-tailed, paired-samples *t* test for evaluation of the study hypothesis	Education and instruction on non-technical skills provided significant results in student knowledge enhancement Study displayed no correlation between instinct and time to anesthetists' non-technical skills Instruction and continued exposure are effective methods in promoting non-technical skills and promoting patient safety	Level III	Strengths: results were statistically significant with $P < 0.005$ Limitations: small sample size, recruitment method based on convenience, and lack of interrater reliability
Article 9: Evaluating Situation Awareness: An Integrative Review									
Orique, S. B., & Despins, L. (2018). Evaluating situation awareness: An integrative review. *Western Journal of Nursing Research*, *40*(3), 388–424. https://doi.org/10.1177/0193945917697230	Explorative Research	Integrative Review	50 articles included in the integrative review from the databases CINAHL, PubMed, Scopus, and PsycINFO Inclusion criteria included	Independent variables: Dependent variables:	Assessment of publications by a checklist developed by Desborough, Forrest, and Parker assessing clarity of information	N/A	SAGAT and behavioral marker systems found to have high reliability and validity Direct measurement of situation awareness assesses for	Level III	Strengths: Limitations: variability in measurement of situation awareness and lack of conceptual definition in association with nursing

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			peer-reviewed publications, measurement of situation awareness, and establishment of psychometric properties for measure of situation awareness Exclusion criteria included lack of mention of situation awareness, unpublished theses, retracted articles, conference abstracts, and non-peer-reviewed publications		Direct method: situation awareness global assessment technique (SAGAT) scale Indirect methods: behavior marker systems and performance measures		perception of current events Indirect measures use observation and performance to deduce situation awareness In situ simulation provides a direct assessment of situation awareness Identification of effective situation awareness will minimize errors to patient safety and outcomes		
Article 10: Adaptation and Validation of the Situation Awareness Global Assessment Technique for Nurse Anesthesia Graduate Students									
Dishman, D., Fallacaro, M. D., Damico, N., & Wright, M. C. (2020). Adaptation and validation of the situation awareness global assessment technique for nurse anesthesia graduate students. *Clinical Simulation in Nursing*, *43*, 35–43. https://doi.org/10.1016/j.ecns.2020.02.003	Explorative Research	Mixed Methods Study	Three-phase study design to implement goal-directed task analysis with two focus sample groups: one with seven participants and one with 49 participants Utilized an exploratory sequential	N/A	Situation awareness global assessment technique (SAGAT) scale	N/A	Qualitative results demonstrated the validity of SAGAT Quantitative results with a validity of 0.92	Level III	Strength: Limitations: design of the study

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			mixed-methods design						
Article 11: Predictors of situation awareness in SRNAs									
Wright, S. M., & Fallacaro, M. D. (2011). Predictors of situation awareness in student registered nurse anesthetists. *AANA Journal*, *79*(6), 484–490. https://www.aana.com/docs/default-source/aana-journal-web-documents-1/predictors_1211_p484-490af8e37731dff6ddbb37cff0000940c19.pdf?sfvrsn=4b715ab1_6	Explorative Research	Correlational Design Study	71 student registered nurse anesthetists participated in the study Inclusion criteria included random selection of participation currently enrolled in Virginia Commonwealth University, Louisiana State University, and Samford University	N/A	Wondrous Original Method for Battle Airmanship Testing in Complex Systems (WOMBAT-CS)	Utilized SPSS 17 for statistical analysis	Study findings displayed a positive linear correlation between cognition and situation awareness Memory and automaticity do not add predictive value to assessment of situation awareness	Level III	Strengths: validation of predictors assessing for situation awareness and applicability to nurse anesthesia program admissions process Limitations: utilization of a generic assessment tool to measure situation awareness (WOMBAT-CS) and recruitment method based on convenience
Article 12: Comparison between Simulation-based Training and Lecture-based Education in Teaching Situation Awareness									
Lee Chang, A., Dym, A. A., Venegas-Borsellino, C., Bangar, M., Kazzi, M., Lisenenkov, D., Qadir, N., Keene, A., & Eisen, L. A. (2017). Comparison between simulation-based training and lecture-based education in teaching situation awareness: A randomized controlled study. *Annals of the American Thoracic*	Explorative Research	Randomized Control Trial Random assignment of participants into	17 critical care fellows participated in the study	Independent variables: simulation or lecture trainiing	Modified Situation Awareness Global Assessment Technique	Utilized SPSS 22 for statistical analysis	Results were statistically significant with P < 0.005	Level II	Strengths: results were statistically significant with P < 0.005 and

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Society, *14*(4), 529–535. https://doi.org/10.1513/annalsats.201612-950oc		two separate groups: simulation-based training (n=8) and lecture-based training (n=8) for management of a critically ill patient Simulation training involved eight critical care cases running ~20 minutes each with a 10-minute debriefing session following the simulation Lecture-based training involve a two-hour long lecture focusing on critically ill patient scenarios and a review of situation awareness concepts	Selection of participants based on randomization Inclusion criteria included critical care fellows beginning fellowship training at Montefiore Medical Center	Dependent variables: perception, projection, comprehension	(SAGAT) scale	Utilized a two-tailed *t* test to compare the scores of the two groups Utilized the Mann-Whitney *U* test to compare the outcome medians of the two groups	Primary outcome: statistical difference in SAGAT scores of the simulation group compared to the lecture group Secondary outcome: slight decrease in scores in both groups Perception scores were higher in the simulation group with no significant difference in projection and comprehension between both groups Simulation training is significantly more effective in providing education in situation awareness and increasing perception		novel study directly comparing simulation-based training with lecture-based training on situation awareness education Limitations: study completed on critical care fellows with no association to anesthesia and study performed at one testing center