ANESTHESIA CRISIS RESOURCE MANAGEMENT: IMPROVING NONTECHNICAL SKILLS

By

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DNP Capstone Project Approval Form

This is to certify that ____________________________________________________________________________

(Name of Student)

successfully defended his/her Capstone project entitled:

__________________________________________________________________________________________

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on ______________________________________________________________________________________

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Abstract

This study evaluated the relationship between an ACRM course, response times and ANTS scores during a simulated anesthesia machine malfunction. The objective being improved patient safety by training SRNAs to properly manage a crisis. Only one study assessed this relationship, finding an ACRM intervention improved ANTS scores in SRNAs. The information processing theory lays the theoretical framework for this study. This pilot study uses a quasi-experimental pretest-posttest design. Two different scenarios were randomized and completed by each student for the pretest and posttest. A dependent group t-test and Pearson’s r was used for statistical analysis. The intervention accounted for a statistically significant improvement in response times and ANTS scores. Pearson’s r showed no correlation between ANTS scores and response times pre- or post-intervention. This project has the potential to improve patient outcomes through allowing SRNAs to effectively respond to an anesthesia machine malfunction in clinical practice. Future research should incorporate a similar design while focusing more on the ANTS framework and creating a more immersive environment by providing students with a full team to communicate with and elicit help from. This will allow for nontechnical skills to be better assessed following the intervention.
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Background

The operating room is a melting pot of different professions, working together to provide the highest level of patient care. When a crisis, such as myocardial infarction, cardiac arrest, acute hemorrhage, pulmonary embolism, tension pneumothorax, anaphylaxis, malignant hyperthermia, bronchospasm, and/or laryngospasm arises in the operating room, the anesthesia provider becomes the team leader. As the team leader, nontechnical skills, such as communication, promotion of teamwork, management of tasks, planning and prioritizing are vitally important to ensure a good outcome.

Medical error is the eighth leading cause of death in the United States, accounting for as many as 100,000 deaths annually (Awad et al., 2005). Numerous other studies point out that communication failure and deficient nontechnical skills in the operating room are considered one of the leading causes of inadvertent patient harm (Gillespie et al., 2008; Halverson et al., 2011; Rydenfalt, Johannson, Larsson, Akerman & Odenrick, 2011). In 1999 the Institute of Medicine released its report “To Err is Human” highlighting the patient safety crisis in the United States. Often the causes of medical error are related to these aforementioned nontechnical skills (Halverson et al., 2011). A renewed focus on nontechnical skills in medical education is needed to help promote good outcomes following crisis events.

In 1989 Gaba and colleagues recognized that medical training was lacking effective crisis management (Gaba et al., 2001). They developed the first Anesthesia Crisis Resource Management (ACRM) course to help bridge this gap. The first session of this ACRM course was held in the fall of 1990 (Gaba et al., 2001). This ACRM course focuses on teamwork and use of technical, cognitive and behavioral skills in the management of a crisis. The ultimate goal of this course was to familiarize students with the many aspects of dynamic decision making,
management of available resources, leadership, communication skills, and working with a diverse population (Gaba et al., 2001). These ACRM courses place students in a high fidelity simulation environment and provide a realistic crisis scenario. Following the simulation session, a video recording of the event is viewed by all the participants. An expert in nontechnical skills and the Anesthetists Nontechnical Skills (ANTS) tool will review the student’s actions during the crisis and critique how he or she scored on the assessment and how they can improve in the future. This method of debriefing using video assistance has proven to be very effective in teaching and reinforcing the behaviors necessary for management of a crisis (Gaba et al., 2001).

For ten years following the development of this ACRM course there was no universal, statistically significant method of rating nontechnical skills. This was addressed in 1999 when the University of Aberdeen and the Scottish Clinical Simulation Centre developed an assessment tool for measurement of anesthetists’ nontechnical skills (Fletcher et al., 2004). Following four years of research, the Anesthetists Nontechnical Skills (ANTS) assessment system was created. This system outlines four areas of nontechnical skills vital to ensuring a better patient outcome during a crisis scenario. Task management focuses on planning and preparing, prioritizing, providing and maintaining standards, and identifying and utilizing resources. Team working includes coordination of activities with team members, exchange of information, utilization of authority, assessment of team member’s capabilities, and support of others. Situation awareness involves gathering information, processing and understanding the information, and anticipating future changes that could occur. Finally, decision making involves identifying different options, balancing risks and benefits, as well as reevaluation. The ANTS assessment tool has been shown to be an effective measurement of nontechnical skills of anesthesia providers (Fletcher et al., 2004).
Teaching nontechnical skills should be a priority in medical education across the world. Providing practitioners with training in communication and teamwork will help reduce adverse outcomes following crisis events.

**Review of the Literature**

The databases MEDLINE, PubMed, Web of Science, EMBASE, and CINAHL were probed for pertinent literature. Keywords, including *anesthesia, nontechnical skills, and anesthesia crisis resource management* were used. This yielded 499 records, which were screened for duplicates, 231 remained after this screening. These 231 articles were screened for relevance and 95 full text articles were reviewed for inclusion. To be included a study must have been in English, have been a full text article, included anesthesia providers as study participants, and utilize an ACRM course in their study design. Using these criteria, 85 articles were excluded, three qualitative articles, and seven quantitative articles were included in this review.

The goal of this review was to explore the relationship between an anesthesia crisis resource management course and its ability to improve nontechnical skills in experienced anesthesia providers, anesthesiology residents and student registered nurse anesthetists.

Three qualitative studies showed that the majority of anesthesia providers were enthusiastic about participation in an ACRM course and felt as though it would improve their ability to effectively manage a crisis in clinical practice (Blum et al., 2004; Holzman et al., 1995; Kurrek et al., 1996). These studies all had self-assessment bias limitations; however, they provide a useful background for the feasibility of implementation of an ACRM course. Blum et al. (2004) helped improve participation by reaching an agreement with a malpractice insurance
company to provide malpractice insurance discounts following completion of the course. This can be utilized to incentivize participation in similar courses in the future.

Three studies incorporated a randomized controlled trial design assessing the effect of debriefing following simulation. Morgan et al. (2011) studied 58 practicing anesthesiologists in Toronto, Ontario, Canada. This study found no statistically significant difference in ANTS scores between the group receiving debriefing intervention and the group receiving no debriefing. However, ANTS scores were improved in both groups by a mean of five percent between the first and second simulation session (P<0.01). These results show that the simulation itself and not the debriefing led to the improvement in ANTS scores. Savoldelli et al. (2006) studied the difference between oral debriefing and video-assisted oral debriefing against a control group that received no debriefing in a group of anesthesiology residents. Both the oral and video-assisted oral groups saw a statistically significant improvement in ANTS scores compared to the control group. There was no observed significant difference in ANTS scores between the two experimental groups. This study also found a statistically significant difference in baseline ANTS scores between senior and junior residents supporting the notion that nontechnical skills are learned over time in clinical practice. A study by Skelton et al. (2016) looked at the ability of a low-cost simulation model to teach and improve ANTS scores in anesthesiology residents and practicing anesthesia technicians in a hospital in Rwanda. This study found that ANTS scores were significantly improved in the experimental group that received debriefing intervention following simulation. A unique aspect of this study showed that the skills learned during simulation were adequately translated into improvement in clinical practice. This study only looked at nontechnical skills during cesarean delivery, which is the
most commonly encountered operation at the hospital studied. This does limit the
generalizability of the results to other anesthetic procedures.

Four other studies using various research methods were found. Sidi et al. (2014) utilized a
cross-sectional study finding universally low rates of nontechnical skill performance amongst
anesthesiology residents, with the most common errors being anchoring, availability bias,
premature closure and confirmation bias. This study suggests routine assessment of nontechnical
skills in anesthesiology training to identify common areas of weakness. Following this
assessment, an intervention to close the knowledge gap can be implemented to improve
nontechnical skills. A study by Welke et al. (2009) incorporated a prospective randomized
design to assess the difference between a computer-assisted debriefing design and a traditional
video-assisted oral debriefing design. A group of 30 junior anesthesiology residents were
randomized into one of the treatment groups. The results indicated a statistically significant
improvement in ANTS scores following both debriefing interventions; no statistically significant
difference was noted between the multimedia debriefing and video-assisted oral debriefing
groups. This study could have been strengthened through the addition of a control group that
compared the impact of simulation without debriefing to the experimental groups. Yee et al.
(2005) utilized a pretest-posttest design to measure the effect of repeated ACRM simulation and
video-assisted debriefing on 20 anesthesiology residents training at the University of Toronto.
This study found that following the initial ACRM session and debriefing, ANTS scores were
statistically significantly improved in both junior and senior anesthesiology residents. The study
incorporated a third ACRM session and found no significant improvement between the second
and third session of simulation. This study was limited by a lack of control group, but does
provide a foundation on the benefit of ACRM simulation on nontechnical skills in anesthesia students.

Only one study examined the impact of an ACRM intervention on student registered nurse anesthetists. This study utilized a pretest-posttest design and found that an educational intervention on nontechnical skills statistically significantly improved the ANTS scores of 32 first year student nurse anesthetists at the Florida International University’s Nurse Anesthesia Program (Wunder, 2016). Although these results were promising, the study was limited by a low effect size (Cohen’s d = 0.28), and a lack of control group (Wunder, 2016). Also limiting this study was the use of only one researcher rating ANTS scores of the participants, as well as only examining first year nurse anesthesia students (Wunder, 2016). This study can be utilized to help design future research. Incorporation of a randomized design with a control group, as well as studying both first and second year nurse anesthesia students should be undertaken to ensure greater statistical power and generalizability to a larger population.

**Objectives**

A gap in the literature was identified regarding the effect an ACRM intervention has on the nontechnical skills in the Student Registered Nurse Anesthetist (SRNA). More research needs to be completed to prove the hypothesis that an ACRM intervention improves the nontechnical skills of anesthesia providers. Should this be completed, we will help ensure proper patient care during a crisis that promotes good outcomes through the evidence based training of SRNAs on how to properly respond to, and manage a crisis.

Even though anesthesia machine malfunctions are relatively rare, they play an important role in critical incidents accounting for up to 20% of reported adverse events (Mehta, Eisenkraft,
Due to the lack of research on the role an educational seminar on troubleshooting common anesthesia malfunctions plays on the proper identification and correction of a malfunction, this topic needs to be investigated further. This study explores the question “do first year SRNAs at the University at Buffalo receiving an ACRM-based educational intervention on troubleshooting common anesthesia machine malfunctions have improved nontechnical skills and response times to the malfunctions in the simulation lab as compared to students not having received the educational intervention?”.

As part of the Principles of Anesthesia I course, students partake in a learning day. During this session students complete one of two randomized simulations, followed by a lecture on identifying and correcting common anesthesia machine malfunctions. After completing the lecture, students then go into the simulation lab to complete the second simulation session. The two simulations are as follows: Simulation A was the loss of pipeline oxygen to the anesthesia machine. Students were required to correctly identify that the oxygen supply had been lost, and perform corrective action by turning on the emergency oxygen tank behind the anesthesia machine and verifying that oxygen supply has been restored to the breathing circuit. Simulation B was a major leak in the anesthesia machine circuit. The surgeon in the simulation disconnected the inspiratory hose of the circuit when the student went to answer the door. Students then witnessed the anesthesia machine alarming “cannot drive bellows”. They were then required to search through the breathing circuit for problems.

The effects of the educational intervention were operationalized using the ANTS scoring system, as well as an assessment of response times from the start of the failure to corrective action. The results were compared both pre- and post-intervention. First and foremost, this study seeks to improve patient safety by training SRNAs to properly identify and respond to an
anesthesia machine malfunction. Following completion of the study, when students are faced with a crisis scenario in clinical practice where a malfunctioning anesthesia machine is to blame, they will be able to expeditiously identify the causative agent and perform corrective action. As well as responding more quickly to an anesthesia machine malfunction, since students will become more familiar with anesthesia machine malfunctions following completion of the study, they will be able to handle issues that arise in clinical practice with less stress. Ultimately this all leads to better patient outcomes by mitigating the risk of an adverse event following an anesthesia machine malfunction. This study also helps anesthesia providers and educators glean knowledge on ACRM courses and the potential benefit they have on practice. The results are also applicable to anesthesia program administrators when considering material to add to their curricula.

**Theoretical Framework**

To qualify as an ACRM course, the principles outlined in the ANTS tool must be taught and understood by students of the course. According to Gaba et al. (2001), an ACRM course focuses on two distinct sets of behavior, dynamic decision making, and team working skills. The crisis scenarios that students undergo require several processes that make for a successful outcome. Rapid collection and prioritization of data, identification and selection of interventions, evaluation of patient response to the interventions, and anticipation of future changes must be mentally processed simultaneously. Teamwork is another component of successful crisis management, including coordination with an interdisciplinary team, delegation of responsibilities, as well as facilitating the open exchange of information between team members (Gaba et al., 2001). Taking a deeper look into the components of the ANTS assessment tool and
The ANTS tool is arranged in a logical progression involving the decision-making process. The first component is situation awareness, involving data collection, prioritization of this data, and anticipating future events. Task management follows situation awareness and includes planning and prioritization of interventions, as well as identification and utilization of resources. Next in the progression, decision making occurs where options are identified, risks and benefits are weighed, and a decision is made based on the available data. The final step in the ANTS progression is slightly varied from the aforementioned concepts of dynamic decision making. However, teamwork is of paramount importance in the management of a crisis. In the ANTS tool, teamwork includes leadership, coordination of activities and assigning roles while considering functional abilities (Fletcher, et al., 2004). This pinnacle of crisis management revolves around the open communication and mutual respect of all team members.

With this tool deconstructed we can see that a specific theoretical framework is at play that came from the cognitive revolution of the 1950’s. This era was characterized by the desire to develop theories of cognition that focused on interior mental processes rather than observable attributes. The information processing theory (IPT) came about during this period and focuses on the concept that humans process the information that they receive rather than merely responding to a stimulus (Information Processing Theory, 2015). A critical analysis of this theory is in order to adequately understand the link to the ANTS tool.

The IPT has four critical assumptions that make its basis. First, thinking is the perception of external stimuli, followed by the coding and storage of this information. Second, the analysis of encoded stimuli occurs, being tailored by the brain’s cognition and interpretation processes to
facilitate decision making. There are four subsets of the second piece, including strategizing, generalizing and automation. Situational modification occurs next and includes the comparison of stimuli and decisions made in the current situation to allow for adequate derivation of a solution. Finally, obstacle evaluation takes into account the nature of the situation, while sorting out misleading, confusing or irrelevant information (Information Processing Theory, 2015).

These four assumptions apply to three main components of the IPT, which include sensory memory, working memory and long-term memory. Sensory and working memory work together to process large amounts of information, laying the framework for encoding information to be stored in long-term memory. Automaticity is also at play, being an adaptive mechanism to compensate for limited attentional resources, allowing for the processing of familiar stimuli rapidly (Information Processing Theory, 2015).

With these components deconstructed we can apply them to the ANTS theory to explain the cognitive processes involved in managing a crisis scenario. Throughout the sensory memory stage of the IPT, incoming stimuli are screened and filtered so that only relevant information to the current situation is present. This stage mirrors the situation awareness stage of the ANTS tool. Following the first step of the IPT, sensory memory then collaborates with working memory which assigns meaning to the incoming stimulus and subsequently links it to other information. This component resembles the task management phase of the ANTS tool, which centers on planning, prioritizing and maximizing resources (Fletcher et al., 2004). The final piece that coordinates with working memory in the IPT is long-term memory, which encodes and retrieves memories (Schraw, 2013). This is closely resembled by the decision-making stage of ANTS where retrieval of existing knowledge and connections to incoming information occurs, allowing delineation of corrective measures (Fletcher, et al., 2004). Finally, the teamwork phase
of ANTS must be examined using the IPT. To arrive at an adequate conclusion of the correlation, we must deconstruct what makes a good team. According to Wright and Kaber (2005) automation is essential to good team dynamics and as outlined in the IPT includes acquisition and analysis of information, selection of a decision and implementation of an action. Teams that use automation tend to detect problems faster, have standardized communication procedures, were comfortable vocalizing their situation assessment, and used more leadership statements (Wright & Kaber, 2005). This construct directly compares to the teamwork component of the ANTS tool, which involves information exchange, maintaining leadership, and the support of others through the anticipation of their needs (Fletcher, et al., 2004).

With this theory deconstructed it becomes clear that many of the components of the IPT mirror the aspects of the ANTS tool. We can come to the conclusion that the IPT lays a solid framework for the workings of the key components of the ANTS tool.

**Methods**

This pilot study uses a quasi-experimental pretest-posttest design. A convenience sample of 17 first-year SRNAs at the University at Buffalo were used in the study. As part of the Principles of Anesthesia I course, students are required to undergo a simulation day where a simulated malfunction of the anesthesia machine occurs. Students are expected to draw from their knowledge gained during the didactic portion of the course and translate it into action. These simulation sessions are video recorded as part of the class. Each of the subjects perform as the principal anesthesia provider for the pretest and posttest, serving as their own control. The order of scenarios A and B were randomized so that each student completes one for the pretest and one for the posttest. There is also an educational intervention as part of the Principles of Anesthesia I class, which serves as the intervention for the study. All subjects were de-identified
by wearing a surgical cap and mask during the scenarios. All of the students signed consent to have the PI review their videos.

**Data Analysis/Evaluation Tools**

This study explores the hypothesis that an ACRM teaching intervention centering on anesthesia machine malfunctions improves nontechnical skills and response times in a simulated crisis. The independent variable in this study is the ACRM intervention and the dependent variables are the ANTS score as a measure of nontechnical skills, as well as the response times to the event. The independent variable is a nominal level of measurement, meaning that it is simply a yes or no response to having received the intervention. The dependent variables are interval levels of measurement. Before being released, the ANTS assessment tool underwent a rigorous evaluation. It was found to have acceptable levels of inter-rater reliability, rater accuracy, as well as usability, validity and acceptability. This tool comprises four basic categories: task management, team working, situation awareness, and decision making. These four categories are scored on a one through four scale. A score of one is poor performance, two is marginal performance, three is acceptable performance, and four is good performance. Each of the four items in the tool gets assigned a score, making the score range from four to sixteen (Flin, Patey, Glavin & Maran, 2010). Response times to corrective intervention were scored in a value of seconds. Data, such as participant’s age, gender, years of ICU experience, and type of ICU that their experience was in, was also collected.

In this study, all data was analyzed using SPSS v24. Each student was scored on two separate crisis scenarios, both before and after the intervention. Since the independent variable is a nominal level of measure and the dependent variables are interval levels of measurement, a t-test was one of the statistical measures of choice. Being that the same student was assigned a
score at two separate points in time, a dependent group t-test accurately describes the relationship between the independent and dependent variables. In order to quantify that the results did not occur by chance, statistical significance was set as a p value of less than 0.05. To express how far apart the two means were, effect size was measured with Cohen’s d. Having this comparison of means and effect size for ANTS scores and response times allowed for the prediction that the difference in mean values before and after the intervention were attributed to the intervention and not by chance. In addition to a t-test, in order to test for a relationship between the dependent variables, both pre- and post-intervention a Pearson’s r test was also used.

Results

Seventeen students enrolled in Principles of Anesthesia I were enrolled in the study. At the time of the study students had no prior anesthesia clinical experience. Each subject served as the principal anesthesia provider for the two separate scenarios. The sessions were video recorded and reviewed by the PI in the simulation lab at the University at Buffalo.

Data describing the population was collected and descriptive statistics calculated. The mean age of participants was 32 at the time of the study. The majority of students are female accounting for 76% of the total population. The average number of years since graduation from nursing school was six. There were four different types of ICU where participants worked; most commonly, 41% had worked in a cardiac ICU, followed by 23% having worked in a trauma ICU, 18% of participants had worked in a surgical ICU and 18% had worked in a medical ICU.

Statistical testing was carried out following review of the videos to test the hypothesis that response times to corrective action and ANTS scores will improve following the educational
intervention. A two-tailed, paired samples t-test was computed for response times and ANTS scores pre- and post-intervention (see table one). The mean response time to corrective action pre-intervention was 75.13 seconds, SD = 33.706 and 50.6 seconds, SD = 32.991 to corrective action post-intervention, P = 0.031. The standardized difference in means indicated a medium effect size, $d = 0.735$. The mean ANTS score pre-intervention was 10.5, SD = 1.317 and 12.56, SD = 1.209 post-intervention, P = 0.000004. The standardized difference in means indicated a large effect size, $d = -1.63$. Pearson’s $r$ was calculated to assess a correlation between response times and ANTS scores both pre-intervention and post-intervention (see table two). Pre-intervention response times vs ANTS scores Pearson’s $r$ was -0.029, P = 0.917. Post-intervention response times vs ANTS scores Pearson’s $r$ was -0.003, P = 0.990.

**Discussion**

In tables one and two, a discrepancy in N values was noted. One case was omitted from the response time group due to the student failing to troubleshoot the problem. One other case in the pre-intervention group was omitted due to a technical error in the recording software.

Based on the results of the statistical analysis we can conclude that the educational intervention accounted for a statistically significant improvement in response times and ANTS scores. For response times to corrective action, the medium effect size, as indicated by Cohen’s $d$ leads to the conclusion that there are favorable odds that one will have an improved response time post-intervention. Regarding ANTS scores, the large effect size also leads to the conclusion that there are favorable odds that one will have an improved ANTS score following the intervention. Pearson’s $r$ failed to show any linear correlation between response times and ANTS scores. This leads to the conclusion that although a student may have had a favorable response
time, their ANTS score could be poor, and vice versa. These results were the same both pre-
intervention and post-intervention.

During the intervention a common theme emerged, when troubleshooting the
intervention, participants tended to use a self-inflating bag as a means of backup ventilation in
both scenarios (76% of participants). This could be attributed to their comfort with the utilization
of a familiar piece of equipment. Although this was not considered an incorrect action, 96% of
participants failed to mention the need for an alternate means of providing anesthesia when
deviating away from the anesthesia machine and volatile anesthetics. Further education is
necessary to ensure that should this issue arise in clinical practice, students understand that the
discontinuation of volatile agents needs to be coupled with a means of providing intravenous
anesthesia. This is likely attributed to a lack of anesthesia clinical experience. Further research
should be performed to follow up with this study group after they have started anesthesia clinical
to see if their actions have changed.

Implications

This study highlights the importance of an ACRM teaching intervention and its ability to
help SRNAs become more proficient in troubleshooting anesthesia machine malfunctions. This
increase in proficiency will allow students having undergone the program to troubleshoot
anesthesia machine malfunctions in clinical practice quickly and effectively. Ultimately this will
lead to improved patient safety. Due to the ease of implementation into a course curriculum and
ability to positively impact response times and ANTS scores, similar interventions should be
considered by course coordinators when designing their curricula.
Future research should incorporate a similar design with a larger sample size to attempt to recreate the results. It would be prudent to incorporate students with anesthesia clinical experience into future research. This would allow correlations to be drawn regarding the ability of clinical experience to impact a student’s ability to troubleshoot an anesthesia machine malfunction. Another interesting study to explore would be a similar project that incorporated more nontechnical skills teachings. This could be accomplished through creating a more realistic simulated operating room with a surgeon, circulator, and scrub nurse. This would allow the students to engage the team more effectively and afford better judgement of their ANTS scores following the intervention. This design would help to improve team dynamics by engaging students as part of the team. Ultimately this would assist in training students to function more effectively as part of the interdisciplinary team in the operating room.

**Strengths and Limitations**

The strengths for this study include the study design, allowing students to be tested pre-and post-intervention in the simulation lab. It also allowed for the assessment of first year SRNAs understanding of the anesthesia machine and its function, which allowed knowledge gaps to be identified and interventions planned based on this information. Another strength of this study includes adding to the limited body of evidence the ability of an ACRM intervention to improve nontechnical skills in the SRNA population. Finally, the study helps to improve patient safety through training SRNAs to properly identify and correct an anesthesia machine malfunction. Doing so limits the possibility of an adverse event occurring following an anesthesia machine malfunction in clinical practice. Limitations of this study include a small sample size, the possibility that students could discuss the content of the scenarios while waiting to be tested, as well as difficulty in assigning an ANTS scores when students did not verbalize
their thoughts. The last limitation could lead to skewed ANTS scores pre- vs post-intervention. The small sample size was due to a convenience sample in this pilot-study. To help control students from discussing the content of the scenarios they were asked to not discuss the content until the post-session debriefing.

**Ethical Issues**

Since this study’s data collection took place as part of a course within the University at Buffalo’s Nurse Anesthesia curriculum, there are no ethical issues associated with the data collection. Consent to video record the scenarios is routinely gathered as part of the class. This study sought simply to gain consent to analyze these videos and see how students responded to the class. The ethical issues that surround the study are maintaining anonymity, random selection of students, and access to information. To ensure ethical research, anonymity was maintained by de-identifying participants through wearing a hat and mask during the scenarios. Students were randomly assigned a letter A or B indicating the order of scenarios in the class. This ensured random selection of participants for the purpose of this study. In regard to access of information, the videos were stored on a protected computer that was only able to be accessed by the principal investigator on University at Buffalo’s South Campus.
### Appendix

Table 1 – Demographic Data

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Male</th>
<th>Female</th>
<th>CVICU</th>
<th>TICU</th>
<th>SICU</th>
<th>MICU</th>
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<tbody>
<tr>
<td>Age (Years)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td>24%</td>
<td>76%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Years Since Graduation From Nursing School</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Type of ICU Experience</td>
<td></td>
<td>41%</td>
<td>23%</td>
<td>18%</td>
<td>18%</td>
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</tr>
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TABLE 2 – Paired Samples t-test

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>N</th>
<th>Standard Deviation</th>
<th>Significance</th>
<th>Cohen’s d</th>
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<tbody>
<tr>
<td>Pre-intervention Response Times</td>
<td>75.13</td>
<td>15</td>
<td>33.706</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post-intervention Response Times</td>
<td>50.6</td>
<td>15</td>
<td>32.991</td>
<td>0.031*</td>
<td>0.735</td>
</tr>
<tr>
<td>Pre-intervention ANTS Scores</td>
<td>10.5</td>
<td>16</td>
<td>1.317</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post-intervention ANTS Scores</td>
<td>12.56</td>
<td>16</td>
<td>1.209</td>
<td>0.000004*</td>
<td>-1.63</td>
</tr>
</tbody>
</table>

* Denotes statistical significance at the P<0.05 level.
TABLE 3 – Pearson’s $r$

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Correlation (Pearson’s $r$)</th>
<th>Significance</th>
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</thead>
<tbody>
<tr>
<td>Pre-intervention Response Times vs ANTS Scores</td>
<td>15</td>
<td>-0.029</td>
<td>0.917</td>
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<tr>
<td>Post-intervention Response Times vs ANTS Scores</td>
<td>17</td>
<td>-0.003</td>
<td>0.990</td>
</tr>
</tbody>
</table>
References


Wunder, L. L. (2016). Effect of a nontechnical skills intervention on a first-year student registered nurse anesthetists’ skills during crisis simulation. *AANA Journal, 84*(1), 46 -

August 17, 2017

Dear Brian Lowe,

On 8/17/2017, the University at Buffalo IRB reviewed the following submission:

<table>
<thead>
<tr>
<th>Type of Review:</th>
<th>Initial Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Title of Study:</td>
<td>ANESTHESIA CRISIS RESOURCE MANAGEMENT: IMPROVING NONTECHNICAL SKILLS</td>
</tr>
<tr>
<td>Investigator:</td>
<td>Brian Lowe</td>
</tr>
<tr>
<td>IRB ID:</td>
<td>STUDY00001725</td>
</tr>
<tr>
<td>Funding:</td>
<td>None</td>
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</table>
|                  | - ANTS Handbook 2012(1).pdf, Category: Other;  
|                  | - HRP-302 Adult Consent to Participate in a Research Study.pdf, Category: Consent Form |

The study materials for the project referenced above were reviewed and approved by the SUNY University at Buffalo IRB (UBIRB) by Non-Committee Review. The UBIRB has determined on 8/17/2017 that the research is Exempt according to 45 CFR Part 46.101. There is no expiration date.

In conducting this study, you are required to follow the requirements listed in the Investigator Manual (HRP-103), which can be found by navigating to the IRB Library within the Click system.

This UBIRB determination is given with the understanding that the proposed study design will be followed. If modifications are needed that significantly alter the purpose, design, or data collected, then those changes should be submitted to the IRB to determine if the modifications alter the research such that the criteria for an exempt determination are no longer met. You can create a modification by navigating to the active study in Click IRB and selecting ‘Create Modification / CR.’ Otherwise, this study no longer needs to be reviewed by the IRB.

For more information on exemption criteria and categories, see the IRB Toolkit Worksheet: Exempt Determination (HRP-312). If you have any questions about this determination, please contact the IRB.
As principal investigator for this study involving human participants, you have responsibilities to the SUNY University at Buffalo IRB (UBIRB) as follows:

1. Ensuring that no subjects are enrolled prior to the IRB approval date.
2. Ensuring that the UBIRB is notified of all reportable information in accordance with the New Information SOP (HRP-024).
3. Ensuring that the protocol is followed as approved by UBIRB including minor changes which can be made if they do no impact the exempt determination.
4. Ensuring that the study is conducted in compliance with all UBIRB decisions, conditions, and requirements.
5. Bearing responsibility for all actions of the staff and sub-investigators with regard to the protocol.
6. Bearing responsibility for securing any other required approvals before research begins.

If you have questions, please contact the UBIRB at 716-888-4888 or ub-irb@buffalo.edu. Please include the project title and number in all correspondence with the UBIRB.
Anesthesia Crisis Resource Management
Improving Nontechnical Skills
Brian M. Lowe BSN, RN, CCRN, SRNA, DNP-c

Introduction

• When a crisis occurs in the operating room, the anesthesia provider becomes the team leader.
• Medical error is one of the top 10 leading causes of death in the U.S., accounting for up to 100,000 deaths annually.
• Anesthesia Crisis Resource Management (ACRM) courses focus on teaching aspects of teamwork, the use of technical, cognitive, and behavioral skills during the management of a crisis.
• The Anesthesiologists’ Nontechnical Skills (ANTS) tool is an effective and validated measurement of nontechnical skills in anesthesia providers.
• Although rare, anesthesia machine malfunctions account for up to 20% of reported adverse events in anesthesia practice.

Methods

• This pilot study used a quasi-experimental pretest-posttest design and a convenience sample of 17 first-year Student Registered Nurse Anesthetists (SRNAs) in the University at Buffalo’s Nurse Anesthesia program.
• As part of the Principles of Anesthesia I course, students were taken into the simulation lab and underwent two separate simulations, one before an ACRM-style educational intervention on troubleshooting common anesthesia machine malfunctions, and one after.
• Simulation A was the loss of pipeline oxygen supply to the anesthesia machine.
• Simulation B was a major circuit leak that occurred when the expiratory limb became disconnected.
• ANTS scores and response times to corrective action were assessed pre and post intervention.

Objectives

• Improve patient safety by training SRNAs how to properly identify and respond to an anesthesia machine malfunction.
• Improve patient outcomes by mitigating the risk of an adverse event in clinical practice following an anesthesia machine malfunction.

Data Analysis

• This study explored the hypothesis that an ACRM teaching intervention centered on anesthesia machine malfunctions improves nontechnical skills and response times in a simulated crisis.
• Descriptive statistics were used to describe the sample population.
• Data was analyzed using SPSS v.24.
• Independent group t-tests were used to analyze the relationship between the educational intervention (IV) and ANTS scores as well as response times (DVs).
• Cohen’s d was used to describe the magnitude of difference in the means of ANTS scores and response times pre and post intervention.
• Pearson’s r was used to assess the correlation between ANTS scores and response times. It was hypothesized that students who had higher ANTS scores would also have better response times.
• Statistical significance was set at P < 0.05.

Results

<table>
<thead>
<tr>
<th></th>
<th>Mean ± SD</th>
<th>Tрансcription</th>
<th>Significance</th>
<th>Cohen’s d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-intervention Response Times</td>
<td>10.8 ± 3.2</td>
<td>0.33</td>
<td>0.13</td>
<td>0.0000</td>
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<tr>
<td>Post-intervention Response Times</td>
<td>10.5 ± 3.1</td>
<td>0.13</td>
<td>0.0000</td>
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<tr>
<td>Pre-intervention ANTS Score</td>
<td>12.5 ± 3.6</td>
<td>0.06</td>
<td>0.0000</td>
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<tr>
<td>Post-intervention ANTS Score</td>
<td>10.3 ± 3.2</td>
<td>0.33</td>
<td>0.13</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

References

Available upon request

www.buffalo.edu