USING HIGH-FIDELITY SIMULATION OF A CRISIS EVENT, CO_2 EMBOLISM, TO INCREASE CONFIDENCE LEVELS IN THE CRNA

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Dedication and Acknowledgments

Thank you to my friends and family for supporting me through this program. Thank you to Angie Rickelton for encouraging me and being my mentor through the program in times I wanted to give up.

Abstract

Background: Crisis events occur in the operating room and can impact patient survival if not managed appropriately, one being a carbon dioxide, CO2, embolism. There has been an increase in use of laparoscopic procedures by surgeons over the last decade with advancements in technology. CO2 embolisms are a rare, but potentially fatal event that can occur during these procedures. Simulation has been used to provide education for Certified Registered Nurse Anesthetists (CRNAs) to improve confidence levels in management of these crisis events.

Purpose: This quality improvement project aims to determine whether simulation increases confidence levels in the CRNA's ability to manage crisis events in the operating room.

Methods: A mixed methods approach explored confidence levels towards management of crisis events in the operating room. This ranged from neurological, cardiac, respiratory, and hemodynamic instability. Data was collected through an anonymous online survey that was administered at the time of the simulation.

Results: No significant changes in confidence levels pre and post simulation were found with the use of simulation in education for management of a crisis event in CRNAs.

Recommendations and Conclusion: Simulation should be used as a guide for education. Confidence levels may be studied in students may show more significant change in confidence in management of a crisis event in the operating room.

Key Words:

Concept	Search Terms
Nurse Anesthesia	(nurse anes* OR anesthesia* OR nurse anesthesia* "nurse anesthetist" OR "crna")
Simulation	("high fidelity simulation" OR "clinical simulation" OR "simulation training")
High Fidelity Simulation	("high fidelity" OR "high fidelity simulation" (MeSH))
CO2 Embolism	("CO2 embolism" OR embolus* OR CO2 embolism*)

Background and Significance

Carbon dioxide (CO_2) embolisms are rare, but a potentially fatal complication of surgery. Certified registered nurse anesthetists (CRNAs) are typically not exposed to CO_2 embolisms in the clinical environment or hands on training due to the rarity of the event. High-fidelity simulation education provides hands on training to prepare CRNAs for this event.

CO_2 embolisms occur during laparoscopy procedures where CO_2 gas is used to insufflate the abdomen (Bonjer et al., 1997). A CO_2 embolism is the entrapment of air into a large vessel that then travels to the right atrium, preventing the forward flow of blood through the heart (Bralow & Piehl, 2018). Embolisms occur during laparoscopy procedures where CO_2 gas is needed to pressurize the abdomen to increase visualization of abdominal organs (Cassai et al., 2019).

The CO_2 embolism can result in cardiac arrest and death. In a systematic review, a gas embolism occurred in 0.001% of cases (7/489,000 cases) with the Veress needle (Bonjer et al., 1997). Although studies show that a CO_2 embolism is rare, the mortality rate is approximately 60% when the event does occur (Park et al., 2012).

In recent years the use of laparoscopic procedures have increased due to the numerous patient benefits, such as decreased length of stay, decreased pain, and quicker recovery time (Cassai et al., 2019). CO_2 embolism training is needed due to the increased use of laparoscopic procedures (Cassai et al., 2019). With advancements in technology in the operating room, advancements in education need to be made as well.

High-fidelity simulation provides education and skills for a CO_2 embolic event and improves the ability of CRNA providers to recognize and respond in a timely manner if this event were to occur (Cannon-Diehl et al., 2012). High-fidelity simulation prepares CRNAs for a

CO2 embolism post-graduation and are administering anesthesia as the predominant provider (Lee et al., 2018). CRNA's can orchestrate interdisciplinary teamwork in the operating room if the event occurs, potentially increasing the chance of patient survival. Critical events are multifactorial involving many different variables. For example, a CO2 embolism could present as tachycardia and hypotension on the monitor; however, anaphylaxis can also present this way. The ability to dissect and recognize variables to establish confidence in the CRNA caring for patients can provide safe and competent patient care. If a patient survives a CO2 embolism, permanent damage from brain anoxia can result in seizure disorders, neurological deficits, cardiac problems, and death.

PICOT question: Does a high-fidelity simulation (I) with certified registered nurse anesthetists (CRNAs) (P) improve confidence in recognition (O) of a CO2 embolism?

Purpose

This project aims to develop a high-fidelity simulation scenario for CRNA providers to practice the critical event of an intraoperative CO2 embolism. This project will help determine whether high-fidelity simulation increases confidence in critical thinking skills by recognizing a CO2 embolism in a controlled environment and/or increases CRNA's ability to retain the essential knowledge needed to identify and treat this rare event.

Review of Current Evidence

The search for evidence between the years of 1990-2022 was conducted using CINAHL, PubMed, Cochrane Database of Systemic Reviews, Cochrane Central Register of Controlled

Trials, and Google Scholar. The search time frame was utilized from 1990 due to the little information on CO2 embolisms found during the first few searches to find decent articles. Using a wider time frame allowed for a wide range of data and progression of studies on simulation and CO2 embolisms. The search terms that were used alone and in combination with Boolean operators are “high fidelity simulation training”, “nurse OR nurse anesthetist”, and “simulation-based training”, “recertification”, “nurse anesthetist OR anesthetist OR crna”, “clinical simulation OR simulation training”, “CO2 embolism OR pulmonary embolism”, “PE OR pulmonary embolism”. Inclusion criteria were articles with simulation-based studies that included qualitative and quantitative measurements. Sources were included after reviewing the title, abstract, then lastly, the full-text form to determine if inclusion criteria were met. Articles not published in the English language were excluded.

The evidence was critically appraised using the methods described by Johns Hopkins levels of evidence. Evidence source included three randomized control trials, two systematic reviews, two observational studies, two correlational studies, and three used expert observations and opinions on checklists. The levels of evidence ranged from I to VII, majority of the studies remaining randomized control trials. A total of eleven studies were reviewed and their levels of evidence ranged due to length of age, differing study types, and differing participants. There was a range of simulations performed for the studies, one simulation had 667 participants, while another had less than 10. Depending on the sample, whether convenience sample or not; the studies could have some potential bias. The samples ranged from student nurse anesthetists to anesthesiologists. This range included medical students, medical residents, anesthesiologist residents, anesthesiologist fellows, certified registered nurse anesthetists and anesthesiologists.

The years of experience ranged from students with no years of experience to seasoned anesthesiologists.

Simulation interventions included, but were not limited to convenience sampling, randomization, and volunteers. The participants were each given a scenario, which ranged from intraoperative MI to any ACLS event that can occur intraoperatively. Other high-fidelity simulations utilized included arterial gas embolism from deep sea diving, amniotic fluid embolism during delivery, and venous air embolism during insufflation of gases for laparoscopic procedures. The format of the simulation was a self-guided checklist that followed an algorithm each study either borrowed from an existing simulation or created on their own. The outcomes of these high-fidelity simulations yielded positive reviews of high-fidelity simulation and its impact on education and real-life events that can and will occur in the operating room.

Limitations included attempting to avoid bias, lack of data follow up with participants, missing survey data, sample size, and potential for anxiety in those that performed simulations individually. Lessons learned for future studies included the ability to use a team dynamic approach, the replicability of the simulations, and measurements to establish skill sets for certain requirements to be performed in the simulation. Other limitations included lack of participation from participants. The use of compensation for participation seemed to yield the best results for the simulations that were performed.

CRNAs need to be able to quickly identify and treat a CO_2 embolism in the operative setting. Gas embolisms must be rapidly identified and treated to prevent cardiac arrest in a deteriorating patient. A CO_2 embolism simulation scenario can provide CRNAs with hands-on training in a safe learning environment, enhancing their knowledge and skill set in identifying and reacting to a CO_2 embolism. A high-fidelity simulation scenario will prepare CRNAs for this rare event when they are in independent practice (Lee et al., 2018). The safe and non-judgmental environment can be explained before the high-fidelity simulation scenario to help with potential performance anxiety. Scenarios should be repeated every few months to provide continuing education on emergency situations (Lee et al., 2018). The use of high-fidelity simulation can provide a realistic environment that recreates different CO2 embolism scenarios for CRNA providers to gain knowledge on the range of intraoperative signs and symptoms (Halverson et al., 2016). High-fidelity simulation scenarios assessed by clinical experts in the past discussed whether results were due to years of experience or repeated high-fidelity simulation scenario exposure (Erlinger et al., 2019). The study used a counterbalancing technique to control the high-fidelity simulation mode and changed the groups based on experience level, ultimately eliminating the factor of exposure to the high-fidelity simulation (Erlinger et al., 2019). Their results showed that the same high-fidelity simulation scenario could be repeated, and although the high-fidelity simulation is the same, the perceptions felt by the participants were different, just as a real-life event would be (Erlinger et al., 2019). Overall, the CRNA's ability to recognize and treat a crisis event is linked directly to their training (Erlinger et al., 2019).

CO2 embolisms can be difficult to identify due to a multitude of events that can occur under anesthesia. For example, anaphylaxis can present as tachycardia and hypotension, which can also be signs of a CO2 embolism (Cassai et al., 2019). CO2 embolisms are based on differential diagnosis can occur due to the variable presentation of signs and symptoms, such as a decrease or little change in end-tidal CO2, tachycardia, or bradycardia, hypertension, or hypotension (Cassai et al., 2019). The clinical manifestations all depend on the gas pressure and the rate of influx of CO2 gas during insufflation (Orhurhu et al., 2022). These two variables can cause a CO_2 embolism that creates a variety of patient clinical manifestations ranging from no symptoms to cardiac arrest.

High-fidelity simulation has been used as an educational modality in nursing for 30 years; and is currently used by approximately 96% of nurse anesthesia programs to replicate events CRNAs may experience in the clinical setting (Cannon-Diehl et al., 2012). High-fidelity simulation training allows CRNAs to practice their critical thinking abilities, hands-on skills, and clinical decision-making in a safe environment (Cannon-Diehl et al., 2012). The sample within the studies involved participants in the medical field, including nurses, CRNAs, SRNAs, medical students, medical residents, and anesthesiologists. Sample size ranged from small groups (N = 39) to N = 667 participants (Erlinger et al., 2019; Hayden et al., 2014). Sample size ranged, high-fidelity simulation studies ranged as well from one high-fidelity simulation that was repeated to 488 high-fidelity simulations that were given at random (Erlinger et al., 2019; Henrichs et al., 2009). Multiple different scenarios were used, for example an intraoperative crisis of a myocardial infarction (MI) and time to recognize the symptoms of an MI were used with multiple different groups of different years' experience (Erlinger et al., 2019). Other studies that utilized high-fidelity simulation used small groups of 26 CRNAs and 35 anesthesiologists to compare the skill level of CRNAs to anesthesiologists with comparable years of experience (Henrichs et al., 2009). Performance was rated based on an expert panel, comfort level with dealing with a crisis scenario using a Likert Scale or whether certain tasks were completed during the scenario (Cannon-Diehl et al., 2012; Bralow & Piehl, 2018; Everett et al., 2019). The measurements varied from time to recognition of a crisis event to effectiveness of the high-fidelity simulation itself.

Each of these are important when creating a high-fidelity simulation scenario and when formulating a scenario that could be used for future students or continuing education. For the DNP project, the use of a pre-test, education session, post-test, and debriefing session that involves a checklist of whether the task was performed would be helpful for a high-fidelity simulation (Collins et al., 2019). The purpose of this checklist is to prevent ambiguity on whether the task was performed. This reduction in bias is helpful to determining the effectiveness of high-fidelity simulations and their applicability to future possible simulation events (Collins et al., 2019). The checklist was refined in this study to remain clear to whether a specific task was performed. For example, the participant treated the blood pressure with a medication could be one of the requirements of the checklist. This is reflected in a high-fidelity simulation done with 10 CRNAs, involving key items that were educated on prior to the high-fidelity simulation (Collins et al., 2019). A checklist was formulated for the high-fidelity simulation performed using a pre and post survey with RedCap® (Collins et al., 2019). This can be applied to future high-fidelity simulation studies and current high-fidelity simulation studies to allow for future studies to have a checklist to go by during the high-fidelity simulation. For the project, a high-fidelity simulation will occur to then be monitored by an expert panel of CRNAs where the use of a checklist during the simulation will be utilized to determine whether the task was performed or not.

High-fidelity simulation has been the expected transition of practice with the help of sophisticated technology that can replicate realistic operating room (OR) scenarios (Cannon-Diehl et al., 2012). High-fidelity simulation scenarios help create an environment that is applicable to real-life (Henrichs et al., 2009). The fictitious operating room has a mannequin in it that has breathe sounds, breathes, has veins that can be hooked up to fluid to simulate life-like bodily fluids, and accept these intravenous fluids that are drained using a drainage system under the operating table. The surgical team can consist of actors or actresses that are in scrubs ready to perform a procedure. The room can be set up with a ventilator, IV pole, IV fluids, an intubated patient, all while displaying a real-time set of vital signs that can be changed from a device in another room. The best practice for these scenarios are for real-time vital sign changes to occur and reflect on a monitor that the participant can see actively changing (Erlinger et al., 2019). For example, if the blood pressure is low and the participant treats the blood pressure with a vasoactive agent, the blood pressure on the monitor will increase because the blood pressure was treated and this is what could occur in real-life scenario (Erlinger et al., 2019). The best types of scenarios are those that have either occurred in the past and based off real-life patient scenarios that would follow potential signs and symptoms of a disease process that could be treated (Erlinger et al., 2019).

Using high-fidelity simulation can help prepare the CRNA brain and muscle reflexes for the actual event if it occurs during a procedure (Bralow & Piehl, 2018). With the use of muscle memory from high-fidelity simulation, there is the opportunity to provide safe and innovative care for patients. High-fidelity simulation has been shown to increase confidence and reaction time, allowing the healthcare worker to learn without having to experience potentially traumatizing events (Byrne & Greaves, 2001).

The ability to think critically and clearly without the stress of harming a patient is allowed through technology and control of using simulated events. The safe environment provided by high-fidelity simulation creates an optimal environment for learning, which can help the CRNA recognize critical clinical signs and symptoms of a CO_2 embolism during a real-life event. The ability to perform and practice the potential consequences in a safe and controlled environment allows for uninhibited learning (Henrichs et al., 2009). Furthermore, high-fidelity simulation allows the CRNA provider to practice skills until comfort and proficiency are met (Erlinger et al., 2019). High-fidelity simulation provides an avenue for the potential unknown; and the ability to show the CRNA provider the potential consequences of specific actions.

Conceptual Framework/Theoretical Model

This project is guided by Kolb's experiential learning theory. Kolb's experiential learning theory is the completion of four stages: concrete experiences, reflective observation, abstract conceptualization, and active experimentation (Murray, 2018). The high-fidelity simulation scenario can provide different avenues of education, such as hands-on, visual, auditory, and multi-level learning (Murray, 2018). These experiences by learners can be individualized, producing connections between classroom knowledge and clinical events.

Through high-fidelity simulation, the providers gain a concrete learning experience. The debriefing allows them to reflect on how they think they did, which would be reflective observation. Abstract conceptualization would be the knowledge gaps found during the high-fidelity CO2 embolism simulation (Everett et al., 2019). With hands-on learning, active experimentation can be achieved. The active experimentation could vary from group to group depending on the time to recognize the CO2 embolism, the treatment each group decides to use, and the team's ability to communicate throughout the high-fidelity simulation. The nursing theories that could be applied to the DNP project will be applicable throughout the research project. Kolb's theory is helpful to apply to the actual high-fidelity simulation and the learning ability of the providers during the high-fidelity simulation. The high-fidelity simulation using a CO2 embolism will be able to help translate the competence learned in high-fidelity simulation to practice.

Methods

The primary investigator (PI) will be asking CRNAs in North Carolina to participate in a CO_2 embolism crisis simulation that could occur in the OR. This will be a convenience sample, based on the CRNAs that are available at the times of the simulation that is given. This project will be implemented using the UNCG campus simulation lab. The project's hope is to make the CRNAs aware of their confidence levels pre- and post-simulation to improve their confidence and ability to respond to a crisis event in the OR.

The event of CO_2 embolisms intra-operatively is rare; however, when it does occur there is up to an 60% mortality (Park et al., 2012). With simulation, confidence levels will improve if the CRNA sees this crisis event occurring in the OR. This group will consist of both men and women CRNAs of various ages and ethnicities. This sample will be measured using a questionnaire/survey with debriefing sessions to discuss confidence pre and post simulation. The primary investigator (PI) will be asking CRNAs in North Carolina to participate in a CO_2 embolism crisis simulation that could occur in the OR. No education will be offered during this time. The survey will be conducted and analyzed by the PI, faculty advisor, and statistician. Detailed charts after the simulation will be created based on data collected from the surveys to show the pre and post survey results. This project is simply created to identify the ability of simulation to increase confidence levels of the CRNA in their ability to respond to a crisis event.

Survey

Survey data will be collected using a survey format designed to be an anonymous online survey. A secure web-based company, RedCap®, will be the online questionnaire tool to allow participants to remain anonymous and block and identify the IP address, URLs, and email addresses. CRNAs wishing to participate in the project will be asked to access the RedCap® link included the day of the simulation. Instructions will be provided to participants. Consent will be obtained by the participant voluntarily participating in the study. No individual data or PHI will be shared with the PI or faculty advisor. All data will be reported and shared with the PI and faculty advisor during the study.

Sample

The primary investigator (PI) will be asking CRNAs in North Carolina to participate in a CO2 embolism crisis simulation that could occur in the OR. This will be a convenience sample, based on the CRNAs that are available at the times of the simulation that is given. This project will be implemented using the UNCG campus simulation lab. The project's hope is to make the CRNAs aware of their confidence levels pre- and post-simulation to improve their confidence and ability to respond to a crisis event in the OR. The event of CO2 embolisms intra-operatively is rare; however, when it does occur there is up to an 60% mortality (Park et al., 2012). With simulation, confidence levels will improve if the CRNA sees this crisis event occurring in the OR. This group will consist of both men and women CRNAs of various ages and ethnicities. This sample will be measured using a questionnaire/survey with debriefing sessions to discuss confidence pre and post simulation.

The survey will be open for 8 weeks and both surveys will be provided prior to the simulation and after the simulation. The simulation will take place 4 times during the 8 weeks. This will be offered to all NC CRNAs willing to participate in the study. Differing Data, pre/post confidence levels based on the survey, will be analyzed, and deciphered by the PI and faculty advisor.

Design

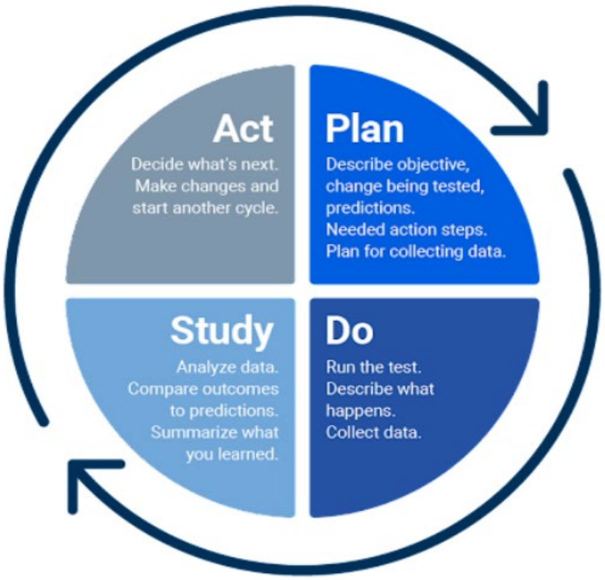
This quality improvement project will use the Plan-Do-Study-Act (PDSA) model (Coury et. al., 2017). This project will use a mixed methods design to obtain information through a RedCap® pre and post survey based on confidence levels that the participant feels he/she achieved. The survey will be given in person via QR code that is created to link with a RedCap® survey. The survey comes from a journal based out of Nurse Anesthesia Journal. This survey will be utilized using a Likert Scale to measure confidence levels pre simulation followed by a link to the same survey to measure confidence levels post simulation. The participants will be convenience sample of who can participate at the times the simulation is given, as well as those that choose to participate in the simulation.

Translational Framework

This quality improvement project will use the Plan-Do-Study-Act (PDSA) model (Coury et. al., 2017). **Plan:** Identify the anesthesia providers that will be participating in the high-fidelity simulation. **Do:** A step-by-step simulation that will occur for everyone participating. The high-fidelity simulation will be groups of individuals that are second- or third-year students with a baseline knowledge of CO2 embolisms. **Study:** will consist of an CRNA using a self-assessment tool to assess their confidence levels in their ability to identify and treat a CO2 embolism. **Act:** The changes based on the confidence levels that need to be made to the high-fidelity simulation for future simulations in crisis management of a CO2 embolism.

Figure 1

PDSA Cycle



PDSA Cycle

Population and Setting

A non-probability convenience sample of CRNAs who work at a large hospital in the southeastern United States was investigated. A local university was utilized for the administration of a controlled simulation of a crisis event. Inclusion criteria was any CRNA in the operating room. Exclusion criteria include any Nurse Practitioner, Registered Nurse, or Student Nurse Anesthetist.

Project Implementation

The online survey questions can be found in Appendix C. Demographic data was questioned first, addressing age, experience in years, and job title. Content-related questions are rated on a Likert scale corresponding to agree strongly, agree, neutral, disagree, and strongly disagree. Once the online survey was complete, the simulation was provided. Fifteen minutes after completion of the simulation, a post online survey was completed. All questions were focused on hemodynamic or airway management and attitudes toward management of a crisis event in the operating room.

Instruments

Survey data will be collected using a survey format designed to be an anonymous online survey. A secure, web-based company, RedCap®, will be the online questionnaire tool to allow participants to remain anonymous and block all identifying IP addresses, URLs, and email addresses.

Those wishing to participate in the simulation will be asked to access a RedCap® survey through a QR code included in the post-simulation debriefing session. Instructions will be provided to participants and a copy of the instructions will be included in a follow up email sent after the simulation. Consent will be inferred by the participant voluntarily participating in the simulation.

No individual data or PHI will be shared with the PI or faculty advisor. All data will be reported and shared with the PI and faculty advisor in the aggregate.

Timeline and Critical Milestones

Task	Mar 2023	April 2023	May 2023	Jun 2023	Jul 2023	Aug 2023	Sept 2023	Oct 2023	Nov 2023	Dec 2023	Jan 2024	Feb 2024	Mar 2024	Apr 2024	May 2024
Submit IRB		X													
Develop educational content		X	X	X											
Administer Surveys					X	X	X								
Perform Simulation					X	X	X	X							
Data analysis								X	X	X	X				
Write report											X	X	X		
Poster Presentation														X	
DNP Graduation															X

IRB Approval

After obtaining Institutional Review Board (IRB) study approval, recruitment flyers were posted on social media groups for CRNAs in North Carolina (Appendix A). The primary investigator was on-site during the simulation for voluntary participants to ask questions and deliver the simulation at a local simulation laboratory. Several steps were taken to ensure the participants identities were protected. All the survey responses remained anonymous through RedCap®. An email was sent to the participant prior to the simulation and then five minutes after completion of the simulation. No data was or will be shared within the survey website. Questions were welcomed and encouraged throughout participation of the simulation.

Data Collection

Survey data was collected using a survey format as an anonymous online survey (Appendix C). A secure web-based company, RedCap®, was the online questionnaire tool to allow participants to remain anonymous by blinding IP addresses, URLs, email addresses, and personal information. Volunteers wishing to participate in the project were given a pre and post simulation survey through a link sent to personal emails, blinded by the primary investigator, through RedCap®. Instructions were provided to participants. No individual data or PHI was shared with the primary investigator or the faculty advisor.

The data collected and stored is kept confidential in RedCap®. This is a secure server to be accessed only by the primary investigator via a username and password. The data was exported to an excel file format stored on the primary investigator's computer and password protected. After three years, the excel data file will be deleted from the primary investigators' personal computer. Once the project is completed, the data stored on RedCap® will be destroyed by the survey. Additionally, aggregate data will be held in a UNCG-specific box site that will only be accessible by the PI and faculty advisor. This data will be deleted once the project is complete and disseminated the findings.

Data Analysis

The survey consisted of seventeen questions. The first portion of the questions identify the respondent of their background, years as a CRNA, the type of setting in which he/she worked, and participation in simulation prior to this study. The next set of questions were core questions about how confident the respondent felt that they could care for a patient with respiratory, cardiac, neurological, and hemodynamic changes. This aims to see where their confidence lies on a Likert Scale to see if their confidence increased, decreased, or remained the same after the simulation. A paired t-test analysis using excel software was performed on this section of the data to determine if there is a correlation between confidence levels pre and post survey. This was calculated on the twelve core questions that were studied. The average was taken for these core questions to see if there was a change in confidence after the simulation.

Overall, the confidence levels varied due to the sample size n=45, years of experience, and setting in which he/she works. The demographics taken from this survey could be deeper studied to see which area increased confidence the most and which variables determined this increase.

Results

Evaluate Outcomes

Recruitment for simulation participants was delivered through flyers that were posted in break rooms, in the operating rooms, and on social media inviting CRNAs to participate in an in-person simulation of a crisis event. Forty-five survey responses were analyzed using quantitative statistics. The first five questions were related to demographic data, as seen in Table 1. Responses were mainly collected from CRNAs with various experience and years of experience. Most participants were 30-45 years of age, and most had less than one year of experience. Almost half of the participants worked in an inpatient setting. The most variable portion of the survey was the number of simulations that had been performed prior to this simulation. 35.55% of participants had participated in 5 to 10 simulations. Overall, everyone completed the pre survey, simulation, and post survey and no data was missing from these participants. Distribution of the survey via RedCap® that was utilized through email.

Table 1.

Demographics

Age (years)	n	%
<30	2	4.44%
30-45	34	75.50%
46-60	9	20%

Number of Times Participated in a Simulation	**n**	**%**
0-3	12	26.67%
3 to 5	6	13.33%
5 to 10	16	35.55%
10 to 15	6	13.33%
>15	5	11.11%

Years as a CRNA	**n**	**%**
<1 year	20	44.44%
1-5 years	8	17.77%
6-10 years	8	17.77%
>10 years	9	20%

Current Position	**n**	**%**
Obstetrics	3	6.67%
Inpatient	22	48.89%
Outpatient	6	13.33%
More than One	14	31.11%

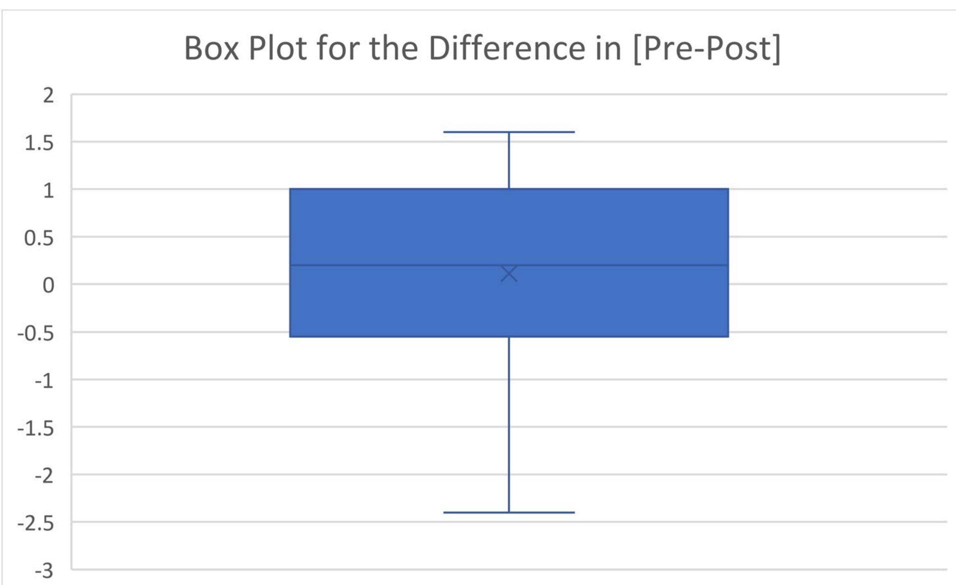
Table 2

t-Test: Paired Two Sample for Means

	Variable 1	*Variable 2*
Mean	4.36444444	4.47111111
Variance	0.33507071	0.46437374
Observations	45	45
Pearson Correlation	-0.3322283	
Hypothesized Mean Difference	0	
df	44	
t Stat	-0.6944895	
P(T<=t) one-tail	0.24551315	
t Critical one-tail	1.68022998	
P(T<=t) two-tail	0.49102631	
t Critical two-tail	2.01536757	

Figure 2

Box Plot for the Difference in [Pre-Post]



Identify Barriers to Success

Barriers to the simulation discussed included insufficient time within a busy schedule, inability to come at the times when the simulation was offered, distance to travel to participate in the simulation, childcare, and lack of experience with simulation. The simulation took a total of 45 minutes to perform. This posed a large problem for those that were also traveling to participate in the simulation.

Strengths to Overcome Barriers

Strengths to overcome barriers include identifying the problems listed and finding solutions for each issue. The strengths include open communication between participants. The project did not plan for these specific barriers, as those traveling over 30 minutes to participate in the simulation would have had the same problem had the simulation been offered in another location or on site of the workplace. The project did not plan for these specific problems; therefore, dates and times were added to the schedule. This opens a gateway for future projects and future studies that can be done to better the hospital system. This was the goal of the QI project to find whether confidence increased or decreased with simulation, and it did not significantly change from pre to post surveys that were analyzed as seen in the paired t test in Table 2.

Discussion

After an extensive review of the articles, simulation can help guide multiple events and provide the education needed to transition successfully to practice. Although not all schools use simulation to train proficient providers, it is proven to establish the confidence needed to allow student nurse anesthetists to be successful in their practice (Cannon-Diehl et al., 2012). Using active participation through small group or individual simulations can provide the person assessing the simulation with insight into multiple variables occurring in the simulation. A variety of emergencies or crises can and have been used in simulation studies depending on the number of years of experience, and it was a common theme that those with more experience yielded quicker recognition and treatment of the crisis occurring in the simulation (Bralow & Piehl, 2018). The measurements that were used ranged from a checklist regarding whether the skill or intervention was performed or not (Everett et al., 2019). This also provides an avenue for safety without using actual patient participants. Intraoperative emergencies can be practiced until goals are met (Heyes et al., 2018). This allows providers to recognize and treat emergencies that may or may not have been seen in practice (Henrichs et al., 2009).

This translation to practice can be met through simulation, whereas other testing strategies and assessments were made that were not as effective before simulation was used. With CO2 embolisms being a rare but potentially fatal event that can occur in the operating room, a simulation practicing this emergency could yield an increase in patient safety and survival rate.

Future Directions

For future reference, high-fidelity simulations should be used to guide education (Orique & Phillips, 2018). Gaps of knowledge can be addressed through high-fidelity simulation and provide areas where improvements must be made to continue to advance the education needed to provide safe patient care. Multiple studies have shown an increase in confidence levels for those that have performed a high-fidelity simulation in their training versus those that have not. Emergency high-fidelity simulations can benefit providers' confidence in recognizing and treating an emergency (Everett et al., 2014). The literature review synthesis has provided an avenue for direction with the DNP project. Using a pre-test, educational session, high-fidelity simulation, and debriefing session of an emergency, using the example of CO_2 embolism, will provide providers with the confidence needed to recognize and treat a deteriorating patient.

After review and assessment of multiple articles and studies, high-fidelity simulation using the confidence levels of providers is going to be the best measurement for the project. The providers can be given a pre-test assessing current knowledge; then provided an education session on CO_2 embolisms, recognition, treatments, and signs or symptoms of the deteriorating patient; followed by a high-fidelity simulation that allows the providers to act out interventions for a CO_2 embolism emergency; and finally, given a debriefing session with a post-survey to allow the providers to assess their confidence levels in being able to recognize and treat a CO_2 embolism compared to before the education and high-fidelity simulation. This will allow providers to be met where they are in education while providing them with an emergency that could be potentially seen during their careers.

Not only is this an excellent way to assess confidence levels, but it can also be repeated to see if years in school or years of experience matter in time to recognize and effectively treat a CO_2 embolism. With the research articles found, there are multiple avenues this project could take, but the literature review has provided the information needed to be able to design and further the DNP project.

Conclusion

In conclusion, although studies have shown an increase in confidence in relation to utilizing simulation for crisis events, the study showed that there was no significant change in confidence levels pre and post simulation. Education use with simulation could be used as reliance on technology increases; however, for CRNAs that are already practicing, even only a year out, there may not be a significant change in confidence of management of a crisis. The primary participants in this study had been practicing CRNAs for only a year, so that could have played a part in management of a crisis as compared to using learning students as most studies suggested. The Plan, Do, Study, Act framework that was used for this project can be translated to other projects to improve confidence in the CRNA provider. This framework should be utilized in yearly education trainings, review sessions, and teaching sessions on crisis events in the operating room to facilitate annual review of events that do not happen often in the operating room.

Although the study did not show the expected results, the management of a crisis in the operating room remains the same. Having a vigilant provider that is equipped with skills that can be practiced through simulation is extremely valuable. Education in general on these scenarios that do not happen often is critical in the management of an unstable patient. Simulation is a good tool to utilize when teaching, reviewing, and managing of critically ill patients. Overall, future studies could further this DNP project by studying student participation and confidence levels.

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Appendix A

Recruitment Flyer Posted to Social Media

Appendix B

Halverson B, Malkin M, Lenart J, Vadi M. Simulation Case: Cardiac Arrest After Carbon Dioxide (CO2) Embolism. *MedEdPORTAL*. 2016;12:10327. https://doi.org/10.15766/mep_2374-8265.10327

Use of Appendix 1: Simulation instructions.

State	Patient Status	Student learning outcomes or actions desired and trigger to move to next state	
1. BASELINE (0:00)	Awake HR 84 BP 164/63 RR 14 SpO_2 98% Temp 36.8°C On room air	**Learner Actions:** o Interview patient o Confirm history of present illness and past medical history o Perform focused physical examination including airway examination	**Operator:** o Read case stem to learner o Answer learner's questions using voice of patient **Teaching Points:** o Pre-anesthetic history and physical **Trigger:** Learner induces general anesthesia
2. Induction (3:00)	Anesthetized HR 106 BP 82/44 RR 10 SpO_2 96% Temp 36.4°C $ETCO_2$: 36	**Learner Actions:** o Induce general anesthesia o Confirm satisfactory endotracheal tube position o Notify surgeon when anesthetic induction complete	**Operator:** o Phenylephrine increases BP to 106/55, decreases HR to 75 **Confederate:** o Nurse: apply sterile prep to patient's abdomen o Surgeon: apply sterile drapes; ask learner when surgical procedure may begin; place Veress needle and begin CO_2 insufflation **Teaching Points:** o Confirmation of endotracheal tube placement **Trigger:** Surgeon places Veress needle and begins CO_2 insufflation
3. CO_2 EMBOLISM (6:00)	Anesthetized HR 49 BP 52/25 RR 14 SpO_2 74% Temp 36.2°C $ETCO_2$: 6	**Learner Actions:** o Identify acute decrease in $ETCO_2$ o Re-confirm satisfactory endotracheal tube position o Instruct surgeon to discontinue CO_2 insufflation	**Operator:** o Vasopressor and IV fluids do not improve hypotension o Proceed to "4. Pulseless Electrical Activity" regardless of intervention. **Operator:** o Surgeon: "What do you think is going on?"

		○ Change patient position to left lateral decubitus with steep Trendelenburg ○ Call for help ○ 100% oxygen ○ Turn off volatile anesthetic ○ Administer IV fluids and vasopressors	**Teaching Points:** ○ When to call for assistance ○ Effective communication of changes in patient's status with surgeon and nurse ○ Differential diagnosis for acute intraoperative decrease in $ETCO_2$ **Trigger:** No trigger
4. PULSELESS ELECTRICAL ACTIVITY (PEA) (8:00)	Anesthetized HR 55 BP none RR 14 SpO2 none Temp 35.7°C $ETCO_2$: 0	**Learner Actions:** ○ Identify pulseless electrical activity and notify surgeon of critical change in patient's condition ○ Continue 100% oxygen ○ Place defibrillator pads ○ Initiate ACLS	**Operator:** ○ Patient remains in PEA until 2^{nd} round of epinephrine given **Confederate:** ○ Nurse: "Doctor, how are we going to do chest compressions with the patient in the lateral position?" **Teaching Points:** ○ Differential diagnosis for PEA (5 H's & T's) ○ CPR is less effective when not in the supine position **Trigger:** 2^{nd} round of epinephrine given
5. RETURN OF SPONTANEOUS CIRCULATION (12:00)	HR 134 (sinus) BP 75/35 RR 14 SpO2 92% Temp 35.1°C ETCO2: 75 ABG: 7.14/82/283/14 Base Def -12 Hgb 13.2 Lactate 8.2 Na 138 K 4.9, ionized Ca 1.12	**Learner Actions:** ○ Place arterial line ○ Check ABG, electrolytes ○ Consider administration of amnestic agent ○ Consult critical care specialist for possible therapeutic hypothermia after cardiac arrest	**Operator:** ○ BP improves over 1 min to 96/48 with return of circulation **Confederate:** ○ Surgeon: "What do we do now? Can I do the case?" **Teaching Points:** ○ Inclusion/exclusion criteria for therapeutic hypothermia after cardiac arrest **Trigger:** No trigger
6. STABLE NORMOTENSIVE (15:00)	HR 95 BP 100/65 RR 14 SpO2 100% Temp 35.6°C $ETCO_2$: 40	**Learner Actions:** ○ Determine appropriate postoperative setting for patient (PACU, ICU, etc.) ○ Determine what studies need to be done to evaluate end organ damage	**Operator:** ○ Maintain patient's hemodynamic status **Confederate:** ○ Nurse: "Where will the patient be going after he leaves the OR?" ○ Surgeon: "Can we extubate? The patient is stable." **Teaching Points:** ○ Extubation criteria ○ Appropriate patient disposition after critical intraoperative event

Appendix C

Survey Questions

4 Demographic Questions

1. What is your age?
   - < 30 years
   - 30-45 years
   - 46-60 years
   - 61-75 years
   - >75 years

2. How long have you been a CRNA?
   - < 1 year
   - 1-5 years
   - 6-10 years
   - >10 years

3. What best describes your current position?
   - Inpatient
   - Pediatrics
   - Outpatient
   - Obstetrics
   - More than one of the above

4. How many times have you participated in a simulated scenario?
   - 0-3
   - 3-5
   - 5-10
   - 10-15
   - >15

Core Survey Questions

Permission granted displaying notice of:

Hicks, F. D. (2009). *Report of Findings from the Effect of High-fidelity Simulation on Nursing Students' Knowledge and Performance: A Pilot Study*

APPENDIX D: SELF-CONFIDENCE SCALE

Appendix D: Self-confidence Scale	Not at all confident	Somewhat not confident	Somewhat confident	Moderately confident	Very confident
1. How confident are you that you can recognize signs and symptoms of a cardiac event?	1	2	3	4	5
2. How confident are you that you can recognize signs and symptoms of a respiratory event?	1	2	3	4	5
3. How confident are you that you can recognize signs and symptoms of a neurological event?	1	2	3	4	5
4. How confident are you that you can accurately assess an individual with chest pain?	1	2	3	4	5
5. How confident are you that you can accurately assess an individual with shortness of breath?	1	2	3	4	5
6. How confident are you that you can accurately assess an individual with changes in mental status?	1	2	3	4	5
7. How confident are you that you can appropriately intervene for an individual with chest pain?	1	2	3	4	5
8. How confident are you that you can appropriately intervene for an individual with shortness of breath?	1	2	3	4	5
9. How confident are you that you can appropriately intervene for an individual with changes in mental status?	1	2	3	4	5
10. How confident are you that you can evaluate the effectiveness of your interventions for an individual with chest pain?	1	2	3	4	5
11. How confident are you that you can evaluate the effectiveness of your interventions for an individual with shortness of breath?	1	2	3	4	5
12. How confident are you that you can evaluate the effectiveness of your interventions for an individual with changes in mental status?	1	2	3	4	5