The Impact of an Interdisciplinary Simulation Training on Provider Confidence and Competence in the Management of a Malignant Hyperthermia Critical Incident

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Table of Contents

Acknowledgments..................................................................................................................4
Abstract.................................................................................................................................5
Introduction............................................................................................................................6
Background and Significance .................................................................................................6
Project Purpose, Aims, And Objectives...................................................................................9
DNP Essentials and Contributions to Scholarship.................................................................10
Theoretical Framework..........................................................................................................11
Literature Review..................................................................................................................12
Methods and Design..............................................................................................................19
Results.................................................................................................................................22
Discussion.............................................................................................................................24
Conclusion .............................................................................................................................26
References .............................................................................................................................28
Table 1..................................................................................................................................31
Table 2..................................................................................................................................31
Figure 1.................................................................................................................................32
Figure 2..................................................................................................................................32
Figure 3..................................................................................................................................33
Appendix A: Student Satisfaction and Self-Confidence in Learning........................................34
Appendix B: Critical Incident Perceptions, Confidence and Competence Instrument..............35
Appendix C: Critical Incident Training Recruitment Flyer.......................................................42
Appendix D: Consent HRP 502.............................................................................................43
Appendix E: Malignant Hyperthermia Scenario.................................................................47
Appendix F: IRB Approval Form.........................................................................................50
Appendix G: Oral Defense PowerPoint Presentation.........................................................52
Appendix H: Executive Summary and Recommendations................................................63
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Abstract

Malignant hyperthermia (MH), a rare but life-threatening crisis, may occur when genetically susceptible patients undergo anesthesia. During an MH crisis, patient survival depends on an immediate and coordinated perioperative team approach. Because of the infrequency of MH, potential exists that clinicians may be unprepared to manage the crisis. Research supports that interprofessional simulation is an effective strategy in preparing clinicians for managing critical incidents (CIs). The purpose of this Doctor of Nursing Practice (DNP) Project was to examine the impact of an MH CI simulation training session on clinicians working on an interprofessional team at an ambulatory surgical center located in Western New York (WNY). The aim of the project was to increase clinician confidence and competence in managing an MH CI as part of the interprofessional perioperative team. The interprofessional team consists of surgeons, anesthesia providers, Physician Assistant (PAs), perioperative nurses, and surgical technicians. Clinicians were voluntarily recruited for project participation. Bandura’s Social Learning Theory will provide context for this project. A mixed methods design using a pre-and post-intervention with two surveys, the National League for Nursing (NLN) Student Satisfaction and Self-Confidence in Learning Questionnaire and an MH CI Questionnaire developed by the DNP project student, were utilized to collect data. Data analysis was guided by a quantitative methods expert on faculty in the School of Nursing at University at Buffalo (UB). The project was implemented after gaining approval by the UB Institutional review board (IRB). Upon data analysis, findings revealed a statistically significant increase in clinician confidence, perceived competence, and true competence after completing the MH CI training.

Keywords: malignant hyperthermia, simulation, interprofessional, ambulatory surgery, critical incidents
Malignant hyperthermia (MH) is a life threatening crisis that may occur when genetically susceptible patients undergo anesthesia in the operating room (OR). When faced with an MH crisis, patient survival depends on the immediate intervention of perioperative clinicians so that specific treatment may be employed to prevent patient death (Cain, Riess, Gettrust, & Novalija, 2014). Despite an estimated 1 in 400 individuals being genetically susceptible to MH, the crisis is rare, occurring once with every 10,000 to 250,000 anesthetics (Rosenberg, Pollock, Schiemann, Bulger, & Stowell, 2015). Because of this infrequency, many perioperative providers may not be competent in effectively managing the crisis (Cain et al., 2014). Prompt and correct management by perioperative staff is critical as MH carries a mortality rate of 70-80% if not properly treated (Malignant Hyperthermia Association of the United States [MHAUS], 2019).

Crucial to the effectiveness of managing an MH crisis is cohesive collaboration among perioperative staff, as evidenced by various studies demonstrating that a direct relationship between perioperative team performance and patient outcomes exists (Phitayakorn, Minehart, Hemingway, Pian-Smith, & Petrusa, 2015). According to the American Association of Nurse Anesthetists (AANA, 2018), although anesthesia professionals may be the first to recognize the onset of an MH crisis, a coordinated team response is vital in the effective treatment and management of MH. In an effort to improve interprofessional crises management, including provider confidence and competency, simulation has been established as an effective training technique in preparing health care providers to work as a team during critical events (Elder, 2017).
Background and Significance

When exposed to a volatile anesthetic gas or the depolarizing muscle relaxant, succinylcholine, patients who are genetically predisposed to MH will have an adverse response that begins inside the skeletal muscle. According to the AANA (2018), when a skeletal muscle contracts, it starts with an action potential. This action potential releases calcium from the muscle cell’s sarcoplasmic reticulum. The calcium is then used within the skeletal muscle to bind with adenosine triphosphate (ATP). As ATP is broken down it produces heat, which prompts the muscle contraction. The muscle relaxes once the calcium is transferred via calcium pumps back into the sarcoplasmic reticulum. A genetically susceptible skeletal muscle cell cannot transfer enough of the calcium back into the sarcoplasmic reticulum for the contracted muscle to relax and return to its resting state. This resultant skeletal hypercalcemia leads to hypermetabolism, increased sympathetic tone, increased carbon dioxide production, increased oxygen consumption, metabolic acidosis, and disruption of cell membranes. Clinically, the patient will have muscle rigidity, a sudden rise in end-tidal CO2, tachyarrhythmias, tachypnea, hypoxia, skin mottling, and increased body temperature. Left untreated, the patient may develop acute renal failure, circulatory failure, rhabdomyolysis, myoglobinuria, disseminated intravascular coagulation, hyperkalemia, and cardiac arrest (AANA, 2018).

The successful management of an acute MH crisis is heavily dependent on an effective interprofessional team approach. Providers must work together to rapidly identify and treat the MH crisis with the specific intervention it requires. This includes discontinuing triggering agents, hyperventilation, cooling by all available routes, and most definitively, the administration of dantrolene (Rosenberg et al., 2015). While the introduction of dantrolene has decreased mortality from 70-80% to less than 1.4%, there are some inherent challenges to its administration
MALIGNANT HYPERTHERMIA CRITICAL INCIDENT TRAINING

(Kim, 2012; Rosenberg et al., 2015). Dantrolene is poorly soluble, with each vial requiring 60 milliliters of sterile water for reconstitution (Rosenberg et al., 2015). With patients commonly requiring 8-10 ampules for initial treatment alone, this process is demanding (Rosenberg et al., 2015). Of note, an improved formulation of dantrolene known as Ryanodex received United States Food and Drug Administration (FDA) approval in 2014. While this concentrated formulation has many significant benefits, including less time and liquid volume required for reconstitution, the cost is much greater as compared to traditional dantrolene, deterring facilities from purchasing (Association of Surgical Technologists, 2015).

Because patient prognosis is strongly dictated by the time between the onset of MH symptoms and the administration of dantrolene, it is critical that perioperative clinicians are well versed in the administration of this drug. Both the Association of periOperative Registered Nurses (AORN) and the AANA recommend that institutions establish policies and protocols for MH prevention and management. Included in these recommendations is access to a dantrolene stocked MH cart wherever triggering agents are available and evidence of regularly scheduled MH education to promote perioperative team confidence and competence, including mock drills (Mullen & Byrd, 2013; AANA, 2018).

Several studies have documented the inadequate preparedness of facilities when faced with MH crises (Cain et al., 2014; Hirshey Dirksen, Van Wicklin, Mashman, Neiderer, & Merritt, 2013). Areas of inadequate preparedness included failure to recognize signs and symptoms of MH, a prolonged length of time to prepare the dantrolene, delays in procuring cooling methods, and failure to contact the MHAUS hotline (Hirshey Dirksen et al., 2013). Additionally, study findings revealed that perioperative leadership often does not provide annual
MH education for perioperative teams, that MH treatment carts were not up to date, and that policies and procedures for MH management were not in place (Cain et al., 2014).

To increase a patient’s chance of surviving an MH crisis, an immediate and coordinated interprofessional response for better education and training is required (Hirshey Dirksen et al., 2013). The perioperative staff consists of a dynamic group of providers, including preoperative, intraoperative, and postoperative nurses, in addition to nurse anesthetists, anesthesiologists, surgical technicians, surgeons, physician assistants, residents, and ancillary staff. This wide array of varying perioperative professions makes interdisciplinary communication inherently challenging. According to Paige et al. (2015), the operating room (OR) is “home to the silo mentality”, where role ambiguity, heightened tension, and ineffective teamwork are common (p. 754). These factors combine and contribute to technical errors, disruptions, distractions, decreased patient safety, and increased morbidity and mortality (Paige et al., 2015). This dysfunctional collaboration is lethal, as evidenced by the 100,000 deaths that occur annually due to medical errors, often stemming from ineffective teamwork (Rodziewicz & Hipskind, 2019).

In order to maximize patient survival during an MH crisis, interprofessional communication and collaboration must be highly functional.

**Purpose, Aims, and Objectives**

The purpose of this Doctor of Nursing Practice (DNP) Project was to examine the impact of an MH CI simulation training session on clinicians working on an interprofessional team at an ambulatory surgical center located in Western New York (WNY). The aim of the project was to increase clinician confidence and competence in managing an MH CI as part of the interprofessional perioperative team at the ambulatory surgical center. The interprofessional team consisted of surgeons, anesthesia providers, perioperative nurses, and certified surgical
technicians. Clinicians were voluntarily recruited for project participation. The project site offered the interprofessional perioperative team opportunity to experience a scripted MH crisis simulated scenario together. The objectives of this DNP project were to 1) evaluate via pre-test clinician confidence and competence in managing an MH crisis using the National League for Nursing (NLN) Student Satisfaction and Self-Confidence in Learning Questionnaire (Appendix A) and a CI Questionnaire developed by the DNP project student (Appendix B); 2) develop and implement an MH crisis training simulation session for the perioperative team at the ambulatory surgical center; 3) evaluate via post-test clinician confidence and competence in managing an MH crisis using the National League for Nursing (NLN) Student Satisfaction and Self-Confidence in Learning Questionnaire (Appendix A) and a CI Questionnaire developed by the DNP project student (Appendix B); and 4) develop a recommended policy and procedure guideline for managing an MH crisis based on project findings for the clinicians working at the ambulatory surgical center. The project outcome was improved clinician level of competence and confidence in managing an MH crisis with increased knowledge and an improved skillset to act rapidly and effectively to maximize patient survival.

**DNP Essentials and Contribution to Scholarship**

By implementing this project in the perioperative setting, evidence based best practice paired with current clinician knowledge and confidence are addressed in the American Association Colleges of Nursing’s (AACN, 2006) DNP Essential III, *Clinical Scholarship and Analytical Methods for Evidence-Based Practice*. DNP Essential II, *Organizational and Systems Leadership for Quality Improvement and Systems*, is addressed in this project because the project aims not only to benefit the clinicians and patients at the ambulatory surgical center, but also the perioperative, organizational, and systems leadership teams at the ambulatory
surgical center as well. DNP Essential V, *Health Care Policy for Advocacy in Health Care*, is addressed in this quality improvement project because the outcome of this project is to promote perioperative clinician and leadership management of MH through education related to MH and critical events. As staff are educated regarding the risks and focused assessment points related to MH, potential MH susceptible patients may be identified and treated as such, therefore preventing this crisis which is demonstrated in DNP Essential VII, *Clinical Prevention and Population Health for Improving the Nation’s Health*. DNP Essential VII speaks to the clinical prevention and for improving the nation’s health.

**Theoretical Framework**

To enhance understanding of the impact of an interprofessional MH CI simulation on clinicians working in an ambulatory surgical center in WNY, Bandura’s Social Learning Theory guided this project as the theoretical framework. Social Learning Theory was first proposed by Albert Bandura in 1977 as a constructivist learning theory. Constructivists believe that social interaction fosters learning and enhances construction of knowledge (Billings & Halstead, 2016). Upon completion of the interprofessional MH CI simulation, the perioperative teams’ confidence and competency were assessed. According to Social Learning Theory, clinicians will experience improved self-efficacy upon completion of social learning, contributing to their confidence level when taking on complex tasks, such as a critical event management (Billings & Halstead, 2016). A foundational concept of Social Learning Theory, as explained by Billings and Halstead (2016), is that when clinicians believe they can perform well, their self-confidence and efficacy will improve, allowing them to take on complex tasks with confidence. Given the opportunity to practice interprofessional critical event management during the simulation training, clinician self-efficacy should increase. Social Learning Theory is demonstrated in the research completed
by Elder (2017), where simulation exercises resulted in improved nursing knowledge and self-confidence.

The proposed interprofessional MH CI simulation, grounded in Social Learning Theory, allowed clinicians at the ambulatory surgical center to learn and practice MH management in the context of a high intensity, low risk environment. With the multidisciplinary support of the perioperative professions, clinicians were able to enhance their understanding and competency of MH management, which according to Social Learning Theory, will then contribute to improved self-efficacy. Based on Social Learning Theory, clinician MH crisis confidence and competency should increase. Furthermore, if faced with an MH crisis, clinician confidence and competence will contribute to prompt and effective management required for patient survival.

**Literature Review**

A literature review was conducted to explore the interprofessional management of MH CIs in the OR as well as the benefits of interprofessional MH crisis simulation training on clinician confidence and competency and perioperative team confidence and competency. Databases searched included PubMed, CINAHL, and MEDLINE. The following keywords were utilized both singularly and in multiple combinations to generate best results: malignant hyperthermia, simulation, interprofessional, ambulatory surgery, and critical incidents. The search was narrowed to published works between the years 2014-2019. It should be noted that several seminal works prior to 2014 were included in the review due to their significant contribution to this area of study. Inclusion criteria included the following: studies analyzing simulation educational training or similar interventions; studies including either healthcare professionals or students; studies conducted in specialty settings such as perioperative, critical care, emergency, and medical-surgical settings; qualitative studies; and quantitative or mixed-
malignant hyperthermia critical incident training

methods studies. Research published in a language other than English and simulation exercises that took place outside of the healthcare setting were excluded. The following presents a summary of the literature review findings.

**Malignant Hyperthermia**

In the face of an MH crisis, patient symptoms must be identified early on and the specific emergency response must be activated. Studies have demonstrated that a direct correlation exists between early recognition and prompt treatment of MH with patient survival (Cain et al., 2014; Hirshey Dirksen et al., 2013; Hommertzheim & Steinke, 2006). In previous studies, barriers to rapid treatment of MH have included delayed recognition, inadequate temperature monitoring, delayed reconstitution and administration of dantrolene, lack of cognitive aids, and not calling the MHAUS hotline (Cain et al., 2014; Hirshey Dirksen et al., 2013). To reduce the risk of these challenges, the AANA recommended that healthcare providers maintain familiarity with current MHAUS recommendations and that facilities conduct interdisciplinary MH crisis team training (AANA, 2018, p. 4).

After exposure to a triggering agent, the rise in end-tidal carbon dioxide is often the earliest sign of MH (Rosenberg et al., 2015). However, this hypercarbia may be masked when minute ventilation is increased by the anesthesia provider. In contrast, the detrimental hyperthermia that follows is more discernable as body temperature increases 1 to 2 degrees Celsius every five minutes, therefore implying the importance of vigilant temperature monitoring (Rosenberg et al., 2015). The North American Malignant Hyperthermia Registry (NAMHR) of the MHAUS found that the routine monitoring of core body temperature was associated with decreased morbidity and mortality from MH. In support of these findings, a retrospective chart review by Larach et al. (2010) assessed deaths from MH and found that patients had a 14 times
greater risk of dying from MH when their core body temperature was not monitored. In effort to
detect this indicative sign as early as possible, MHAUS recommended core temperature
monitoring of all patients who are under general anesthesia for more than thirty minutes (AANA,
2018). Despite these recommendations, studies have revealed a lack of intraoperative core body
temperature monitoring among perioperative staff, increasing the risk of delayed MH recognition
and poor patient outcomes (Bindu, Bindra, & Rath, 2017). These results confirm the need for
interprofessional MH education.

**Malignant Hyperthermia Management and Teamwork in the Operating Room**

After the introduction of dantrolene, the mortality from MH decreased from 80% to 1%
(Kim et al., 2012). However, there are inherent challenges to dantrolene administration.
Dantrolene is supplied in powder form, requiring tedious reconstitution with 60 milliliters of
sterile water and vigorous shaking (Mullen & Byrd, 2013). The reconstitution process takes 2
minutes per vial, and with patients often requiring ten vials for initial treatment alone,
reconstitution may take upwards of twenty minutes (Rosenberg et al., 2014). As demonstrated
by Larach et al. (2010), patient morbidity from MH increased 1.6 times for every 30-minute
delay in dantrolene administration. Because of the correlation between time of dantrolene
administration and patient outcomes, perioperative staff must work together to administer the
medication as quickly as possible.

In addition to administration of dantrolene, there are numerous simultaneous tasks
specific to each professional role that must be coordinated during an MH crisis. Many
perioperative staff members are needed to carry out the necessary tasks during the stressful and
high-stakes MH situation (Hirskey Dirksen et al., 2013). Such tasks include assigning roles,
retrieval of the MH treatment cart, calling the MHAUS hotline, placing venous and arterial lines,
cooling the patient using ice packs or lavage, hyperventilation with 100% oxygen, closing surgical wounds, drawing lab work, providing cardiovascular support, and transporting the patient to a hospital center or intensive care unit (ICU) (Hirskey Dirksen et al., 2013; Cain et al., 2014). In order to prepare perioperative staff for the demands of an MH crisis, MH simulation training has been shown to be an effective method to improve clinical knowledge, confidence, competency, and to increase interdisciplinary collaboration (Schaad, 2017; Mullen & Byrd, 2103; Phitayakorn et al., 2015).

**Simulation to Improve Outcomes**

A quasi-experimental design by Elder (2017) utilized simulation to determine if it improved nurse recognition of patient deterioration. Results were gathered using a knowledge and self-confidence pretest and posttest, along with a clinical decision making and self-confidence scale. After completion of the simulation, there were statistically significant improvements in knowledge and self-confidence among the nurses. The results of this study support that simulation may improve perioperative nurse confidence and competency in detecting an acute patient event, such as deterioration or MH.

A case report by Schaad et al. (2017) analyzed an interprofessional MH simulation. The scripted simulated scenario was followed by a debriefing session, where simulation facilitators provided explanations for why each action was critical for effective MH management. After completion of the simulation, facilitators found that the intervention improved facets of high performing teams, such as increasing professional empowerment to call attention to safety concerns, and improved communication and collaboration among disciplines. Additionally, the facilitators used the ideas and concerns that were raised during the debriefing session for management review and potential policy amendment. Because of the positive outcomes and how
well received the exercise was, the facility’s MH policy was augmented to include yearly MH simulations as part of the annual competency requirement for staff. This report highlighted the effectiveness of an interprofessional MH simulation for improved collaboration among profession in addition to the benefits of including a debriefing session after the simulation.

A qualitative study by Mullen and Byrd (2013) found that upon interdisciplinary MH simulation, nurses had improved clinical knowledge and competency as compared to before the simulation. In addition to improved competency, benefits of the simulation included increased awareness of the silos between professions, and improved collaboration, conversation, and learning in a nonthreatening environment. The qualitative findings revealed the lessons that the participants learned from the simulation which included the importance of assigning roles. The study suggested flashcards identifying specific duties which should be left on the MH cart and distributed to team members during a crisis. Lastly, the group benefited from the experience of mixing expired dantrolene. Many staff members had never mixed this type of medication before and were surprised by the difficulty, recommending annual practice with mixing expired dantrolene. This study supported interdisciplinary MH simulation training for improved teamwork and competency in MH management. The study also provided examples for important facets of simulation, such as using premade flashcards for role assignment and practicing with expired dantrolene.

A qualitative observational intervention was conducted by Cain et al. (2014) where an interdisciplinary perioperative team received an MH educational presentation followed by simulation. After the simulation, qualitative data was collected using open ended questions. Study findings were positive and demonstrated support for simulation evidenced by improved role clarity, anticipatory response, and team cohesion. Following the simulation, Cain et al.
MALIGNANT HYPERTHERMIA CRITICAL INCIDENT TRAINING

(2014) found that nurses and surgical technicians reported increased knowledge and confidence related to roles and responsibilities in the event of an MH crisis. Of note, upon completion of the simulation coordinated by Cain et al. (2014), the facility’s MH treatment cart was updated and an institutional MH policy was implemented. The positive results of these interventions echo the MHAUS recommendation for facilities to run a mock drill at least yearly (MHAUS, 2019).

A quasi-experimental post intervention study conducted by Stephens et al. (2016) utilized an interprofessional training course that the authors designed. The course detailed crises and human factors for perioperative teams, with the goal of improving teamwork and fostering a culture of safety through interprofessional learning and problem solving. Several groups of 10-15 perioperative staff were created that included surgeons, anesthesia providers, post-anesthesia care unit (PACU) nurses, radiology technicians, and ancillary staff. Over 4 weeks, the groups rotated through different learning activities that sought to improve facets of teamwork.

Participant feedback and self-assessed learning was collected from a questionnaire and as well as a follow up study completed by perioperative staff. Likert scales were used to quantify results and qualitative data was processed through open ended questions. Of the 102 participants, over 85% of staff agreed or strongly agreed with statements demonstrating interest in reviewing critical events and an improved understanding of what team members would consider exemplary behavior.

An experimental mixed methods study by Alamrani et al. (2018) compared the effect of simulation and traditional teaching methods on the self-confidence and critical thinking skills among nursing students. A pretest posttest design was used and data were analyzed using paired sample t test and Wilcoxon signed-rank tests. Both groups received a 2-hour PowerPoint presentation on the topic of electrocardiogram (ECG) knowledge. After the presentation, the
control group received traditional lecture on ECG interpretation, while the experimental group completed a 1-hour simulation session on arrhythmia interpretation. Although nursing students demonstrated increased confidence and critical thinking after simulation, there were no statistically significant differences between teaching methods. The authors concluded that educational interventions using either simulation or traditional methods can promote nursing students’ critical thinking ability and self-confidence. This study supported simulation as an effective means of nursing education.

The review of the literature demonstrated that interprofessional simulation has a beneficial role in the management of MH by improving teamwork, provider competency, and self-confidence. Future implications of these results include promoting increased use of scheduled interprofessional MH simulations. The results of the reviewed literature suggested that continued use of interprofessional MH simulations will improve facility leadership, preparedness, and patient outcomes.

While many consistent benefits of utilizing simulation for interprofessional education and training were identified in the literature, substantial gaps remain. The literature lacked experimental studies examining the effect of simulation on clinician confidence and competency as compared to a control group. Of the reviewed literature, the majority of studies were qualitative. Additionally, most of the studies were specific to one facility’s perioperative department and did not include a large-scale study that assessed multiple OR staff at various facilities. Despite consistent results suggesting the positive effect of interprofessional MH simulation, several studies were found to be poorly powered and therefore had limited generalizability. Because of the rare occurrence of MH crises, qualitative retrospective case studies would be valuable in determining the training that various perioperative teams need prior
to experiencing crises, specifically if their facility conducted MH simulation or interprofessional critical event training and if they found it to be helpful in managing a real MH crisis. Lastly, it would be beneficial to conduct longitudinal cohort studies which assess perioperative provider and team confidence and competence after remaining engaged in regularly scheduled interprofessional MH simulation over time.

The review of the literature exhibited support for interprofessional MH simulation. The benefits of an interprofessional MH simulation include improved perioperative clinician and perioperative team confidence and competency, empowerment, anticipatory response, enhanced role clarity, and improved team cohesion, interaction, communication, and collaboration. In addition, facility benefits include improved MH treatment carts and augmented policies for MH crisis education and management. Improved perioperative clinician confidence and competency will facilitate prompt and effective MH crises management and optimize patient survival.

**Methods and Design**

**Design**

The project design was constructed using a mixed methods quality improvement approach. Data was collected using questionnaires to address the following question: In ambulatory surgical perioperative clinicians, how does interprofessional MH CI training compared to no interprofessional MH CI training affect clinician confidence and competence in managing MH crises? The project outcomes were improved clinician level of competence and confidence in managing an MH crisis with increased knowledge and an improved skillset to act rapidly and effectively to maximize patient survival and determining the need for MH CI training as perceived by the perioperative staff. The simulation script (Appendix E) was reviewed for content accuracy by two anesthesiologists prior to implementation.
Perioperative clinicians were informed of and recruited for the CI training 2 weeks prior to the event by informative flyers (Appendix C). The flyers were posted in both male and female locker rooms and the lunch room which is shared by all perioperative staff at the surgery center. Information about the CI training session and consent information were conveyed to all potential perioperative staff members. Sufficient time was allowed for subjects to consider the process and ask all necessary questions. Verbal consent was given after the DNP project student asked participants if they had a chance to read the consent information sheet, if participants had questions, and if the CI training session could begin.

**Data Collection Strategy and Instruments**

The National League for Nursing (NLN) Student Satisfaction and Self-Confidence in Learning Questionnaire (Appendix A) was utilized to assess clinician self-confidence pre and post intervention (the MH CI simulation training). The NLN Questionnaire was completed by participants immediately after the Critical Incident Training, and used a five-point Likert scale to respond to 13 self-report statements ranging from “strongly disagree” to “strongly agree” to assess user satisfaction with the Critical Incident Training and self-confidence. This instrument’s reliability was tested and received a Cronbach’s alpha score of 0.87 (NLN, 2019).

A Critical Incidents Questionnaire developed by the DNP project student was utilized to collect data specific to clinician confidence, perceived competence, true competence, and to determine the need for MH CI training as perceived by the perioperative staff (Appendix B). The CI Questionnaire included four parts which were comprised of multiple choice, open ended, and Likert-scale questions. The CI Questionnaire was administered immediately before and immediately after the intervention.
Perceived competence and confidence was assessed using a 5-point Likert scale, where the perioperative clinicians were able to rate their perceived competence and confidence in response to self-report statements ranging from “strongly disagree” to “strongly agree” (Appendix B, Part II). True competence was assessed with 14 questions specific to critical incident management (Appendix B, Part III). Included were knowledge based questions related to pharmacologic interventions, role responsibilities, clinical signs of patient decompensation, and resource utilization. The questionnaire contained similarly themed questions related to other OR CIs, such as Local Anesthetic System Toxicity (LAST) and cardiac arrest. Because the CI Questionnaire was developed by the DNP project student, it did not have a reliability or validity score. The questionnaire was sent to 10 perioperative clinicians at two different hospitals for feedback in order to establish validity.

Data Analysis

Data was analyzed using Microsoft Excel and Statistical Package for Social Sciences (SPSS) version 26. Analyzed summary variables included perceived competence, confidence, true competence, satisfaction, and the need for MH CI training as perceived by the perioperative staff.

Results of pre and post Critical Incident Questionnaire were analyzed using descriptive statistics, including both measures of central tendency and measures of variability. Paired t-tests were used to analyze differences in pretest and posttest data. The NLN Questionnaire is designed for post-intervention data collection and therefore there was no comparison with pretest data. NLN Questionnaire results were analyzed using descriptive statistics. Statistical Package for Social Sciences (SPSS) version 26 software was employed to analyze responses from both
Instruments. Data analysis was guided by a quantitative methods expert on faculty in the School of Nursing at University at Buffalo (UB).

**Human Rights Protection and Ethical Considerations**

This project received approval by the UB IRB prior to implementation. As a Kaleida facility, the surgical center had a standing reciprocal IRB agreement with UB’s IRB. Permission through the ambulatory surgical center was also obtained prior to the start of data collection. Participating perioperative staff were verbally consented to participate in the questionnaires. Anonymous data was collected using paper instruments, which were stored in a locked file cabinet drawer in the DNP project student’s home office until it was translated electronically onto Microsoft Word, Excel, and SPSS. Only the DNP project student had access to the locked file cabinet drawer. No information that could be used to identify participants was collected as part of the survey process. The computer containing these programs is password protected and used only by the DNP project student and the School of Nursing quantitative methods expert. Upon transcription, paper data was shredded and disposed. Electronic data will be protected for 3 years after project defense until its permanent deletion, per UB IRB protocol. Perioperative staff were made aware that they were free to refuse to answer any questions that they did not feel comfortable answering, and had the right to withdraw from the study at any time. There was no risk to patients as perioperative staff practiced MH crisis management in a simulated environment.

**Results**

Sixteen perioperative clinicians consented to participate in the Critical Incident Training. Participants consisted of nine Registered Nurses (RNs), two Medical Doctors, and five Certified
Competence

Results from Part III of the CI Questionnaire confirmed that prior to the Critical Incident Training, clinicians’ competence was lacking. Participants incorrectly answered questions pertaining to crisis management, including drug indications and dosages, role responsibilities, clinical signs of patient decompensation, and resource utilization. As depicted in Table 1, the mean competence score prior to the intervention was 63.7 out of a possible 100 points (SD = 16.7). The minimum score was 28.56 and maximum score was 85.6. Post-intervention, participants scores significantly improved (Figure 1). The mean improved to 94.2 (SD 5.2), with a minimum score of 83.3 and a maximum of 100. Statistical significance was evidenced by the large improvement in competence scores (t = -7.871; p = .000).

Confidence and Perceived Competence

Data pertaining to confidence and perceived confidence was gathered using Part II of the CI Questionnaire, which participants answered using a five-point Likert scale. Results were numbered one through five with higher scores indicating higher confidence and perceived competence, and lower scores indicating lower confidence and perceived competence. The highest possible score was 80, representing a high degree of confidence and perceived competence, and the lowest possible score was 16, representing the lowest degree of confidence and perceived competence. The mean pre-intervention score was 52.9 (SD = 19.2). Post-intervention, the mean improved to 68.1 (SD = 7.3) (Figure 2). A paired t-test was used to determine if there was a statistically significant improvement pre and post-intervention. Results of the paired t-test found that after receiving the Critical Incident Training, a statistically
significant improvement in confidence and perceived competence occurred \((t = -3.885; p = .001)\), illustrated in Table 1. Interestingly, there was a strong correlation between pre and post confidence and perceived competence \((r = .628; n = 16; p = 0.009)\), indicating that those who did well on the pre-intervention tools did well on the post-intervention tools (Table 2).

**Satisfaction and Self Confidence in Learning Tool**

The NLN Student Satisfaction and Self Confidence in Learning tool depicted participants’ satisfaction with the intervention. Possible scores ranged from 13 to 65, with larger scores indicating a higher degree of satisfaction from intervention, and lower scores indicating a lower degree of satisfaction from the intervention. Upon completion of the Critical Incident Training, participants’ minimum score was 52 and maximum score was 65. Analysis of the tool reflected a mean score of 61.9 (SD = 4.2). These results indicate that clinicians had a high degree of satisfaction with the Critical Incident Training. The instrument is designed for post-training only, so there was no comparison with pre-intervention data.

**Discussion**

Findings revealed a significant improvement in perioperative clinicians’ confidence, perceived competence, and true competence. This improvement supports that the Critical Incident Training was effective in increasing clinician preparedness in the MI critical incident management. These results were predicted by Bandura’s Social Learning Theory, which served as a guide for the construction and analysis of this DNP Project. Echoing Social Learning Theory, upon completion of this social learning intervention, clinicians had improved self-efficacy, contributing to their confidence levels when taking on critical tasks such as the management of a patient in an MH crisis.
Upon completion of the intervention, perioperative management and chief anesthesiologists decided to update their MH cart to include role assignment cards, which the cart did not previously contain. During the intervention, use of the role assignment cards allowed for prompt delegation of life saving tasks to the specific provider responsible for the respective tasks so that critical interventions may be completed simultaneously. These results support the use of a regularly scheduled Critical Incident Training for perioperative clinicians. Additional observations included the ambulatory surgical center’s lack of resources related to crisis management, including individual sterile water vials, intravenous pumps required for medication infusions, and means to process intraoperative lab values such as a Point of Care device. Without these important pieces of equipment, perioperative teams would not be able to sterilely reconstitute dantrolene, safely infuse sedation or dantrolene maintenance in preparation for patient transfer, as well as not be able to determine potential life threatening potassium, base excess, and glucose levels. Upon realization of these shortcomings, staff verbalized concern and intention to raise these issues with nursing management.

There was an overall poor response to the open ended questions included in Part II and Part V of the CI Questionnaire. The participants who did respond mentioned: “I do not know the steps required for an MH crisis because I’ve never had one”, “I now feel more capable of managing a malignant hyperthermia crisis”, and “Prior to today I did not feel prepared to handle an MH crisis”. There was not enough of a response to conduct the intended qualitative analysis included in the mixed method study design. Due to this limitation, the analysis was unable to determine the need for MH CI training as perceived by the perioperative staff.

Critical incident management is of paramount importance in the OR. This is especially true during an MH crisis, when delays in time to treatment equates to significantly increased
complications and risk of death (Larach et al., 2010). Regular CI training for crises such as MH increases provider competence and confidence so that clinicians may be better prepared to manage a crisis rapidly and effectively to improve the chances of patient survival. Results of this intervention reflect the findings of previous research specific to the use of multidisciplinary simulation as an effective tool for training clinicians in critical incident management.

Completion of the DNP project allowed for the intended DNP Essentials to be met. Included in these were Essential III: Clinician Scholarship and Analytical Methods for Evidence-Based Practice, Essential II: Organizational and Systems Leadership or Quality Improvement and Systems; Essential V: Health Care Policy for Advocacy in Health Care, and Essential VII: Clinical Prevention and Population Health for Improving the Nation’s Health.

**Conclusion**

**Strengths and Limitations**

Strengths of this intervention include the clinical importance of critical incident competence and confidence. Successful MH crisis management increases the likelihood of patient survival post MH. There is potential that the results of this DNP project could better prepare all perioperative clinicians employed at the ambulatory surgical center for MH and therefore save patient lives. Additional strengths include that, the intervention’s design was not unique to the ambulatory surgery center and could therefore be implemented in all perioperative environments on a city, state, or national level. Furthermore, data collection was a simple and cost efficient process, and the NLN tool is supported by a high degree of validity.

Limitations included the small sample size of participants (n=16), therefore limiting the project’s power and potentially increasing its margin of error. In addition, participants were all from the same ambulatory surgical center and this may not reflect all perioperative
environments, which can limit the generalizability of these results. The tools that were used to analyze the project were limited. The Critical Incident Questionnaire was created by the DNP project student and therefore does not have a reliability or validity score associated with it, however it had been reviewed by 10 perioperative clinicians at two different hospitals for feedback in order to establish validity. The NLN Student Satisfaction and Self Confidence in Learning tool does have established reliability, however both the NLN tool and CI Questionnaire were self-report instruments and therefore it is possible that clinicians did not answer honestly or self-report accurately.

**Future Implications and Recommendations**

This project confirmed the notion that a multidisciplinary MH CI training could improve clinician confidence, perceived competence, and true competence. The statistically significant positive results support MH CI training in all perioperative environments.

The study could be replicated in other hospitals with other perioperative teams in order to increase the reliability of the results. Increasing the number of participants would increase the power of the results and decrease the margin of error. Lastly, future implications would include improving the design of qualitative data collection, in addition to designing critical incident trainings of varying etiologies.
References


Table 1

<table>
<thead>
<tr>
<th>Pair</th>
<th>Confidence and Perceived Competence (Pre) - Competence and Perceived Competence (Post)</th>
<th>Upper</th>
<th>t</th>
<th>df</th>
<th>Sig. (2-tailed)</th>
</tr>
</thead>
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<tr>
<td>Pair 1</td>
<td></td>
<td>-6.85433</td>
<td>-3.885</td>
<td>15</td>
<td>.001</td>
</tr>
<tr>
<td>Pair 2</td>
<td>Competence (Pre) - Competence (Post)</td>
<td>-22.21888</td>
<td>-7.871</td>
<td>15</td>
<td>.000</td>
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</table>

Table 2

<table>
<thead>
<tr>
<th>Pair</th>
<th>Confidence and Perceived Competence (Pre) &amp; Competence and Perceived Competence (Post)</th>
<th>N</th>
<th>Correlation</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pair 1</td>
<td></td>
<td>16</td>
<td>.628</td>
<td>.009</td>
</tr>
<tr>
<td>Pair 2</td>
<td>Competence (Pre) &amp; Competence (Post)</td>
<td>16</td>
<td>.382</td>
<td>.144</td>
</tr>
</tbody>
</table>
Figure 1

True Competence

Figure 2

Confidence and Perceived Competence
Figure 3

Satisfaction and Self Confidence in Learning Tool

![Graph showing satisfaction and self-confidence over time](image-url)
Appendix A

Student Satisfaction and Self-Confidence in Learning

Instructions: This questionnaire is a series of statements about your personal attitudes about the instruction you receive during your simulation activity. Each item represents a statement about your attitude toward your satisfaction with learning and self-confidence in obtaining the instruction you need. There are no right or wrong answers. You will probably agree with some of the statements and disagree with others. Please indicate your own personal feelings about each statement below by marking the numbers that best describe your attitude or beliefs. Please be truthful and describe your attitude as it really is, not what you would like for it to be. This is anonymous with the results being compiled as a group, not individually.

Mark:
1 = STRONGLY DISAGREE with the statement
2 = DISAGREE with the statement
3 = UNDECIDED - you neither agree or disagree with the statement
4 = AGREE with the statement
5 = STRONGLY AGREE with the statement

<table>
<thead>
<tr>
<th>Satisfaction with Current Learning</th>
<th>SD</th>
<th>D</th>
<th>UN</th>
<th>A</th>
<th>SA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The teaching methods used in this simulation were helpful and effective.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>2. The simulation provided me with a variety of learning materials and activities to promote my learning the medical surgical curriculum.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>3. I enjoyed how my instructor taught the simulation.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>4. The teaching materials used in this simulation were motivating and helped me to learn.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>5. The way my instructor(s) taught the simulation was suitable to the way I learn.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Self-confidence in Learning</th>
<th>SD</th>
<th>D</th>
<th>UN</th>
<th>A</th>
<th>SA</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. I am confident that I am mastering the content of the simulation activity that my instructors presented to me.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>7. I am confident that this simulation covered critical content necessary for the mastery of medical surgical curriculum.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>8. I am confident that I am developing the skills and obtaining the required knowledge from this simulation to perform necessary tasks in a clinical setting.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>9. My instructors used helpful resources to teach the simulation.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>10. It is my responsibility as the student to learn what I need to know from this simulation activity.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>11. I know how to get help when I do not understand the concepts covered in the simulation.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>12. I know how to use simulation activities to learn critical aspects of these skills.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>13. It is the instructor’s responsibility to tell me what I need to learn of the simulation activity content during class time.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
Appendix B

Critical Incident Perceptions, Confidence and Competence Instrument

Part I

1. What is your age?

   24 or younger ______ 25-29______ 30-34______ 35-39______
   40-44______ 45-49______ 50-54______ 55 or older______

2. Gender: Male______ Female______ Prefer not to answer______

3. In what role/capacity do you practice (e.g. MD, CRNA, RN)? _____

4. Number of years practicing in this role? _____

5. What is the highest level of education you have completed, your degree?
   AD/Certificate______ BA/BS______ Masters______ Doctorate_____

Part II

SD: (strongly disagree); D: (disagree); UN: (undecided); A: (agree); SA: (strongly agree)

<table>
<thead>
<tr>
<th>Questions</th>
<th>SD</th>
<th>D</th>
<th>UN</th>
<th>A</th>
<th>SA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I feel confident in my skills as a provider during a crisis involving</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>direct patient care.</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Why or why not?</td>
<td></td>
<td></td>
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</tbody>
</table>

| 2. I feel confident in managing the care of a patient in cardiac arrest. |    |   |    |   |    |
| Why or why not?                                                          |    |   |    |   |    |

| 3. I feel confident in managing the care of a patient experiencing an   |    |   |    |   |    |
|   airway emergency (e.g. cannot ventilate or intubate).                |    |   |    |   |    |
| Why or why not?                                                          |    |   |    |   |    |
Why or why not?


Why or why not?

<table>
<thead>
<tr>
<th>Questions</th>
<th>SD</th>
<th>D</th>
<th>UN</th>
<th>A</th>
<th>SA</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. I know the initial interventions required during an MH crisis.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Why or why not?</td>
<td></td>
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<td></td>
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<tr>
<td>6. I feel confident in dosing and administering dantrolene during an MH</td>
<td></td>
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<tr>
<td>crisis.</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Why or why not?</td>
<td></td>
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<tr>
<td>7. I feel confident in my ability to reconstitute dantrolene.</td>
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<td></td>
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<td></td>
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<tr>
<td>Why or why not?</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>8. I am confident in my ability to recognize initial signs and symptoms</td>
<td></td>
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<tr>
<td>based on patient presentation during MH.</td>
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<tr>
<td>Why or why not?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. I know what my roles and responsibilities would be during an MH</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>crisis.</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Why or why not?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. I feel confident in how to coordinate patient transfer to a hospital.</td>
<td></td>
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<td></td>
<td></td>
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</tbody>
</table>
### Questions

<table>
<thead>
<tr>
<th>Questions</th>
<th>SD</th>
<th>D</th>
<th>UN</th>
<th>A</th>
<th>SA</th>
</tr>
</thead>
<tbody>
<tr>
<td>11. I know initial steps in managing a LAST event until lipid emulsion is administered.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Why or why not?</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>12. I feel confident in dosing and administering lipid emulsion during a LAST event.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Why or why not?</td>
<td></td>
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<tr>
<td>13. I am confident in my ability to recognize initial signs and symptoms based on patient presentation during LAST.</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Why or why not?</td>
<td></td>
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<tr>
<td>14. I know the weight-based bolus and infusion dosages of lipid emulsion therapy for treating LAST.</td>
<td></td>
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<tr>
<td>Why or why not?</td>
<td></td>
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<tr>
<td>15. I feel confident in managing cardiac arrest during a LAST event.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Why or why not?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. I know common ACLS medications to avoid during concurrent cardiac arrest and LAST.</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Why or why not?</td>
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</tr>
</tbody>
</table>
Part III

1. What are 3 patient signs or symptoms of MH?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

2. What are three interventions required during MH crisis management?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

3. What is the first step the team should take in caring for a patient with MH?

   a. Call for a stat chest x-ray
   b. Apply heating pads to the patient
   c. Discontinue all anesthetic agents and administer 100% oxygen
   d. Continue with the surgery

4. If a patient has had anesthesia in the past without complication, it’s safe to assume that the patient will not develop MH:

   True or False

5. What volume of sterile water is required to dilute one 20 mg vial of dantrolene?

   __________________________

6. Which medication is NOT an MH triggering agent? (circle your answer):

   Sevoflurane  Succinylcholine  Nitrous Oxide

7. Where could you find the number for the Malignant Hyperthermia Association of the United States?

   __________________________
8. When applying ice packs for surface cooling of the patient, what are three areas on which you would apply them?
   a. Groin, axillae, and neck
   b. Abdomen, popliteal area, and feet
   c. Hips, back, and palms

9. What is the dose of dantrolene for initial treatment?

10. Bolus and infusion dosages of lipid emulsion therapy for patients less than 70kg are? Bolus and infusion dosages of lipid emulsion therapy for patients over 70kg are?

11. List 3 common signs or symptoms of a patient experiencing LAST.

12. During a LAST crisis involving cardiac arrest, epinephrine doses should be reduced to______.

13. What are three common resuscitation medications to avoid in a patient experiencing a LAST crisis?
14. The preferred medication to treat seizures in a patient experiencing a LAST crisis is? (Circle your answer).

Atenolol  Propofol  Midazolam  Haldol  Vasopressin

Part IV

1. In your own words, please define a critical incident (CI)

2. Have you ever participated in a CI training session before today? YES_____ NO_____ 
   If yes, please offer a brief description of the training. If no, why not?

3. Have you ever been involved in a critical incident during your professional practice providing direct patient care? YES_____ NO_____ 
   If yes, did you feel adequately prepared to serve in your role during the event? Why or why not?

   If no, would you feel prepared to serve in your role if a CI were to occur? If no, why not?

4. What do you hope to learn as a result of participation in this CI Team Training Course (pre survey)? OR What did you learn as a result of participation in this CI Team Training Course (post survey)?
5. What impact (application), if any, do you feel this CI Team Training Course will have on your professional practice in the provision of direct patient care?
Critical Incident Training

Who: All perioperative staff including but not limited to preoperative, OR, and PACU nurses, surgical technicians, anesthesiologists, CRNAs, SRNAs, nurse managers, surgeons, physician assistants, surgical residents, and ancillary staff are invited to participate.

What: All perioperative staff are invited to participate in a research study directed by two of UB’s senior nurse anesthetist students. Participants will partake in an interdisciplinary critical incident training, working as a team to manage potential critical incidents in the operating room. Participants will have the opportunity to practice, enhance, and develop skills using evidence based practice related to critical incidents in the OR. Written surveys will be given to participants before and after the Critical Incident Training.

When & Where:
If you’re interested in participating, please meet in Southtowns Surgery Center’s Pre-Operative Unit at 12:00pm (date is to be determined 2 weeks prior to training). Training is expected to require between 2 and 4 hours.
Southtowns Surgery Center
5959 Big Tree Road, Suite 100
Orchard Park, NY 14127

For More Information:
Please contact:
Jeffrey Gaulrapp SRNA (jgaulrap@buffo.edu) or Rachael Schultz SRNA (rmb33@buffalo.edu)
School of Nursing
University at Buffalo
304C Wende Hall
Buffalo, NY 14214

Lunch will be provided to all participants!
Title of research study: Impact of an Interdisciplinary Simulation Training on Provider Confidence and Competence in the Management of a Malignant Hyperthermia Critical Incident.

Version Date: Version #1.0: September, 2019.

Investigator: Rachael Schultz

Key Information: The following is a short summary of this study to help you decide whether or not to be a part of this study. More detailed information is listed later on in this form.

Why am I being invited to take part in a research study?
You are being invited to take part in a research study because you are a staff member involved in the provision of direct patient care at the clinical site of interest where the study is being conducted. Study participation is open to staff employed at Southtowns Surgery Center including: Pre-operative nurses, Intraoperative nurses, Post-anesthesia care unit (PACU) nurses, Nurse manager, Charge nurse, Anesthesiologists, Certified registered nurse anesthetists (CRNAs), Student registered nurse anesthetists, Surgeons, Physician Assistants (PAs), Surgical residents, and Ancillary staff.

What should I know about a research study?
- Someone will explain this research study to you.
- Whether or not you take part is up to you.
- You can choose not to take part.
- Your participation will have no possible effect on your job because your employer will never know whether or not you participated and will not be given access to identifiable data.
- You can agree to take part and later change your mind.
- Your decision will not be held against you.
- You can ask all the questions you want before you decide.

Why is this research being done?
In the United States, over 100,000 deaths annually are the result of critical incidents (CI) and medical errors. In recognition of the role non-technical skills hold in the prevention of patient harm, especially during critical incidents, an increased emphasis is being placed on supporting the development of these skill sets amongst healthcare professionals via interdisciplinary critical
incident training. Simulation-based CI training is a means to bolster staff preparedness in managing such events, yet on-the-job multidisciplinary training sessions are frequently lacking. The intent of this study is to improve the confidence and competence of perioperative personnel in managing such events through participation in an interdisciplinary CI training event.

**How long will the research last and what will I need to do?**

We expect that you will be in this research study for 2-4 hours. You will be asked to complete a written pre-survey questionnaire. Upon collection of surveys, perioperative staff will then participate in two case studies involving simulated crises in the perioperative setting. During the case studies, staff will need to participate alongside perioperative colleagues to manage a critical event. Following the two case studies, participants will complete the written post-training survey questionnaire.

More detailed information about the study procedures can be found under “How long will the research last and what will I need to do?”

**Is there any way being in this study could be bad for me?**

The known risks related to this procedure include the following:

As a part of the critical incident simulation procedure, participants will be working with needles and risk a needle stick causing possible infection. This Physical/Medical risk is usually a Non-Serious situation. The chance that this will occur is Rare (<1%). Although an infection may cause permanent infection, although highly unlikely, most needle sticks do not and only cause minimal pain for 5-10 minutes.

More detailed information about the risks of this study can be found under “Is there any way being in this study could be bad for me? (Detailed Risks)”

**Will being in this study help me in any way?**

We cannot promise any benefits to you or others from your taking part in this research. However, possible benefits include improved confidence and competence in the management of critical incidents.

**What happens if I do not want to be in this research?**

Participation in research is completely voluntary. You may choose not to enroll in this study. Your alternative to participating in this research study is to not participate.

**Detailed Information:** The following is more detailed information about this study in addition to the information listed above.

**Who can I talk to?**

If you have questions, concerns, or complaints, or think the research has hurt you, talk to the research team at 631-742-7224 or rmb33@buffalo.edu. You may also contact the research participant advocate at 716-888-4845 or researchadvocate@buffalo.edu.
This research has been reviewed and approved by an Institutional Review Board ("IRB"). An IRB is a committee that provides ethical and regulatory oversight of research that involves human subjects. You may talk to them at (716) 888-4888 or email ub-irb@buffalo.edu if:

- You have questions about your rights as a participant in this research
- Your questions, concerns, or complaints are not being answered by the research team.
- You cannot reach the research team.
- You want to talk to someone besides the research team.
- You want to get information or provide input about this research.

**How many people will be studied?**
We expect about 20-25 people will be in this research study.

**What happens if I say yes, I want to be in this research?**
Participation will be required over a 2-4 hour period at Southtowns Surgery Center. Perioperative clinicians will receive written pre-survey questions that will be intended to gauge clinician confidence and competency in managing critical incidents (CI) prior to the CI training. Surveys will not ask for any identifying information. Surveys are expected to take between 10 and 20 minutes to complete. Upon completion, clinicians will partake in two case studies. One will occur in the operating room (OR) and the other will occur in the preoperative unit. During each case study, staff will follow a scripted scenario led by the project investigator (PI) during which a mock critical incident will occur. Perioperative staff will collaborate with colleagues to effectively manage the critical incident. Role assignment cards will be utilized during mock critical incidents to randomly assign tasks to participants. Responsibilities during the case studies include team interventions which are applicable to crises in the OR, including preparing medication, retrieving life saving equipment, and interpreting vital signs. Each case study is estimated to take 1 hour, for a total of 2 hours. Following the two case studies, participants will complete the written post-training questions, estimated to take between 10 and 20 minutes to complete. Participants will interact with their perioperative colleagues and Project Investigators.

**What are my responsibilities if I take part in this research?**
If you take part in this research, you will be responsible to: complete a written pre-survey where no identifying information will be collected. Upon collection of surveys, perioperative staff will then participate in two case studies involving crises in the operating room. Responsibilities during the case studies include team interventions which are applicable to crises in the OR, including preparing medication, retrieving life saving equipment, and interpreting vital signs. Following the two case studies, participants will complete the written post-training questions.

**What happens if I say yes, but I change my mind later?**
You can leave the research at any time it will not be held against you. Any data collected to the point of your withdrawal will be destroyed and not included in the study.
Is there any way being in this study could be bad for me? (Detailed Risks)
The known risks related to this procedure include the following:

As a part of the critical incident simulation procedure, participants will be working with needles and risk a needle stick causing possible infection. This Physical/Medical risk is usually a Non-Serious situation. The chance that this will occur is Rare (<1%). Although an infection may cause permanent infection, although highly unlikely, most needle sticks do not and only cause minimal pain for 5-10 minutes.

What happens to the information collected for the research?
Efforts will be made to limit the use and disclosure of your personal information, including research study and medical or education records, to people who have a need to review this information. We cannot promise complete secrecy. Organizations that may inspect and copy your information include the IRB and other representatives of this organization.

Your information or samples that are collected as part of this research will not be used or distributed for future research studies, even if all of your identifiers are removed.

Will I get paid for my participation in this research
You will not be paid for participating in this study.

Verbal Consent for Capable Adult
Before the study begins, the researcher will ask you to respond to the following questions:
1. Have you had a chance to read the consent information sheet?
2. Do you have any questions?
3. May we begin?
Appendix E

Malignant Hyperthermia Scenario

Nicole R. is a healthy 17-year-old male having left knee arthroscopy after an injury she sustained during lacrosse practice. She has no allergies. Past medical history includes exercise induced asthma which is well controlled with her albuterol inhaler. She is not on any other medications. She received anesthesia as a child for a tonsillectomy without complication. Her parents have had anesthesia in the past uneventfully. Nicole is scheduled to have a general anesthetic with a laryngeal mask airway (LMA).

The LMA is placed and surgery is underway.

5 minutes and the patient remains stable.
Vital signs are as follows:

SPO2: 100%
Heart Rate: 80 beats per minute
Blood Pressure: 100/50
End Tidal CO2: 35
Temperature: 98.6 F

10 minutes later, while repositioning the patient’s leg, the resident comments that the patient’s leg seems stiff and more difficult to reposition.

The vital signs are as follows:
SPO2: 95%
Heart Rate: 105 beats per minute
Blood Pressure: 189/95
End Tidal CO2: 65
Temperature: 100.8 F

The anesthesia provider asks the OR team if they have any suspicion as to what is going on.
P.I: Does anyone have any ideas about the patient condition?

The anesthesia provider announces that he believes this may be MH, and needs help stat.
P.I: What is MH?
Has anyone ever experienced a MH crisis?
What are the signs and symptoms of MH?
What do you think caused MH in this patient?
What interventions are required by the OR team during an MH crisis?
Why are we still seeing deaths from MH?
What is the dose of dantrolene? How is it prepared?
Cart arrives to room. Anesthesia provider designates themselves as the leader and distributes role assignment cards.

*PI reviews role assignment cards with participants.*

<table>
<thead>
<tr>
<th>Responsibility/Number of Cards</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>No card necessary</td>
<td>Notify surgeon to stop the procedure</td>
</tr>
<tr>
<td>Card x1</td>
<td>Assist surgeon to close wound STAT</td>
</tr>
<tr>
<td>ST only</td>
<td>Retrieve the MH cart</td>
</tr>
<tr>
<td>Verbal instruction from leader</td>
<td></td>
</tr>
<tr>
<td>Card x1</td>
<td>Call for help</td>
</tr>
<tr>
<td><em>All staff</em></td>
<td>➢ Call MHAUS hotline (1-800-644-9737)</td>
</tr>
<tr>
<td></td>
<td>➢ 911 if an ambulatory center</td>
</tr>
<tr>
<td>Card x2</td>
<td>Discontinue volatile agent (anesthetic gas)</td>
</tr>
<tr>
<td><em>Anesthesia</em></td>
<td>➢ If surgery must be continued, maintain general anesthesia with IV non-triggering anesthetics</td>
</tr>
<tr>
<td></td>
<td>➢ Obtain IV pump</td>
</tr>
<tr>
<td>Card x2</td>
<td>Hyperventilate with 100% oxygen at flows of 10L/min to flush volatile anesthetics and lower ETCO2.</td>
</tr>
<tr>
<td><em>Anesthesia</em></td>
<td>➢ Assist with intubation if patient not intubated</td>
</tr>
<tr>
<td>RN</td>
<td>➢ If available, insert activated charcoal filters into the inspiratory and expiratory limbs of the breathing circuit</td>
</tr>
<tr>
<td>Card x4</td>
<td>Draw up dantrolene</td>
</tr>
<tr>
<td><em>All staff</em></td>
<td>➢ Give IV dantrolene 2.5 mg/kg rapidly</td>
</tr>
<tr>
<td></td>
<td>➢ Repeat as frequently as needed until the patient responds with a decrease in ETCO2, decreased muscle rigidity, and/or a lowered heart rate</td>
</tr>
<tr>
<td>Card x1</td>
<td>Document</td>
</tr>
<tr>
<td><em>All staff</em></td>
<td></td>
</tr>
<tr>
<td>Card x1</td>
<td>Start additional large bore IV</td>
</tr>
<tr>
<td><em>RN or Anesthesia</em></td>
<td></td>
</tr>
<tr>
<td>Card x2</td>
<td>Obtain venous or arterial blood gas to determine degree of metabolic acidosis</td>
</tr>
<tr>
<td><em>RN</em></td>
<td>➢ Retrieve Point of Care i-STAT to process blood results</td>
</tr>
<tr>
<td><em>Anesthesia</em></td>
<td>➢ Consider administration of sodium bicarbonate 1-2 mEq/kg/dose for base excess greater than -8. Maximum dose 50 mEq</td>
</tr>
<tr>
<td>Card x3</td>
<td>Cool the patient if core temperature is greater than 39°C (102.2°F) until the temperature has decreased to &lt;38°C (100.4°F)</td>
</tr>
<tr>
<td><em>All staff</em></td>
<td>➢ Expose patient to ambient air</td>
</tr>
<tr>
<td></td>
<td>➢ Cool IV solution</td>
</tr>
<tr>
<td></td>
<td>➢ Ice packs to groin, axilla, around head</td>
</tr>
<tr>
<td></td>
<td>➢ Avoid hypothermia</td>
</tr>
<tr>
<td>Card x2</td>
<td>Insert</td>
</tr>
<tr>
<td>---------</td>
<td>--------</td>
</tr>
<tr>
<td></td>
<td>• Foley catheter to perform cold lavage to bladder</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Card x2</th>
<th>Treat hyperkalemia</th>
<th>RN or Anesthesia</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Calcium chloride 10 mg/kg or Calcium gluconate 10-50 mg/kg</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Regular insulin 10 units IV in 50 ml of 50% glucose or if pediatric patient: 0.1 unit regular insulin/kg IV and 0.5 grams/kg of dextrose</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Albuterol (beta agonist)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Card x1</th>
<th>Check glucose levels hourly</th>
<th>RN or Anesthesia</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Card x1</th>
<th>Treat dysrhythmias with standard medication but avoid calcium channel blockers</th>
<th>RN or Anesthesia</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Card x1</th>
<th>Diurese to &gt;1 ml/kg/hr urine output</th>
<th>RN or Anesthesia</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Monitor color of urine. “Cola” colored urine indicates myoglobinuria</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Administer Furosemide to reduce fluid overload and promote excretion of K+ and Na+ and to prevent myoglobin-induced renal failure</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Card x1</th>
<th>Consider arterial line/ central line</th>
<th>All staff</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Obtain arterial line/central line kit</td>
<td></td>
</tr>
</tbody>
</table>

| No card necessary | Continue to follow heart rate, core temperature, ETCO2, minute ventilation, blood gases, K+, CK, urine myoglobin, and coagulation studies as warranted by the clinical severity of the patient |

<table>
<thead>
<tr>
<th>No card necessary</th>
<th>When stable, transfer to hospital for intensive care monitoring for at least 24 hours. Stability:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• ETCO2 is declining or normal</td>
</tr>
<tr>
<td></td>
<td>• Heart rate is stable or decreasing with no signs of ominous dysrhythmias</td>
</tr>
<tr>
<td></td>
<td>• Hyperthermia is resolving</td>
</tr>
<tr>
<td></td>
<td>• Generalized muscle rigidity has resolved if present</td>
</tr>
</tbody>
</table>
STUDY EXEMPTION

October 1, 2019

Dear Rachael Schultz,

On 10/1/2019, 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>The Impact of an Interdisciplinary Simulation Training on Provider Confidence and Competence in the Management of a Malignant Hyperthermia Critical Incident</td>
</tr>
<tr>
<td>Investigator:</td>
<td>Rachael Schultz</td>
</tr>
<tr>
<td>IRB ID:</td>
<td>STUDY00003843</td>
</tr>
<tr>
<td>Funding:</td>
<td>None</td>
</tr>
<tr>
<td>Grant ID:</td>
<td>None</td>
</tr>
<tr>
<td>IND, IDE, or HDE:</td>
<td>None</td>
</tr>
</tbody>
</table>

Documents Reviewed:
- Recruitment Flyer Schultz, Category: Recruitment Materials;
- Scientific review form.pdf, Category: Other;
- MH Scripted Scenario and Role Designation, Category: Other;
- Survey Questionnaires. Appendices A-B., Category: Surveys/Questionnaires;
- HRP 503 Schultz, Category: IRB Protocol;
- HRP 502 Consent, Category: Consent Form;

The University at Buffalo Institutional Review Board has considered the submission for the project referenced above on 10/1/2019 and determined it to be Exempt.

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.

UBIRB exemption is given with the understanding that the most recently approved procedures will be followed and the most recently approved consenting documents will be used. If
modifications are needed that may change the exemption determination, please contact the UB IRB Office. Also, see the Worksheet: Exempt Determination (HRP-312) for information on exemption criteria and categories.

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 Reportable New Information Smart Form.
   - Project closure/completion by submitting a Continuing Review/Modification/Study Closure Smart Form in Click.

3. Ensuring that the protocol is followed as approved by UBIRB unless minor changes that do not impact the exempt determination are made.

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 any questions, please contact the UBIRB at 716-888-4888 or ub-irb@buffalo.edu.
Appendix G
Oral Defense PowerPoint Presentation
Background & Significance

Teamwork

Purpose & Objective

Theoretical Framework: Social Learning Theory

MALIGNANT HYPERTHERMIA CRITICAL INCIDENT TRAINING
The Literature Review

Support for the DNP Project
- The review of the literature demonstrates that interprofessional simulation has a beneficial role in the management of malignant hyperthermia by improving teamwork, provider competency, and staff confidence.
- Future implications of these results include increased use of scheduled interprofessional malignant hyperthermia simulations.
- The results of the reviewed literature suggest the continued use of interprofessional malignant hyperthermia simulations, especially in facilities with limited resources, preceptors, and patient lines.

Gaps & Limitations
- The literature lacks experimental studies examining the effect of interprofessional simulation on nurse confidence and competency, as compared to a control group.
- Offline reviewed literature, the majority of the data was qualitative.
- Most of the studies were specific to one facility’s perioperative department, and did not include a large-scale study that measured multiple OR staff at various facilities.
- Despite consistent results suggesting the positive effect of interprofessional simulation, these studies are poorly powered, therefore limiting generalizability.

In Summary
- The review of the literature demonstrates consistent support of interprofessional malignant hyperthermia simulation.
- Provider benefits include improved confidence and competency, empowerment, and collaborative decision-making.
- Improved teamwork, communication, and collaboration.
- Facility benefits include improved effectiveness and improved policies for Malignant Hyperthermia management.
- In effect, the literature supports the effectiveness of interprofessional malignant hyperthermia simulation.

Methodology
Design
- Qualitative methodology using mixed-methods assessment to address the research question.

The outcome was:
- Improved interprofessional communication and collaboration, in an MDT, with improved teamwork and decision-making.
- Enhanced patient safety and staff awareness.
- Effective malignant hyperthermia team management and appropriate patient outcomes.

The outcomes were:
- Improved interprofessional communication and collaboration, in an MDT, with improved teamwork and decision-making.
- Enhanced patient safety and staff awareness.
- Effective malignant hyperthermia team management and appropriate patient outcomes.
Results
True Competence: Pre-Intervention

Prior to the MH Critical Incident Training, clinicians’ competence was lacking.

- Difficulty in decision making
- Inadequate response criteria
- Poor management of critical situations
- Insufficient knowledge and skills

Out of the possible 100 points, the mean competence score was 63.7 (SD = 15).

Results
True Competence: Post-Intervention

Post-MH CI Training, participant scores significantly improved.

Out of the possible 100 points, the mean competence score increased to 94.2 (SD = 6).

Results
Confidence and Perceived Competence: Pre-Intervention

Prior to the CI Training, clinicians’ confidence and perceived competence were low.

- High risk perception for severe MH, leading to inappropriate actions and lack of preparedness
- Overestimation of MH risk
- Insufficient preparation for MH management

The mean competence score was 52.9 (SD = 7.5).

Post-CI Training, the mean increased to 68.1 (SD = 7.3).
Results
Confidence and Perceived Competence

Results
Confidence, Perceived Competence, and True Competence

Results
Correlation Among Paired Samples

Results
Satisfaction and Self-Confidence in Learning Tool
Results
Qualitative Analysis
There was a general poor response to the open-ended questions intended for the qualitative analysis. No one left a comment.

The patient in the scenario presented was:
• T. The patient was intubated before the team arrived due to the rapid progression of the critical event.

Conclusion
Deliverables
- Enhanced learning by providing meaningful feedback and opportunities for learners to apply what they learn.
- Increased understanding of the critical incident through the use of simulation.
- Improved communication and team performance.
- Enhanced confidence in managing critical incidents.

Conclusion
Strengths
- The interaction between the nurse and the patient was genuine and respectful.
- A high level of respect and empathy was shown by the staff.

Conclusion
Weaknesses
- A small sample size was used, which could limit the generalizability of the findings.
- Participants were not the same in each scenario, which may have affected the reliability of the data.

Successful critical incident management increases the likelihood of patient survival.
References

[References list]

MALIGNANT HYPERTHERMIA CRITICAL INCIDENT TRAINING
Appendix H

Executive Summary and Recommendations

This study shows promise with regards to the efficacy of staff training to improve the individual clinicians’ confidence and competence in the management of a CI, while identifying site specific deficiencies to be addressed that may avert untoward patient outcomes in the event a CI were to occur.

Results from pre-post intervention surveys completed by study participants support the hypothesis that participation in a multidisciplinary CI team training event improves clinician confidence, perceived competence, and competence in the management of a CI.

Mean confidence and perceived competence scores improved from 3.32/5 (52.9/80 total) pre-intervention to 4.26/5 (68.1/80 total) following the CI training; statistically significant results: t(15) = -3.9, p = 0.001. Similarly, mean competence scores increased from 63.7% on the pre-test to 94.2% on the post-test, a 30.5% improvement; also statistically significant: t(15) = -7.9, p = 0.000.

Mean score from the NLN Student Satisfaction and Self Confidence in Learning Tool was 61.87, with an average per-item rating of 4.7/5, indicating a high degree of learner self-confidence following the training as well as overall satisfaction with the educational methodology employed by the PIs to conduct the CI event.

Recommendations based on observations and participant feedback, from the CI training:

- Clinicians’ confidence and competence levels benefited from the interprofessional critical incident training, therefore an annual Interprofessional Malignant Hyperthermia Critical Incident Training is recommended.
- Institution did not possess:
Means for sterile reconstitution of dantrolene
- i-Stat/Point of Care device for intraoperative lab work processing
- Intravenous pumps for medication infusions required for hospital transfer
- Arterial line kit
- Central line kit
- Charcoal filters for anesthesia machine

**Strongly recommend addition of these equipment and supplies to facility stock:**
- Means for sterile reconstitution of dantrolene (sterile basin or sterile water vials)
- Means for intraoperative lab work processing (i-Stat or Point of Care device)
- Charcoal filters for anesthesia machine
- Intravenous pumps for medication infusions required during hospital transfer

**Moderately recommend addition of these equipment and supplies to facility stock:**
- Arterial line kit
- Central line kit

- MH cart lacked medications (vials of sterile water, Calcium Chloride, Albuterol, and Lasix), sterile basins (if not using sterile water vials), and charcoal filters. **Recommend addition of these medications and supplies to MH cart.**

- Staff unable to unanimously identify which hospital (Buffalo General Hospital) patient would be transferred to during prolonged resuscitation. **Recommend posting this location and contact information on MH cart.**