A Multimedia Educational Module on the Best Practices of Anesthesia Patient Safety for Quantitative Neuromuscular Monitoring

by

Anthony Hernandez, DNP, CRNA, BSN

Cedar Crest College School of Nursing, Nurse Anesthesia Program

An evidence-based scholarly project submitted

in fulfillment of the requirements

for the degree of

Doctor of Nursing Practice

Author Note

The author has no known possible or perceived conflicts of interest to disclose.

There are no grants, fellowships, awards, or financial incentives received for this research.

Correspondence concerning this article should be addressed to Anthony Hernandez, 3 East Lexington Street, Allentown, PA 18103. Email: akh20108@yahoo.com

A Multimedia Educational Module on the Best Practices of Anesthesia Patient Safety for Quantitative Neuromuscular Monitoring

by

Anthony Hernandez, DNP, CRNA, BSN

Cedar Crest College: School of Nursing, Nurse Anesthesia Program

I certify that I have read this Doctor of Nursing Practice scholarly project and that in my opinion it meets the academic and professional standards required by Cedar Crest College: School of Nursing for the degree of Doctor of Nursing Practice.

Doctor of Nursing Practice degree with the guidance and supervision of the following:

Dr. Bernard J. Gilligan III, DNP, CRNA, CHSE – Program Director, DNP Project Supervisor

Dr. Stephanie B. Woodruff, DNP, MSN, CRNA – Former Anesthesia Program Director and DNP Project Mentor

Dr. Catherine Zurawski, DNP, CRNP, FNP-C – Director of Graduate Nursing Programs and DNP Program Director

Dr. Mae Ann Pasquale, Ph.D. RN – DNP Project Chair

Dedication

I would like to sincerely thank my family for all the help and assistance they have given me this past couple of years. It has provided me with the opportunity to attend graduate school and to pursue a personal aspiration of mine. This would not be possible without the help and dedication I have received from everyone. I want to personally thank my wife Kyla for having the mental and physical fortitude to endure this temporary journey with me, as well as in supporting me throughout this whole process. We surely wouldn't be in this position in our life if it wasn't for you; thank you for helping me aspire to be the best that I can be and for making a better life for us. When I started the DNP NAP Program my daughter Emily was 3 years old and Autumn was 6 months old. They are now almost 6 years old and 3 years old respectively. Having almost finished the program, I am again going to be blessed with another child, whom will be with us shortly! I can only hope that one day my children can view this manuscript and it can be used as an exemplar of what hard work and perseverance can provide for you when you apply yourself, because anything is possible when you put your mind to it.

Abstract

Anesthesia providers have a duty to ensure patient safety is maintained and continuously updated on evidence-based practices (EBPs). E-learning has proven to be an efficient means of translating EBP's into the clinical arena (Elkman, 2018). Amidst the COVID-19 pandemic, four student registered nurse anesthetists collaborated to create a robust multimedia simulation based educational module, guided by the Cognitive Theory of Multimedia Learning's theoretical framework, about current EBP's during the perioperative period. The purpose of this Doctor of Nursing Practice (DNP) project was to improve provider's knowledge on topics of anesthesia safety and to create a willingness to change one's clinical practice. Although four different patient safety topics were reviewed in the module, the main focus of the DNP project is related to the use of quantitative neuromuscular monitoring. From January 23rd – February 5th, 2021 a convenience sample of 24 anesthesia providers completed a pretest, a 12-minute educational module and posttest to assess knowledge attainment and willingness to utilize the EBP recommendations within one's clinical practice. The results of this DNP project concluded that the proportion of correct answers on the pretest to posttest increased by 26% (63% to 89%) and incorrect answers decreased by 27% (38 to 11%). McNemar's analysis exhibited a two tailed exact significance p value of < 0.001 (95% CI). Also, all 24 participants reported a 100% willingness to make personal practice changes. An odds ratio of 4.8 was acquired, indicating that participants were 4.8x more likely to get the correct answer on the posttest then the pretest, thus increasing a provider's knowledge on evidence-based anesthesia patient safety practices. Although the limitations of the project hinder generalizability, there is clinical significance. Acquiring clinical significance with this project is just as valuable as obtaining statistical significance because knowledge acquisition resonates and manifests throughout the healthcare

arena as genuine and palpable effects that influence the everyday lives of patients and the healthcare decisions made on their behalf (Polit & Beck, 2017).

Keywords: education, multimedia, neuromuscular, qualitative, quantitative

Title

A Multimedia Educational Module on Best Practices of Anesthesia Patient Safety

PICO Question

In anesthesia providers, does a multimedia simulation-based educational intervention increase knowledge about current best practice for patient safety, monitoring, and administering medications in accordance with evidence-based practice guidance?

Table of Contents

Figures

Appendices

A Multimedia Educational Module on the Best Practices of Anesthesia Patient Safety

Chapter I: Introduction and Overview of the Problem of Interest

Today's contemporary anesthesia practice prides itself on delivering an unprecedented level of analgesia, amnesia, sedation, hypnosis, and akinesia then once ever historically available. From the days of intravenous curare to cisatracurium administration for medically induced paralysis, the pharmacological profile of these drugs have become exponentially safer. However, in today's fast paced and production pressured surgical milieu, an increased proportion of patients are experiencing a post-surgical phenomenon known as residual neuromuscular blockade (rNMB). In fact, it has been estimated that approximately 20% - 60% of surgical patients that receive neuromuscular blocking agents (NMBAs) as a part of their anesthetic care experience rNMB (Wiatrowski et al., 2018). Simply stated, rNMB results from the inadequate recovery time from NMBAs and has been shown to cause incomplete or complete upper airway obstruction, hypoventilation, hypoxia, hypercarbia, reintubation, silent aspiration, post-operative respiratory failure, and possibly death (Dunworth et al., 2018; Wiatrowski et al., 2018). Adverse respiratory events (ARE) from rNMB leads to increased staff interventions, total hospital costs, admission rates, postanesthesia care unit (PACU) length of stay, and overall hospital length of stay (Fortier et al., 2015; Grabitz et al., 2019; Rudolph et al., 2018).

Currently within the United States (US), the most traditional and predominately utilized method to titrate and assess the reversal of NMBA is via a peripheral nerve stimulator (PNS) and train of four (TOF) count (Dunworth et al., 2018). Considered the gold standard, the use of a PNS provides qualitative data that relies on the examiners subjective visual and/or tactile assessment of the patient's neuromuscular response in order to determine the depth of neuromuscular blockade. However, the use of a PNS is considered to be highly subjective with a wide range of inter-rater reliability (Thilen et al., 2018). The subjectivity of PNS measurements

assessed during a pivotal junction in anesthesia care can increase the incidence of rNMB and risk of postoperative pulmonary complications.

Recently, there has been an increasing call for the use of quantitative assessments to guide both the administration and reversal of NMBA (Dunworth et al., 2018)). In fact, Naguib et al. (2018) published a consensus statement that made recommendations for anesthesia providers who use NMBAs to use objective quantitative neuromuscular monitoring (QNM) as best practice; this should be the only methodology utilized for assuring complete recovery of neuromuscular function. Quantitative neuromuscular monitoring is available in multiple forms; however, acceleromyography (AMG) and electromyography (EMG) are the two modalities commonly utilized within the clinical setting. These QNM methods allow for an objective real-time measure of neuromuscular responses to TOF stimulation and is reported to be a more accurate method when compared to the PNS in determining an appropriate reversal regimen (Grabitz et al., 2019).

Background and Significance

In clinical practice, monitoring of NMBA using TOF stimulation is often used to determine the correct timing and dose of reversal agents for neuromuscular blockade. According to Nagelhout and Elisha (2018), TOF is a series of four twitches with a 0.5 second pause between impulses at a strength of 2Hz. Each twitch is referred to as T1 to T4 respectively. When all twitches are abolished, there is 100% blockade and when 4 twitches are elicited (and of equal strength), the best assessment the clinician can conclude is that there is $\leq 70\%$ neuromuscular receptor blockade. To complicate the subjectivity of the assessment further, when non-depolarizing neuromuscular agents are used, there is the concept of fade. Fade is described as the inability to maintain a consistent strength or response to an impulse/stimulus delivered by clinical monitoring equipment (Nagelhout & Elisha, 2018).

Logistically, these TOF counts are obtained at different anatomical landmarks depending on the modality utilized; however, evaluation of the values remains the same. The most commonly assessed muscle is the facial nerve via the orbicularis oculi muscle (during induction) or the ulnar nerve via the adductor pollicis muscle (during emergence). These locations are chosen because their tissue saturation of muscle relaxant correlates with the laryngeal/pharyngeal muscles or the diaphragm, respectively.

By definition, full recovery from muscle relaxants is defined as a TOF recovery ratio of ≥ 0.9%; however, qualitative assessment via a PNS can only measure the gross saturation of receptor sites to a depth of ≥ 0.7% blockade (a gap of 0.6% according to the consensus of full recovery) (Nagelhout & Elisha, 2018). Comparatively, objective measurements using QNM can measure a finer degree of receptor site saturation, up to a ratio of ≤ 1.0%. According to Dunworth et al. (2018), when patients have a TOF recovery ratio of < 0.9% then the phenomenon of rNMB is clinically present and inadequate pharyngeal and laryngeal musculature weakness will be present.

When a clinician assesses a TOF ratio in a patient receiving NMBAs, there are several responsibilities one must perform with these measures. For example, based on the TOF ratio, a clinician can redose the paralytic to maintain paralysis, reverse the paralytic with the most commonly utilized reversal agents known as neostigmine/glycopyrrolate or suggamadex (depending on the utilization of aminosteroid or benzylquinolones), hold the dose due to adequate depth of paralysis, or simply negate paralytic reversal entirely due to the pharmacodynamics of the medication (Nagelhout & Elisha, 2018). The qualitative and subjective assessment of the PNS is often questionable and has led to a wide variety of interpretation/differentiation throughout clinical practice and research due to the poor level of inter-rater reliability and the inability to detect fade by clinicians (Dunworth et al., 2018).

Bhananker et al. (2015) conducted a prospective observation cohort study in a Level I trauma center and a multitude of referral hospitals in the pacific northwest area in order to assess the level of agreement and/or disagreement of 75 anesthesia providers regarding a simulated TOF count generated by a PNS. There were 687 separate TOF count measurements. When the PNS counts elicited a TOF value of 0 or 4, there was 97% agreement; however, if the TOF value was 1, 2, or 3 twitches, there was a 36% agreement (Bhananker et al., 2015). Also, for 96% of the time clinicians assessed a TOF value that was actually higher than what was elicited (indicating a deeper level of paralysis then one perceived) (Bhananker et al., 2015). Variability such as these findings has led to the inappropriate dosing of reversal agents, increased dosing for nondepolarizing muscle relaxants, and even the lack of needed reversal agents (Sorin & Kopman, 2017). It has also been found that inappropriate dosing of NMBA or even reversal agents (either with high or low doses) has also led to the incidence of rNMB. Fortier et al.'s (2015) study succinctly states that:

> Although the use of conventional neuromuscular reversal agents such as neostigmine is recommended, their use does not appear to markedly reduce the incidence of rNMB, as defined by a TOF ratio of < 0.9, during routine practice. In our study, among patients receiving NMB reversal with neostigmine, residual paralysis was present in 64.6% at tracheal extubation and 59.7% at PACU arrival. This suggests that one cannot rely on neostigmine alone to avoid rNMB. Instead, other factors such as precise titration of nondepolarizing neuromuscular blocking drugs, clinician attitude regarding the importance of avoiding rNMB, and situational awareness of surgical timing are likely important (p. 369 – 370).

Although Fortier et al. (2015) states that rNMB is multi etiological, it is paramount to emphasize that the intraprofessional dynamic of clinician's attitude and confidence levels plays a pivotal

role in attenuating rNMB. To support this notion, the American Association of Nurse Anesthetists (AANA) conducted an international survey that included a diverse sample of anesthesia providers across the entire US and Europe. The findings revealed that 77% of the respondents perceived rNMB to be a significant public health problem; however, there remains some opposition, resistance, and pushback to the practice of QNM (Wiatrowski et al., 2018).

As well, an international study performed by Naguib et al. (2019) sought to find a common denominator to explain the lack of QNM integration. The study also assessed the perception of clinician confidence and knowledge related to neuromuscular monitors. A nine-question survey was distributed to a total of 2,560 people over 80 countries, of which, 1,629 respondents were anesthesiologists. The findings concluded that anesthesiologists expressed 'overconfidence', which may have played a large part of the reason for the lack in integration of perioperative QNM (Naguib et al., 2019). Multiple studies also attest that more effective methodologies of monitoring neuromuscular blockage, such as QNM, should become the standard of care to reliability attenuate the incidence of rNMB (Bhananker et al., 2015; Dunworth et al., 2018; Fortier et al., 2015; Todd et al., 2014; Tajaate et al. 2018; Thilen et al., 2018).

Many arguments have been proposed to counter the incidence of rNMB. For example, Tajaate et al. (2018) purports that allowing a longer recovery time to spontaneous recovery and allowing for the incorporation of longer reversal intervals is key to preventing rNMB. However, today's surgical milieus are fast paced and production pressured, often requiring an institutional culture and attitude change that supports Tajaate et al.'s (2018) recommendations. However, Tajaate et al. (2018) also attests that reversal intervals that exceed 15 minutes are often poorly tolerated by the patient and staff, thus putting the patient at greater risk for self-extubation, desaturation, increased coughing, and increased surgical site stress.

Although experts advocate for allowing more time to spontaneously recover from anesthesia, one of the largest hurdles to actually modulating change is to grossly modify clinician attitude, knowledge, and institutional culture (Todd et al., 2014). Dunworth et al. (2018) attests that change agents must remain cognizant of these dynamics because the implementation of new technology challenges the status quo by introducing new technical obstacles and demands a cognizant/proactive alteration in one's individual ideologies and behaviors.

The Institute of Medicine (IOM) set a goal that by 2020, 90% of all clinical decisions are to be supported by accurate and timely evidence-based research; however, there appears to be a multitude of barriers to successful evidence-based practice (EBP) implementation and utilization (Lehane et al., 2019). Shayan et al. (2019) conducted a systematic review to determine barriers to EBP implementation among nurses in low and middle-income countries. The findings revealed three main themes (1) institutional-related barriers (i.e., low resources, limited access to information, or support); (2) interdisciplinary barriers (i.e., communication problems between academic and clinical practice environments, lack of teamwork, and societal images of the nursing profession); and (3) nurse-related barriers (i.e., limitations in scope of practice, time, or knowledge of EBP). By remaining cognizant of these barriers and intervening in these areas when appropriate, knowledge dissemination of high-quality research findings can be integrated into clinical practice as a means of improving patient outcomes and closing the existing evidence-to-practice gap.

At this junction, it is important to note that the author's original Doctor of Nursing Practice (DNP) project was specifically designed to examine if a practice change using intraoperative QNM would reduce length of stay in the PACU for patients undergoing laparoscopic procedures, however, the COVID-19 pandemic interrupted the ability to carry out the DNP project in the clinical setting. Recognizing that QNM is the best method to assess

neuromuscular function recovery and reduce perioperative rNMB (Sager et al., 2019), it became especially important to continue to work to educate anesthesia providers about the use and benefits of QNM. Recognizing the difficulties the pandemic placed upon healthcare systems worldwide, and the increased stress and demands placed specifically on anesthesia care providers to ensure patient safety, determining an alternative way to disseminate evidence-based information that can ensure the best practices are continued even in unconventional times became a priority.

As a way of determining the best ways to improve knowledge and education in anesthesia providers, Castanelli and colleagues (2015) surveyed 364 anesthetists' attitudes to clinical teaching and medical education theory and evidence. Noticeable findings revealed that many anesthetists (greater than 50%) have never assessed a medical education article and that a vast knowledge-practice gap exists. Within the study, and from anecdotal reports, this barrier is largely attributed to the lack of available time due to clinical commitments. Traditional modalities of learning such as reading relevant literature has proven to be not only time consuming, but inflexible in today's fast paced healthcare systems. As well, this method does not touch upon any, if at all, aspect of the cognitive (thinking), psychomotor (doing), and affective (feeling) domains of learning.

Given today's technological age, there are a plethora of educational avenues to learn from that are asynchronous and provide a level of flexibility in clinician teaching. Some contemporary pedagogical learning modalities that have shown to be effective include standalone sessions, clinical and/or curriculum integration, journal clubs, multimedia presentations, online workshops, lectures, seminars, and simulation (Young et al., 2014). All modalities incorporate different techniques that foster intrapersonal development of the three

educational domains, as well as the knowledge, skills, and attitudes required to obtain both technical and nontechnical skills (Robertson et al., 2017).

According to Rouleau et al.'s (2019) systematic review of the effects of e-learning on the continuing education context of nursing care, the main outcome of the review found that the greatest improvement was in nursing skills, followed by knowledge, and an overall positive perception of multimedia education. As a way of moving the aforementioned DNP project forward amidst a global pandemic, a group of senior nurse anesthesia program DNP candidates worked together to create a multimedia module that would incorporate education on multiple topics related to patient safety. It was important that this module could be delivered in a convenient, online format in a short amount of time as this approach has the potential to actually increase the number of participants, since it is not limited by geography or clinical site.

After a thorough review of the literature and numerous anecdotal reports with key stakeholders in two separate healthcare institutions, four relevant topics on patient safety with patients undergoing anesthesia were determined. These topics included (1) prevention of ocular injury; (2) intraoperative multimodal opioid-sparing management with lidocaine infusions; (3) QNM for NMBAs; and (4) timing and dosing of reversal agents. Patient safety is of great importance to every organization when anesthesia services are provided.

PICO Question Guiding Inquiry

The PICO question that guided the overall DNP Project is: In anesthesia providers, does a multimedia simulation-based educational intervention increase knowledge about current best practice for patient safety, monitoring, and administering medications in accordance with evidence-based practice (EBP) guidance? Although the multimedia simulation-based educational intervention included multiple patient safety topics, this manuscript will mainly focus on and describe the findings that pertain to the author's specific component (i.e., QNM), as

well as the efficacy of the robust multimedia simulation based educational module's ability to disseminate contemporary EBP recommendations.

System and Population Impact

According to Botney (2008), anesthesia practitioners have been striving to improve patient safety for decades because anyone who undergoes anesthesia is at a proportionally higher risk for enduring injuries, being a recipient of human error, and ultimately death. Mortality for patients today undergoing anesthesia is 1:250,000 in healthy individuals; however, this mortality rate increases to 1:10,000 – 1:15,000 as the patient population becomes older with comorbidities (Botney, 2008).

According to Sager et al. (2019) rNMB can have a plethora of consequences on the healthcare delivery system. Residual neuromuscular blockade manifests into a higher utilization of resources following PACU discharge, as well as a greater proportion of patients that require respiratory therapy, supplemental oxygen, antibiotics, and interventions by other healthcare members (i.e., anesthesiologists) (Sager et al., 2019). Fortier et al.'s (2015) study found via negative binomial regression that there was a statistically significant association between TOF values and nurse-to-bed visits in PACU. When there was an increase in the TOF ratio by 0.1 (meaning the patient is less paralyzed) there were 4% fewer nurse-to-bed visits ($p = 0.013$) (Fortier et al., 2015).

As healthcare continues to improve its delivery of anesthetic care, it is imperative to focus on minimizing the incidences of preventable problems. According to Farhan et al. (2014) the average cost of treating adverse respiratory events (AREs) following surgery is $62,704 versus $5,015 for uncomplicated surgery. In the US alone, 92,000 additional ICU admissions occur because of ARE's following surgery, costing approximately $3.42 billion dollars per year to the economy (Farhan et al., 2014). According to Naguib et al. (2018), 14% - 30% of patients

who develop pulmonary complications die within 30 days post major surgery, length of stay may be increased by up to 17 days, all awhile increasing the overall healthcare costs to up to > $25,000 per hospital admission. Unfortunately, hospital systems can only absorb so much of these healthcare costs (especially for the uninsured), therefore, the remainder is ultimately dispersed and absorbed by the aggregate populations that reside in the surrounding communities.

Purpose and Objectives

The purpose of the author's DNP project is to improve anesthesia providers' assessment practices and knowledge regarding the use of QNM for monitoring and reversal of NMBAs through a multimedia simulation-based educational intervention that is congruent with expert recommendations and current EBPs. Current evidence has reported that subjective, qualitative monitoring is not predictive of adequate neuromuscular recovery and its use should be abandoned (Dunworth et al., 2018). Two specific objectives of this project include (1) within a 2-week time frame, participant anesthesia providers that enrolled in the educational module will represent at least 50% of the overall anesthesia practitioners, as evidenced by the data received on the total emailed participant list, showing the importance of integrating QNM within clinical practice; and (2) within a 2-week time frame, participant anesthesia providers that enrolled in the educational module will represent at least 50% of the overall anesthesia practitioners, as evidenced by the data received on the total emailed participant list, showed an increased knowledge related to the level of paralysis when 4/4 twitches are elicited.

Anesthesia providers will undoubtedly complete the surveys at their own leisure, at home, or possibly at work. Gathering this information is paramount in acquiring a foothold to implement a quality improvement (QI) initiative, that focuses on perioperative patient safety which includes QNM, in the foreseeable future. Patients will presumably benefit from a more

reliable monitoring technique to assess neuromuscular function recovery that assures improved safety and reduces the occurrence of critical respiratory events in the perioperative period.

Chapter II: Review of the Evidence/Literature

Search Methodology

To answer the proposed PICO question, a thorough search of relevant research on the topic of QNM was first conducted with Google Scholar in an attempt to capture a broad range of studies. Then, the Cumulative Index to Nursing and Allied Health Literature (CINAHL), PubMed, BioMed Central, EBSCO host, SAGE Journal, Springer Link, and the Cochrane library databases were all utilized. Key words included "acceleromyography," "neuromuscular," "residual," "train of four," "multimedia," "electromyography," "complications," "paresis," "education," "monitoring," "quantitative," "qualitative," and "blockade." A combination of Boolean operators (i.e., AND, OR, NOT) and truncation were also utilized in order to populate the different typologies between terms and to narrow or expand the total articles found, of which approximately 25 - 50 reports were located. A hand search of these titles to determine which articles were relevant was then performed. The search also included and excluded peer reviewed studies ≤ 5 years and then ≤ 10 years in an effort to capture the most recent research. Approximately 20 – 25 studies were found utilizing the search engines; however, the reference lists of multiple studies were extensively searched for relevant articles. If public access was not available then the college's educational facilities were accessed to obtain the article.

After critical appraisal and synthesis of the evidence, there are a number of reoccurring themes that can be applied to today's clinical practices on monitoring for rNMB. Fortunately, many of the publications were within the past five years, offering contemporaneous analysis and applicability for modern practices. In order to acquire a greater understanding of rNMB and to foster a holistic understanding of its magnitude, it is imperative to conceptualize the multifaceted dynamics of who, what, where, when, and why rNMB manifests into the problem it is today.

Findings

Who is at Risk for rNMB?

After a thorough review of the evidence, studies have shown that a particular subset of patient demographics/population and anesthetic case types were at an increased risk for rNMB. Adults undergoing intrabdominal surgery via the laparoscopic approach were found to have a clinically significant incidence in rNMB; as well as patient cofounders of an American Society of Anesthesiologist Physical Status (ASA-PS) score of II, increased age, timing of last dose of NMBA, body temperature, and gender (Fortier et al., 2015; Khamtuikrua et al., 2017; Sager et al., 2019). A prospective observational study of adults scheduled for otorhinolaryngology, breast, open abdominal, laparoscopic abdominal surgeries, or extremity surgery showed significant risk factors for rNMB, such as the female gender, patients of increased age, ASA-PS II compared to ASA-PS I, < 30 min from last dose of NMBA, and body temperature on arrival to the PACU (Khamtuikrua et al., 2017). Of the 209 patients evaluated, there was a rNMB probability of 53.1% (Khamtuikrua et al., 2017). Sager et al. (2019) found that patients scheduled for open or laparoscopic abdominal surgery had an increased probability/odds ratio of having rNMB at tracheal extubation. Patient demographics included male gender, an increased BMI, and community hospital performed surgeries (Sager et al., 2019). Critical appraisal of the existing evidence had shown one consistent variable, the laparoscopic approach, so this surgical technique was included into the patient scenario on the multimedia educational module.

What and How are there Risks for rNMB?

Many research articles strive to find out the etiology behind what and how there are risks for rNMB. A prospective observational interrupted time series study helped address these questions related to rNMB (Rudolph et al., 2018). Medically induced neuromuscular blockade is inherently reversed at the conclusion of surgery. The most commonly utilized agent for

medically induced paralytic reversal is neostigmine/glycopyrrolate; however, this agent itself is not the most beneficent drug if administered without vigilance. Overdosing and/or underdosing of this agent can lead to residual and excessive muscle relaxation due to its mechanism of action; which is also greatly confounded by the subjectivity and level of inter-rater reliability of the PNS. Rudolph et al. (2018) examined how an educational QI initiative, based on TOF values and dosing, can improve the utilization and administration of neostigmine/glycopyrrolate. Rudolph et al. (2018) analyzed 12,025 surgical cases and found postoperative pulmonary complications occurred in 220 (7.5%) of 2,937 cases (pre-QI intervention) versus 568 (6.3%) of 9,088 (post-QI intervention). A statistically significant difference in lowered risk of postoperative pulmonary complications ($p = 0.001$), lower costs ($p < 0.001$), and a shorter duration of hospital stay ($p < 0.001$) after implementation of the QI intervention was found (Rudolph et al., 2018). It is imperative to realize that an accurate assessment of neuromuscular function dictates the amount of reversal agent that needs to be administered; thus, indirectly affecting the incidence of rNMB. Subsequently, the study attests to what the risks are by finding out that the QI intervention had clinically significant shorter hospital stays, thus decreased hospital costs (Rudolph et al., 2018). The lack of vigilance, subjectivity of the PNS, and lack of anesthesia provider knowledge demonstrates how the risks can manifest exponentially.

Where and When are there Risks for rNMB?

Within the literature, rNMB has been witnessed during a specific time period and in a specific location. Answering these questions related to rNMB is paramount to understanding the appropriate setting and time to remain cognizant and vigilant; as well as the possible resources and stakeholders to sequester. Naturally, rNMB is occurring in the immediate postoperative period with the use of QLNM. Sager et al.'s (2019) study of 225 adults undergoing open or laparoscopic surgery found that perioperative patients had a TOF ratio of < 0.9 % in 64.7% of

cases, with a ratio as low as < 0.6% in 31.0% of the patients. Grabitz et al.'s (2019) retrospective observational study found there were 457 or 20.5% of the sample size was diagnosed with postoperative rNMB in the PACU; which was associated with an increase in hospital costs and a 3-fold increased likelihood of admission to the intensive care unit. Fortier et al. (2015) found that the incidence of rNMB was present in 63.5% of patients post extubation and 56.5% of patients on arrival to the PACU.

Not only does rNMB precipitate ARE's, but it has also been associated with a mean increase of PACU length of stay of 80 minutes (Grabitz et al., 2019). Fortier et al.'s (2015) study had found that statistically for every increase of 0.1% (less paralysis) of the TOF ratio at tracheal extubation, there was a significantly reduced requirement for oxygen administration once within the PACU. Although Sager et al.'s (2019) exploratory analysis did not reveal statistically significant differences between PACU length of stay, the researchers did acknowledge that additional studies have shown an increased PACU length of stay from 243 to 323 mins ($p = 0.026$). Thilen et al.'s (2018) prospective observational cohort study on protocol development for reversal of NMBAs for patients undergoing elective abdominal surgery showed that PACU length of stay was < 90 minutes for 42% of the protocol group, as compared to 16% of the control group patients; indicating that protocols and educational interventions are advantageous. It is imperative as providers to understand where and when patients are at greatest risk in order to adequately and proactively intervene against rNMB.

Limitations

According to the current literature, culture is by far one of the greatest hurdles to overcome during the process of change. In many instances, most anesthesia providers may be familiar with QNM but still believe that QLNM provides the most accurate assessment of recovery from neuromuscular paralysis. Barriers related to QNM can simply take the form of

education, problem awareness, technical difficulties, lack of availability, and access to accurate and reliable monitoring equipment that ultimately prevents the integration of EBP into clinical practices (Sager et al., 2018; Sorin & Kopman, 2017).

Historically, positioning of the patient's extremities too has been a problem with the integration of QNM because it impedes on the accuracy and reliability of the monitors (Dunworth et al., 2018). Another barrier impinging the use of QNM is the actual operationalization of the monitor, such as the "time to set up and calibrate, change in workflow of anesthesia induction, positioning of the thumb for free adduction, and consistent monitor values" (Dunworth et al., 2018, p. 276). Lastly, the incorporation of suggamadex (Bridion) into practice has questioned the need for QNM. Suggamadex has been coined 'the miracle drug' because of the reliability and efficacy of the medication; however, suggamadex administration to patients have still shown a TOF of < 0.9% in as much as 9.4% of cases where QLNM was utilized (Kotake et al., 2013). However, the high-cost profile, institutional oversight, and regulation of suggamadex has also hindered its utilization.

Some of the other concerns regarding the implementation of QNM into practice are based on the lack of education, problem awareness, lack of availability/accurate monitors, and culture (Cullen et al., 2018; Kotake et al., 2013; Sorin & Kopman, 2017). According to Cullen et al. (2018) education and problem awareness related to QNM and rNMB are paramount to address. This can be assisted by highlighting advantages, compatibilities, emphasizing its anticipating impact, distributing evidence, and displaying posters/fliers (Cullen et al., 2018). The operationalization of a multimedia educational model can meet these needs. The theory behind the efficacy of multimedia education is founded on the Cognitive Theory of Multimedia Learning (CTML). However, there are some disadvantages of multimedia education that need to be highlighted, which includes (1) a high-cost profile; (2) special digital hardware to run

programs; (3) increased time duration to learn how to utilize the digital platform compared to traditional learning; (4) lack of social interaction or immediate support; and (5) lack of structure (Fen, 2018; Jinping & Quiping, 2013). However, the benefits of using a multimedia education intervention can outweigh the disadvantages in that, such an approach fosters a sense of ownership, early adaptation, brings forth barriers, provides rapid feedback, and most importantly, it cultivates an intrinsic and altruistic responsibility to bring about personal change (Mayer, 2005).

Organizational Gap Analysis

After anecdotal reports with key stakeholders such as quality improvement agents, safety and risk management personnel, and anesthesia educational coordinators, it was discovered that a multitude of clinical sites within the region utilize QLNM. The overall evidence indicates that QNM is a more accurate method of assessing rNMB and is superior to the current practice norm of using QLNM (Dunworth et al., 2018). Many anesthesia providers are unaware of the problem of rNMB and the subjectivity of the QLNM. Therefore, the lack of QNM EBP implementation to determine the correct timing and/or dosing for NMBAs is what sparked the initiative for this DNP project. In order to get clinicians to change practice, it is important to continuously monitor and sustain a process of education that reinforces this issue (Todd et al., 2014). Garnering key stakeholder support for this DNP project was imperative and will hopefully provide for a prospective foothold into a future QI initiative.

Conclusion

Given the findings within the literature it is imperative to act proactively in raising awareness of a new EBP. Given that healthcare initiatives are moving toward reduced costs, improved access, increased production, and improved patient outcomes, it is only logical to move toward a current EBP that can replicate these results. The literature supports a quantitative

modality of neuromuscular monitoring. Given the constrains placed upon the DNP doctoral candidates, a multimedia presentation can deliver the necessary educational information regarding patient safety. The literature stated that there is a poor understanding of rNMB and a lack of operationalized QNM. This validates and supports the need for increased awareness and education (Ledowski et al., 2015). A multimedia presentation will be succinct and holistic in nature regarding the contemporary incidence related to rNMB, problems encountered (both patient and facility), how to combat them, high risk population, the different types of QNM's, how it improves care, and interventions that others can do to bring about awareness and recognition. In order to foster this path of future progression it is paramount to gather key aspects within this research related to provider perception, knowledge, and attitude on the efficacy of multimedia education on patient safety.

Chapter III: Organizational Framework of Theory

Conceptual Definitions of Theory and Framework

In a technology driven era, the rapid advances in technology and accessibility enable the development of a broad range of instructional multimedia (Rudolph, 2017). Instructional designers, multimedia designers, and instructors are challenged with finding a balance between the technology and multimedia that fosters meaningful learning (Mayer, 2005; Rudolph, 2017). The Cognitive Theory of Multimedia Learning (CTML) (See Appendix A) is a theoretical framework that helps to create meaningful learning by structuring multimedia "in light of how the human mind works" (Mayer, 2005, p. 32).

The three major assumptions of how the human mind works in CTML are: dual channels, limited capacity, and active processing (Mayer, 2005; Rudolph, 2017). Mayer (2005) noted that humans process information presented in dual channels known as auditory/verbal channels and visual/pictorial channel. With this information the learner integrates the new information into working memory (Rudolph, 2017). Since the capacity of these channels are limited, learners are forced to allocate their cognitive resources to build connections between pieces of new information and existing knowledge (Mayer, 2005). Active learning involves selecting, organizing, and incorporating information with previous experiences as well as filtering extraneous details not relevant to core materials presented. Through active processing, people learn and convey information more efficiently from a combination of words, animations, audio, and pictures, than from words alone (Mayer, 2005; Rudolph, 2017).

To build an effective multimedia module, it is essential to balance the visual and verbal information to engage the learner and minimize extraneous distractions (Rudolph, 2017). The presented material should have a coherent structure and reflect guidance for the learner on how

to build the structure (Mayer, 2005). Learning outcomes can be measured through retention, recall of information presented, transfer, and the ability to understand the information presented to solve new problems (Mayer, 2005). The combination of words and images form the theoretical basis for CTML because it captures the learners' interest, engages memory, prevents cognitive overload, and stimulates reflection (Rudolph, 2017). The goal of the CTML is to demonstrate how words and pictures contribute to a meaningful learning experience.

Relationship of Theory/Framework of Theory

This project incorporated the principles of CTML into the design of the multimedia educational module and outcome assessment. Content was delivered in a format that encompassed the dual channel processing system of the human mind by combining animation, sounds, images, and words (multimedia principles) to (a) reduce cognitive load; and (b) make the four evidence-based topic presentations clearly understandable to anesthesia providers. The educational module was designed to capture anesthesia providers' attention for the previously mentioned four topics and engage them in cognitive processing while integrating it with prior knowledge, thus activating long-term memory formation.

The presentation incorporated the fundamental principles of effective instructional multimedia elements, such as (1) redundancy; (2) signaling; (3) segmentation; (4) animation vs. static images; (5) control; (6) interactivity; and (7) engagement/feedback (Rudolph, 2017). The information was succinctly presented to avoid redundancy and was segmented into individual patient safety topics. Signaling was used to highlight key points to help facilitate the learner's allocation of cognitive resources. Patient safety points were animated and not static in order to facilitate a mental representation of the content (Rudolph, 2017). The control element was incorporated by allowing the viewer to go back, pause, and advance to the next topic at their own pace. Participants were also asked to answer questions related to key points and advance to the

next topic to incorporate the elements of interactivity and engagement. The integration of content into a patient scenario was used to help the learner build a coherent example of topics that would be experienced within clinical practice. The outcomes assessment was employed to evaluate the learner's retention and transfer of information presented in the module to demonstrate the effectiveness of a multimedia educational module on best practices of anesthesia patient safety.

With recent studies showing cohesive moderate-to-large effect size, each of these principles have been shown to have a significant impact on knowledge and willingness to adopt evidence-based findings (Shanim, 2018; Unk & Brasington, 2014). Because of its foundation in fostering meaningful learning, CTML principles were used as a heuristic guide for the simulation-based educational module.

Chapter IV: Project Design

Institutional Review Board Approval

The DNP Project was approved by Cedar Crest College's (CCC) Institutional Review board (IRB) on June 18th, 2020 (See Appendix B).

Ethical Considerations and Protection of Human Subjects

The author completed the Collaborative Institutional Training Initiative (CITI) program prior to project development (See Appendix C). Participation in the DNP project was voluntary, confidential, and was described in the recruitment email. Implied consent was obtained and all data was anonymous and protected by the company SurveyMonkey©. All copies of the raw electronic data were encrypted with password protection in order to protect participant confidentiality and unauthorized user access. Any risk undertaken by participants was assumed that there was no deviation from the normal standards of care or risk of physical and/or emotional well-being.

Implementation Plan

Collaboration with healthcare representatives in quality and safety control, risk management staff, and anesthesia educational coordinators occurred prior to the initiation of the project as implementation of the project was intended to be conducted within the clinical setting. However, the COVID-19 pandemic prevented the ability for the DNP projects to be carried out, therefore, the transition to a multimedia simulation-based education exemplifying the same objectives and goals desired by the institutional site, was developed. Specifically, the author felt that it was vital to still deliver EBP recommendations regarding the use of QNM to improve upon anesthesia patient safety.

The transition from carrying out a single project at a clinical site, to the implementation of a cohesive multimedia simulation-based education module that encompassed four separate

doctoral practice projects required a great deal of collaboration and effort. After multiple discussions with group members, it was determined that the institutional goals and project objectives that were previously discussed embodied the same ideologies of improving provider awareness, education, and knowledge about patient safety practices based upon current evidence-based guidelines.

An evidence-based approach enables healthcare professionals to close the gap between basic research and evidence translation into clinical practice to optimize patient outcomes. Without translational research, existing practice becomes obsolete and may impact patient outcomes. The chapter will provide an overview of the implementation plan, which is broken down into four phases (1) creating awareness and interest; (2) building knowledge and commitment; (3) promoting action and adoption; and (4) pursuing integration and sustained use (Cullen et al., 2018; Iowa Model Collaboration, 2017).

Creating Awareness and Interest

Creating awareness and interest is also known as the pre-planning phase because it involves cultivating a spirit of inquiry, identifying clinical problems/conducting a needs assessment, and collecting and/or appraising the best evidence that supports a practice change. Pre-planning of the DNP project took place pre-COVID-19 within each DNP student's clinical site. Tasks that were accomplished included a needs assessment, conducted by direct observation of anesthesia providers and anecdotal conversations with key stakeholders. To overcome barriers in implementing the practice change, the DNP students employed change agents and champions to spread the word about the EBP's advantages and its impact on healthcare. Utilizing this strategy helped highlight the institution's unique culture and impetus for change amongst stakeholders, organizational leaders, and clinicians (Cullen et al., 2018). The use of journal clubs, attendance to QI meetings, and placement of existing EBPs within the

break rooms helped raise awareness and a sense of personal responsibility to bring about change. Lastly, the investigation into utilizing knowledge brokers (Chief anesthesiologists [MDA] and Chief CRNAs) at each clinical site helped highlight the institution's support for EBP, available resources, institutional barriers, and the necessary partnerships required to bring about a sustainable institutional change.

Building Knowledge and Personal Commitment

After the awareness and interest phase was established, the second phase of implementation began. Building knowledge and personal commitment was orchestrated via teamwork after a gap analysis was conducted and an action plan was developed. In this phase, the pinnacle accolade was the delivery of education via a multimedia simulation-based module and dissemination of credible evidence with a clear implication for clinical practice. The educational module was designed to obtain clinician input and inform today's clinicians on contemporaneous EBP recommendations regarding patient safety that are not implemented within the clinical settings. Since the clinical problem and needs assessment was conducted at the DNP students' primary clinical site, it was concluded that anesthesia providers at each of these institutions should be invited to participate in the module. Adopting this approach helped secure buy-in, stimulated their commitment, promoted action and adoption, and provided an essential foundation for optimizing knowledge synthesis on four different EBP's.

Promoting Action and Adoption

After building knowledge and personal commitment, the third phase of implementation (promoting action and adoption) began. Given this DNP project design, it is limited by the number of interventions that could have been operationalized to promote action and adoption within the clinical setting without developing a protocol or purchasing equipment. However, it was important to use implementation strategies that promoted action and adoption of the DNP

project. Within the clinical setting, reminders and practice prompts were implemented to encourage clinicians to adopt the presented EBP. Implementation strategies adopted to promote action and adoption included the DNP students functioning as role models at various clinical sites, advocating for the proposed practice changes, reporting updates on the project's findings, and emailing educational handouts to providers. These strategies created awareness, promoted adoption and enthusiasm, and garnered support which is important for practice change (Melnyk & Fineout-Overholt, 2018).

Pursuing Integration and Sustained Use

The final phase of the implementation process included pursuing integration and harnessing the sustained use of EBPs. In order to promote the sustained integration of the proposed practice change, the posttest survey included questions related to the participants' willingness to change their clinical practices and provided feedback related to the educational intervention. Due to the project's methodology, it was not feasible to determine whether the participants would actually make a practice change, given these findings would be outside of this project's scope. Despite this however, it was imperative to periodically provide information about the project and the clinical practice recommendations to all stakeholders. The principal investigators functioned as peer influencers and transformational leaders throughout the project's development to deter providers from practicing non evidence-based. To promote integration and sustained use, educational handouts were placed in the staff lounge and locker rooms to facilitate compliance and a continued forward momentum. Furthermore, the project's results and findings were not only disseminated within the proposed institutions, but they were also disseminated to a wider audience via the Eastern Nursing Research Society's virtual conference in April 2021 in order to (1) support the growth of EBP culture, (2) serve as a breeding ground for innovation, and (3) enhance nursing knowledge.

Data Collection Tools

Data was collected using a pretest/posttest method, which is appropriate to assess how the educational module influences participant learning (Polit & Beck, 2017). Due to its ease of accessibility, inexpensiveness, and ability to reach a broad audience, a 10-question pretest (See Appendix D) and 10-question posttest survey (See Appendix E) was developed using SurveyMonkey©. To ensure that the survey was reliable and valid, Melnyk and Fineout-Overholt's (2018) principles for instrument development was followed. The DNP students thoroughly reviewed the surveys to ensure that they were clear, comprehensible, reliable, and valid. The DNP team concluded that the pre/post-test measures what it purported to measure. In addition, the survey questions were formatted either dichotomously or in a multiple-choice format and it was concluded that the pre/post-test measures were accurate and approved by the IRB/director of the DNP program for use.

Resources and Budget Justification

In order to operationalize the DNP project, a multitude of resources were required to create the simulation-based educational model. First and foremost, a mock operating room was required to simulate the authenticity and fidelity of the filming process. Prudent consideration was given to room configuration, including bed orientation, placement of high-fidelity mannequin, anesthesia machine, quantitative monitors, bedside monitors, and the mayo stands. Second, CCC's simulation IQ technology was used to film and acquire different camera angles; however, a handheld Canon VIXIA HF R5000 camcorder was required to get different viewpoints and to highlight aspects of the simulation. Lastly, in order to simulate the QNM technique, collaboration with the Blink Device Company® was needed in order to acquire the TwitchView™ EMG based monitor. Personal expenses of shipping and handling from the state of Washington were required. Other financial resources required a membership to the Wix®

website builder and Davinci Resolve® software to edit the film. Fortunately, the majority of the resources were provided by CCC, free of charge, or personally owned, and if expenses were incurred, they were split between the DNP students to minimize any individual out of pocket costs.

Although the implementation plan of the overall DNP project included hours of coordination amongst the clinical sites and DNP students, there was also a significant amount of time that was dedicated to the specific use of QNM, which included collaboration with ancillary staff, the DNP chairperson, DNP directors, and simulation managers. There was also needed collaboration with an independent QNM company called Blink Device Company®, which is stationed in Washington state. The company's personnel were crucial for their insight on QNM and technologies utilized for the project.

Chapter V: Implementation Procedures and Processes

The DNP project commenced via e-mail recruitment (See Appendix F) of prospective and voluntary anesthesia professionals (i.e., MDA, CRNA, SRNA) from established clinical sites and a peer-network of professional contacts. A recruitment email containing the transmittal heading of *"Evidence Based Practices of Anesthesia Patient Safety"* was sent to a convenience sample of anesthesia practitioners. The body of the email contained a brief description of the project, informed consent to participate in the project, instructions to complete the pre-test survey on SurveyMonkey© (See Appendix G), a link to the educational module website, and contact information of the DNP students. Participants were informed that the module would take approximately one hour to complete and that their participation in the project was anonymous. A link to the educational module website was available to participants for a two-week period and participants had the option to decline participation in the project up until the final submission of the post-test survey.

The educational module was delivered on an online on-demand format via the Wix® website (See Appendix H) which provided a virtual platform for education. The module consisted of an introduction, four 10-minute EBP presentations on each topic of anesthesia patient safety, a robust 12-minute high fidelity simulation scenario, and a conclusion. Supplemental materials for each topic were available for download from the website and for future reference for the participants.

Upon completion of the educational module, participants were instructed to complete the posttest survey. In order to determine if there is an improvement in knowledge, participants were asked knowledge-based questions that were on the pretest and repeated on the posttest. On the posttest there were questions related to the participants willingness to change their practice in order to acquire if there is an attitude change. Specific to the content of each principal

investigators EBP project, in the pretest, there are two demographic based questions and two knowledge-based questions, while on the posttest there are 2-3 knowledge and/or attitude-based questions. Data collected about the role of the anesthesia practitioner and years of experience were also collected for demographic purposes. This demographic data was imperative to collect as it helped to establish trends, patterns, and behaviors witnessed within a specific subset of the healthcare population and too assist in further research (Polit & Beck, 2017).

Implementation of the DNP project took place between a 2-week period from January 23rd, 2021 to February 5th, 2021. This timeframe allowed for adequate time for participants to view the educational modules and simulation scenarios and answer the pre/posttest surveys. All the data collected from the pretest and posttest surveys were stored anonymously on SurveyMonkey© and was then further analyzed using the Statistical Package for the Social Sciences v.25 (SPSS). Based on the methodology of the project, a paired t-test was utilized to analyze the data. A descriptive statistic was used to determine if clinical significance was obtained by measuring the change in knowledge by comparing each participant's pre and post-test surveys.

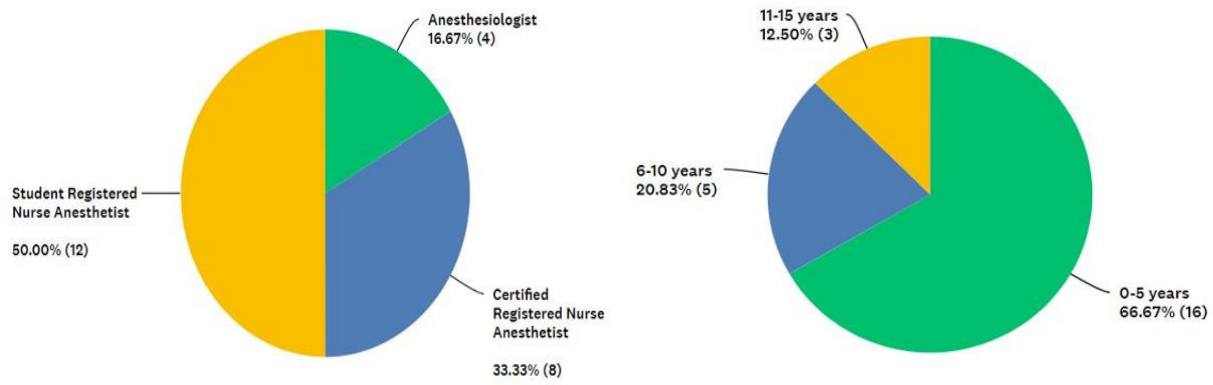
Chapter VI: Evaluation and Outcomes

Demographics

The recruitment email was sent to a total of 40 anesthesia providers across a multitude of healthcare institutions; 24 participants volunteered to participate, resulting in a 60% response rate (n = 24). Of the 24 participants, four were MDA's (16.67%), eight were CRNA's (33.33%), and 12 were SRNA's (50.0%). Sixteen participants had an average of 0 to 5 years of experience (66.67%), five had 6 to 10 years of experience (20.83%), and three had 11 to 15 years of anesthesia experience (12.5%).

Figure 1:

Demographics & Years of Experience



Note: Sample data demographics on the left and years of experience on the right

Evaluations and Responses to Specific Questions

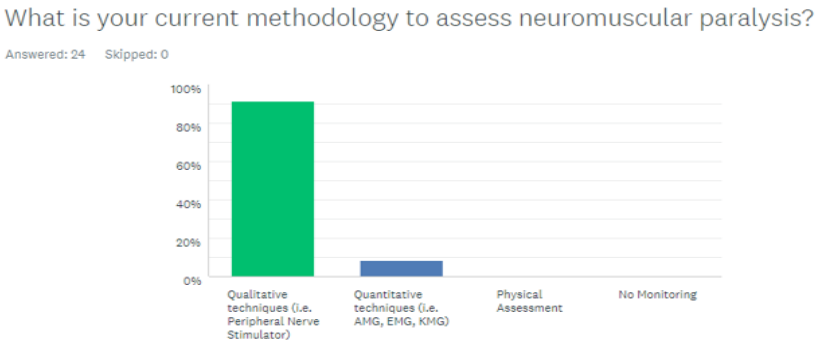
In order to evaluate the efficacy of the multimedia educational module, participants were asked a total of 10 questions on the pretest and the posttest surveys. Specific questions on the surveys corresponded to the different patient safety topics. Specific to QNM, four questions were asked and are presented below. In order to ascertain if knowledge was acquired, a nonparametric McNemar's test was performed on each knowledge-based question.

Project Question #1 and #2

Specific to this project, and in order to gather an understanding of individual clinician usage of QNM and/or QLNM techniques, the pretest included the question, *What is your current methodology to assess neuromuscular paralysis*? Of the 24 participants, 91.6% (n = 22) replied that QLNM was their current method of assessing neuromuscular paralysis, while 8.3% (n = 2) chose QNM techniques. However, when asked in the posttest, *What modality is the most accurate at depicting the depth of neuromuscular paralysis*, 100% (n = 24) of the participants replied QNM techniques.

Figure 2:

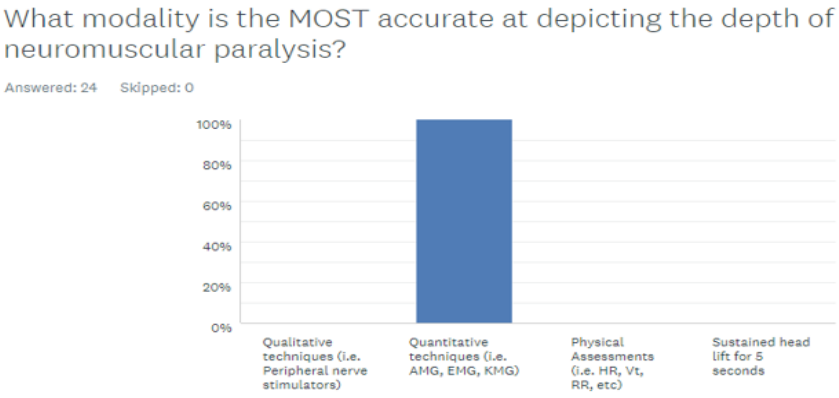
Pretest Question



Note. Current methodology to assess patient neuromuscular paralysis

Figure 3:

Posttest Question



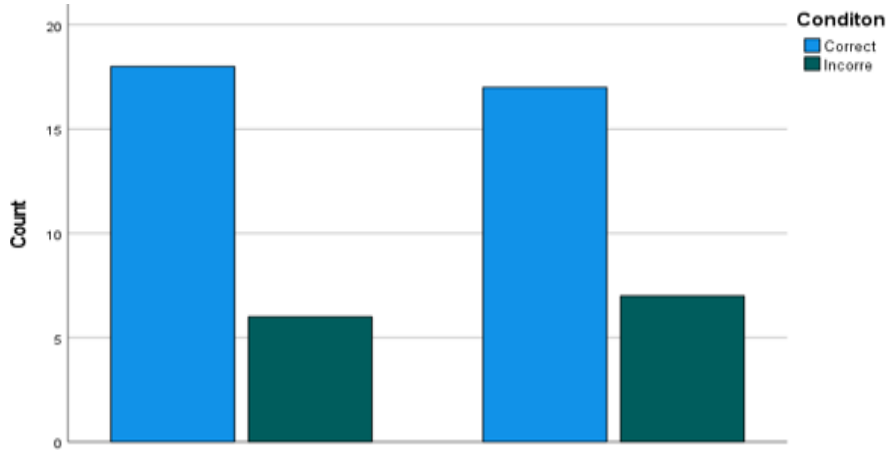
Note. Assessment of knowledge based off EBP recommendations

Project Question #3

On both the pretest and posttest, participants were asked, *What degree of paralysis is present when 4/4 twitches are elicited with a peripheral nerve stimulator?* On the pretest, 29.1% (n = 7) of participants answered the question incorrect while 70.8% (n = 17) answered the question correct. On the posttest, 25% (n = 6) participants answered the question incorrect and 75% (n = 18) participants answered correctly. After analysis, a two tailed exact significance *p* value of 1.000 was generated with an odds ratio (OR) of 1.235% (95% CI [0.345 – 4.426]) (See Appendix I).

Table 1:

Knowledge based Pretest Question



Note. What degree of paralysis is present when 4/4 twitches are elicited with a peripheral nerve stimulator? Pretest is on the right and the Posttest is on the left.

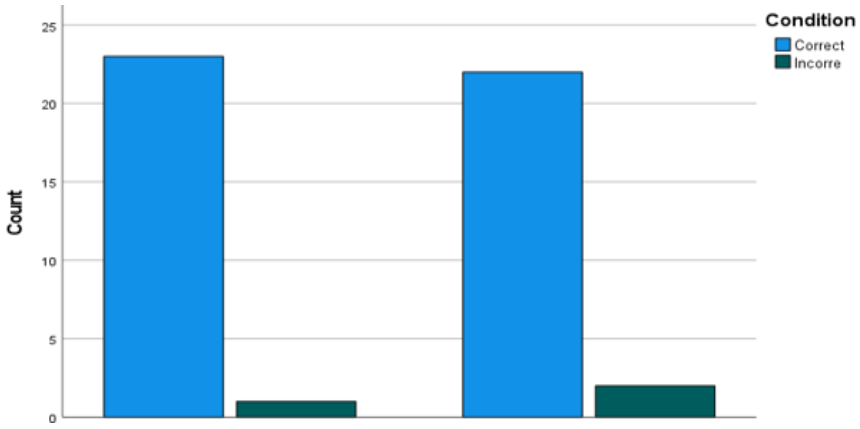
Project Question #4

On both the pretest and posttest, participants were asked, *What is the ideal recovery TOFr to achieve prior to extubation?* On the pretest, 91.5 % (n = 22) of participants answered the question correctly, while 8.3% (n = 2) of participants answered incorrectly. On the posttest, 95.8% (n = 23) of participants answered the question correctly, while 4.1 % (n = 1) of the

participants answered incorrectly. After analysis, a two tailed exact significance *p* value of 1.000 was generated with an OR = 2.091 (95% CI [0.177 – 24.734]) (See Appendix J).

Table 2:

Knowledge based Posttest Question



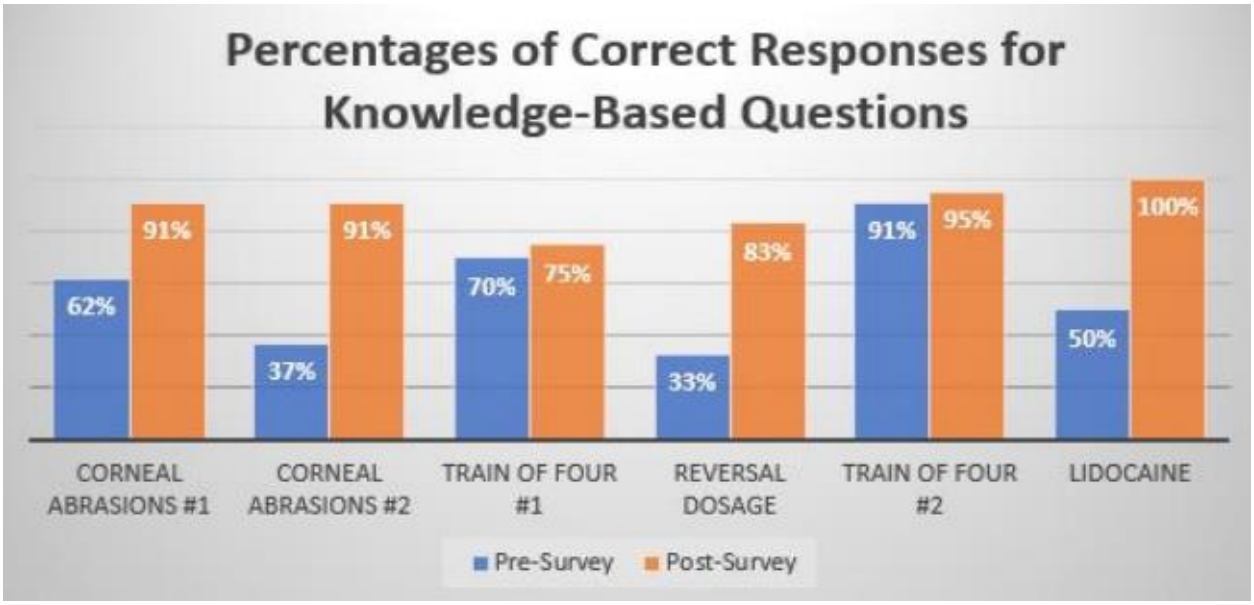
Note. What is the ideal recovery TOFr to achieve prior to extubation? Pretest is on the right and posttest is on the left.

Outcomes of Overall DNP Project

To determine the efficacy of the overall educational module, participants were asked six knowledge-based questions on the patient safety topics of corneal abrasion prevention, timing and dosing of reversal agents, (3) QNM, and (4) intraoperative lidocaine infusions for comparison before and after viewing the module. Examination of the raw data revealed that there was a total of 90 (63%) correct answers and 54 (38%) incorrect answers on the pretest as compared to a total of 128 (89%) correct answers and 16 (11%) incorrect answers on the posttest. Analysis of the pretest and posttest dichotomous variables (i.e., correct vs incorrect answers) exhibited a two tailed exact significance *p* value of < 0.001 and an OR = 4.8 (95% CI [2.583 – 8.919]) (See Appendix K).

Table 3:

Percentages of Correct Responses for Knowledge Based Questions



Note. All six knowledge-based questions of the pretest and posttest survey

Figure 4:

Frequency of Correct Responses

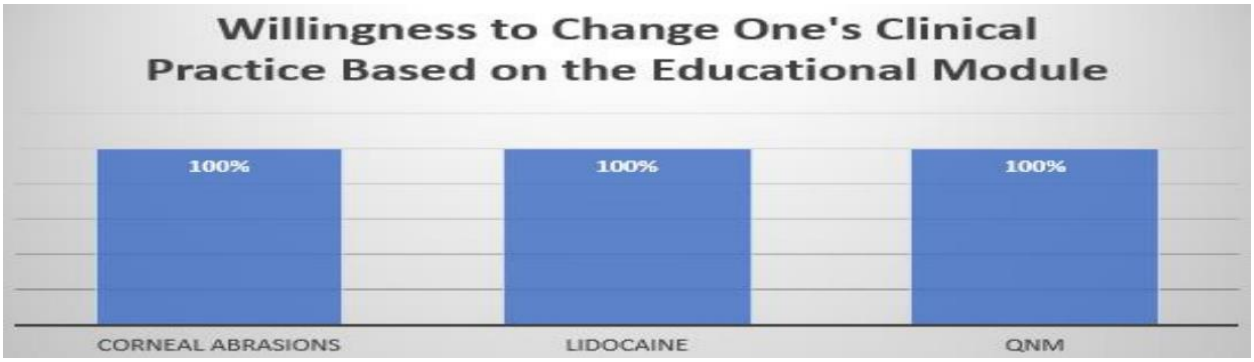
Question	Pretest	Post-test	Significance	Question	Pretest	Post-test	Significance
Corneal Abrasions #1	15	22	$p = 0.002$*	Reversal Dosing	8	20	$p = 0.004$*
Corneal Abrasions #2	9	22	$p = 0.016$*	Train of Four #2	22	23	$p = 1.000$
Train of Four #1	17	18	$p = 1.000$	Lidocaine	12	24	$p = <0.001$**

Note. *$p < 0.05$ and **$p <0.001$

Comprehensive data was also gathered for the entire module on willingness to create a practice change. Posttest questions #1, #4, and #7 asked about willingness to incorporate information from the educational module into practice. With 24 participants, a total of 72 options on willingness to make a practice change was available. Participants answered *"yes"* to all 72 times indicating that 100% of the sample reported a willingness to make a practice change based on information presented in the module.

Table 4

Willingness to Change One's Clinical Practice Based on the Educational Module Information



Note. A total of 24 participants answered "yes" to change one's attitude and clinical practice

Discussion

The purpose of the DNP project was to improve anesthesia providers' knowledge on topics of anesthesia safety which include corneal abrasion prevention, intraoperative lidocaine infusions, the use of QNM, and timing/dosing of reversal agents through a multimedia educational intervention; the author's specific DNP project purpose was to improve anesthesia providers' assessment practices and knowledge regarding the importance of utilizing QNM within clinical practice.

The goals of the project were fulfilled. The proportion of correct answers on the pretest to posttest increased by 26% (63% to 89%) and incorrect answers decreased by 27% (38 to 11%). Further examination of the data revealed that an OR of 4.8 indicates that participants were 4.8x more likely to get the correct answer on the posttest then the pretest, thus increasing a provider's knowledge on evidence-based anesthesia patient safety practices.

Although statistically significant results were revealed, they are inappropriate generalizations given the research design, sample size, and data collection methodology; therefore, limiting generalizability and reproducibility. Although inferential analyses were

conducted, the intent of this DNP project was to prove clinical significance, which can be evidenced by the odds ratio analysis of the pretest and posttest crosstabulation scores (See Appendix K). Acquiring clinical significance with this project is just as valuable as obtaining statistical significance because knowledge acquisition resonates and manifests throughout the healthcare arena as genuine and palpable effects that influence the everyday lives of patients and the healthcare decisions made on their behalf (Polit & Beck, 2017).

Overall, the implementation process unfolded smoothly. The virtual platform proved to be valuable method to disseminate evidence-based knowledge about anesthesia patient safety during the COVID-19 pandemic. The project did meet the objectives to have at least 50% of the overall anesthesia practitioners who participated in the project demonstrate the importance of integrating QNM within clinical practice, as well as show increased knowledge related to QNM. Suggested improvements would include additional questions related to each area of patient safety, specifically QNM, in order to gather a greater understanding of the participant's knowledge base.

This author's specific focus of the DNP project has brought about an increased awareness to the fact that the majority of anesthesia providers utilize QLNM techniques in practice, yet contemporary EBP guidelines advocate to utilize QNM (Dunworth et al., 2018). Although a voluntary sample was acquired for this project, this technique allowed for a diverse stratification of participants across multiple healthcare delivery systems, suggesting the lack of evidence-based practices in multiple northeastern Pennsylvanian institutions. It is clear that a greater awareness and interest among anesthesia providers is needed to successfully integrate the use of QNM into clinical practice. These steps are pivotal and paramount if one is to promote action, adoption, and the sustained usage of QNM techniques (Dunworth et al., 2018).

Chapter VII: Implications for Nursing Practice

Implications for Practice

Although the IOM has set a goal that by 2020, 90% of all clinically based decisions are to be made by accurate and timely EBP's, there still remains a multitude of barriers to successful implementation and utilization (Lehane et al., 2019). This can be attested in the DNP projects findings that the majority of clinicians still use QLNM techniques. Although anesthesia practitioners realized that QNM should be the standard of practice, incorporation of this technology into clinical practice has been reported to be impinged by (1) clinician attitude; (2) institutional culture; (3) use of suggamadex; (4) the type of surgical procedure/positioning; and most importantly; (5) the access to accurate monitors (Cullen et al., 2018; Kotake et al., 2013; Sorin & Kopman, 2017; Todd et al.,2014).

Prior to the COVID-19 pandemic, the author was going to propose a trial using the Blink Device Company® TwitchView™ EMG based QNM in the operating room; however, this was unfeasible. Although the initial trial did not take place, the theory behind the CTML and operationalization of the DNP project's multimedia educational module using a virtual platform helped to meet the demands of promoting awareness, knowledge, and accountability of anesthesia patient safety concerns. Acquiring these three foundational principles are paramount in order to promote the action and adoption of new EBPs. In order to continue the forward momentum of QNM integration into clinical practice, continuous advocacy via the use of champions and change agents is needed so that when prospective trials can take place, they can facilitate the process and allay participant fears/trepidations of procedural changes; thus, assisting in overcoming the multitude of obstacles and allowing QNM to become adopted within the clinical arena.

Strengths of the Project

Strengths of this project include knowledgeable and experienced staff within the healthcare institutions. Through a comprehensive gap analysis of existing institutional anesthesia patient safety concerns, these experienced clinicians helped to formulate the focus of the DNP project. Although face-to-face learning was not possible, the virtual platform proved to be a worthy implementation strategy and allowed the participants the flexibility to complete the project at their own leisure. The incorporation of CTML also allowed for the ability of the educational module to align with individual learning preferences in order to effectively translate the evidence-based patient safety topics. The overall low-cost profile to implement this project during the pandemic was advantageous and another strength of the DNP project.

Limitations of the Project

Despite the strengths of the DNP Project, there are a number of limitations that must be described. There is limited generalizability due to the small/voluntary sample size, lack of a power analysis, and use of a standardized instrument to collect the participant data. Despite the availability of the DNP student's contact information, the virtual platform did not allow for the ability to ask real-time questions. Participants also only had a two-week time period to partake in the DNP project and a longer implementation time could have allowed for a larger sample size. Lastly, specific to the author's focus, the lack of QNM within the proposed clinical institution was a significant concern; however, the ease of working with a Blink Device Company® representative helped potentially bring the product to the institution. The representative did provide a sample monitor and leads for the multimedia educational simulation module.

Linkage to DNP Essentials

The American Association of Critical-Care Nurses ([AACN], 2006) provides a list of eight DNP essentials that govern the DNP degree. Fortunately, this DNP project has allowed for the opportunity to meet the expected curricular elements, goals, and competencies of a doctorally prepared nurse. The DNP essentials that have been met by this project include Essentials I through VIII (See Appendix L) and have been mentioned previously and more descriptively throughout this manuscript. The following section will briefly discuss how each DNP essential was met by the actions taken to conduct this DNP project.

Essential I

The first DNP essential is the "*Scientific Underpinning for Practice."* The foundation for all research and EBP is the inclusion of science. By utilizing different contemporary research/literature findings and theoretical frameworks, the principal investigator incorporated them into the project design. The project took into consideration the different physiological risk factors, psychological concerns, current sociocultural dynamics/norms, and the different organizational sciences that influence the way healthcare institutions operate. These factors were all taken into consideration when choosing which patient safety practices to implement, the theoretical framework, project design, and implementation strategy.

Essential II

The second DNP essential is "*Organizational and Systems Leadership for Quality Improvements and Systems Thinking."* The author functioned as a leader and champion by advocating for specific institutional quality improvement projects and/or patient safety concerns. The acquisition of provider knowledge helped to improve contemporary and prospective clinical practices, thus improving the care and safety of the anesthesia patient population.

Essential III

The third DNP essential is*" Clinical Scholarship and Analytical Methods for EBP's."* Critical appraisal of current literature reviews, randomized controlled trials, clinical practice guidelines, and systematic reviews are the main sustenance behind a viable DNP project. The evidence synthesis was the transcription of relevant research, thus allowing for the application, justification, and translation of QNM best practices. Implementation of these findings occurred at the institutional level while dissemination occurred at the regional level; thus, promoting health promotion and a vast awareness of QNM EBPs.

Essential IV

The fourth DNP essential is*" Information Systems/Technology and Patient Care Technology for the Improvement and Transformation of Health Care."* A virtual platform was utilized as a communication network between the DNP students and participants. This modality allowed for the acquisition of consent, voluntary participation, education, data collection, and evaluation of the project. The robust multimedia simulation based educational module required an intense effort and myriad of collaboration, consultation, and leadership skills to develop the module in an effort to improve the quality and safety of patients undergoing anesthesia.

Essential V

The fifth DNP essential is *"Healthcare Policy and Advocacy in Health Care."* Critical appraisal of contemporary institutional anesthesia patient safety concerns, analysis of the current body of literature and healthcare system quality metrics provided the DNP students with the means to synthesize a plan to clinically prevent patient safety concerns. These concerns were targeted in multiple healthcare delivery systems that allowed for a broad development and implementation of the project, thus harnessing a vast target audience. This is paramount because it is imperative to develop and implement health policies and EBPs at the institutional, local, state, federal, and international levels (AACN, 2006). To increase the awareness of evidence-

based anesthesia patient safety practices, a virtual poster of the DNP project was disseminated to clinicians, researchers, and academics at a highly prestigious conference for the eastern United States region; of which acquired the recognition and accolade of 3rd place for best student DNP Poster.

Essential VI

The sixth DNP essential is *"Interprofessional Collaboration for Improving Patient and Population Health Outcomes."* Collaboration with quality and safety control representatives, risk management, anesthesia providers (MDA, CRNA, and SRNA), and QNM product representatives were necessary to identify current institutional anesthesia patient safety concerns. Collaboration with both interprofessional and intraprofessional parties allowed for the development of the educational module designed to improve upon the quality and safety of multiple healthcare delivery systems.

Essential VII

The seventh DNP essential is *"Clinical Prevention and Population Health for Improving the Nation's Health."* Knowledge and awareness are foundational principles behind one's ability to improve upon population health and promote disease prevention. By educating anesthesia providers on the importance of the best practices of QNM and assessing one's willingness to change their clinical practice emphasizes the importance of proactively changing contemporary practice of QLNM to QNM. The use of QNM has been shown to decrease the problems associated with QLNM, thus improving the nation's health and preventing disease (Dunworth et al., 2018).

Essential VIII

Lastly, the entire DNP Project fulfills the eighth DNP essential, *"Advanced Nursing Practice."* The DNP students successfully designed, implemented, and evaluated a multimedia

simulation based educational module during a global pandemic. This was not only performed during an extremely challenging time in healthcare and academia, but the author functioned as an advanced practitioner (a nurse anesthetist); thus, utilizing EBP on a daily basis to make decisions on patient's behalf. This perspective and professional opportunity greatly illuminates the importance of remaining abreast of current best practices and the importance of continuously improving upon institutional and personal clinical practices.

Chapter VIII: Summary of Project

Summary and Conclusions

Current literature has shown that there is a significant misunderstanding of rNMB and a lack of operationalized QNM techniques within clinical practice; thus, warranting the need for increased awareness and provider education (Ledowski et al., 2015). Residual neuromuscular paresis encompasses an onslaught of anesthesia patient safety concerns that must be attenuated. Despite the fact that current evidence has shown that many anesthesia providers are 'overconfident' when it comes to assessing rNMB and believe that rNMB is a significant public health problem, healthcare institutions continue to utilize the PNS to qualitatively assess the depth of neuromuscular blockade (Naguib et al., 2019; Wiatrowski et al., 2018). The use of a PNS has proven to be highly subjective with a wide range of inter-rater reliability, however, it is still utilized throughout a large portion of the northeastern Pennsylvania healthcare institutions. Attenuating the incidences of rNMB is paramount in combating ever-rising healthcare costs as rNMB has been shown to increase morbidity and mortality, as well as hospital and/or PACU length of stay, respiratory therapy and oxygen needs, and use of antibiotics (Sager et al., 2019).

Utilizing Cullen et al.'s (2018) strategies for mobilizing EBPs, creating awareness and providing education helped to support Ledowski et al.'s (2015) claim. The multimedia simulation based educational module developed for this DNP project created awareness and allowed for knowledge dissemination on anesthesia patient safety concerns. The results proved to be clinically advantageous and can further function as a catalyst for practice change and future EBP's. Based on the current evidence that shows that QNM is the best practice to reduce the incidence or rNMB (Dunworth et al., 2018), it was very concerning to find out that 91.7% of the DNP project participants still utilized QLNM techniques within their clinical practice; however, 100% indicated that they were willing to change their practice following their review of the

educational module. It is hopeful that this DNP project can serve as an exemplar and validate the need to implement QNM techniques into the clinical setting. If it is important for an anesthesia provider to foster a path for safer anesthetic practices during the perioperative period, then it is imperative to continue to advocate for objective modalities to monitor for rNMB.

Dissemination Plans

This DNP Project was disseminated on March 25th, 2021 – March 26th, 2021 at the Eastern Nursing Research Society's (ENRS) virtual 33rd Annual Scientific Sessions conference. A virtual poster presentation was presented to disseminate *"The Efficacy of a Multimedia Educational Module on Best Practices of Anesthesia Patient Safety"* (See Appendix M). Dissemination at this conference permitted an avenue for the principal investigator to target a wider audience throughout the eastern United States region. Information on this project was also virtually disseminated to students, faculty, program directors, and the provost at Cedar Crest College on April 15th, 2021.

Future Ideas

Quantitative neuromuscular monitoring has the potential to reduce morbidity and mortality by attenuating rNMB (Dunworth et al., 2018). This technology can be used to venture into other cost saving initiatives throughout the perioperative period, such as decreasing hospital/PACU length of stay, dosing of NMBA's, and as well as administering the correct dosing and timing of neuromuscular blocking reversal agents (Dunworth et al., 2018). Additional quantitative, as well as qualitative studies, should be performed in order to ascertain the origin, as well as a remedy for the lack of institutional QNM implementation. This DNP project was important and can serve as the impetus to resolve dated anesthetic practices and to bring forth an EBP movement of improving anesthesia patient safety.

References

American Association of Colleges of Nursing. (2006). *The essentials of doctoral education for advanced nursing practice*. http: http://ww.aacnnursing.org/portals/42/publications/DNPEssentials.pdf

Bhananker, M. S., Treggiari, M. M., Sellers, A. B., Cain, C. K., Ramaiah, R., & Thilen, R. S. (2015). Comparison of train of four count by anesthesia providers versus TOF-Watch SX: A prospective cohort study. *Journal of Canadian Anesthesiologists, 62,* 1089 –1096. http://doi.org/10.1007/s12630-015-0433-9

Botney, R. (2008). Improving patient safety in anesthesia: A success story? *International Journal of Radiation Oncology -Biology, 71*(1). 182 –186. http//doi.org/10.1016/j.ijrobp.2007.05.095

Castanelli, D., Smith, N. A., & Noonan, C. (2015). Do anesthetists believe their teaching is evidence-base? *Medical Teacher, 37*(12), 1098–1105.

Cullen, L., Hanrahan, k., Farrington, M., DeBerg, J., Tucker. S., & Kleiber, C. (2018). *Evidence-based practice in action: Comprehensive strategies, tools, and tips from the University of Iowa Hospitals and Clinics.* Sigma Theta Tau International

Dunworth, A. B., Sandberg, S. W., Morrison, S., Luts, C., Wanderer, P. J., & O'Donnell, M. J. (2018). Implementation of acceleromyography to increase use of quantitative neuromuscular blocking monitoring: A quality improvement project. *Journal of the American Association of Nurse Anesthetists, 86*(4), 269 –277.

Elkman, L. (2018). Developing and evaluating an e-learning resource for nurses in haemato-concology. *Cancer Nursing Practice, 17*(6), 37 – 42. http://doi-org/cedarcrestcollege.idm.oclc.org/10.7748/cnp.2018.e1510

Farhan, H., Moreno-Duarte, I., McLean, D., & Eikermann, M. (2014). Residual paralysis: Does it influence outcome after ambulatory surgery? *Current Anesthesiology Reports,* 1-13. http://doi.org/10.1007/s40140-014-0073-6

Fen, T. (2018). *Multimedia applications for educational purposes.* https://www.ukessays.com/essays/media/multimedia-applications-educational-4151.php

Fortier, L. P., McKeen, D., Turner, K., De Medicis, E., Warriner, B., Jones, P. M., Chaput, A., Pouliot, J., & Galarneau, A. (2015). The RECITE study: A Canadian prospective, multicenter study of the incidence and severity of residual neuromuscular blockade. *Anesthesia & Analgesia, 121*(2), 366-372. http://doi.org/10.1213/ANE.0000000000000757

Grabitz, S. D., Rajaratnam, N., Chhagani, K., Thevathasan, T., Teja, B. J., Deng, H., Eikermann, M., & Kelly, B. J. (2019). The effects of postoperative residual neuromuscular blockade on hospital costs and intensive care unit admission: A population-based cohort study. *Anesthesia & Analgesia, 128*(6), 1129-1136. http://doi.org/10.1213/ANE.0000000000004028

Jinping, Q., & Qiuping, Z. (2013). The limitations and application errors in multimedia teaching of college. *International Conference on Education Technology and Management Sciences.* 1103 – 1106. http//doi.org/10.2991/icetms.2013.180

Khamtuikrua, C., Suksompong, S., Rhoopanwong, S., Sangsab, P., Chaikittisilpa, N., & Von Bormann, B. (2017). Risk factors for residual neuromuscular blockade after general anesthesia. *Journal of the Medical Association of Thailand, 100*(7), 75-84. http://www.thaiscience.info/Journals/Article/JMAT/10987788.pdf

Kotake, Y., Ochial, R. Suzuki, T., Ogawa, S., Takagi, S., Ozaki, M., Nakatsuka, I., & Takeda, J. (2013). Reversal with suggamadex in the absence of monitoring did not preclude residual

neuromuscular block. *International Society for Anesthetic Pharmacology, 117*(2), 345-351. http://doi.org/10.1213/ANE.0b013e3182999672

Ledowski, T., O'Dea, B., Meyerkort, L., Hegarty, M., & Von Ungern-Sternberg, B. S. (2015). Postoperative residual neuromuscular paralysis at an Australian tertiary children's hospital. *Anesthesiology Research and Practice*, (2015), 1-4. https://doi.org/10.1155/2015/410248

Lehane, E., Leahy-Warren, P., O'Riordan, C., Savage, E., Drennan, J., O'Tuathaigh, C., O'Connor, M., Corrigan, M., Burke, F., Hayes, M., Lynch, H., Sahm, L., Heffernan, E., O'Keeffe, E., Blake, C., Horgan, F., & Hegarty, J. (2019). Evidence-based practice education for healthcare professions: An expert view. *BMJ Evidence Based Medicine, 24*(3), 103–108. http://doi.org/10.1136/bmjebm-2018-111019

Mayer, R. E. (2005). Cognitive Theory of Multimedia Learning. *The Cambridge handbook of multimedia learning*. Cambridge University Press.

Melnyk, B., & Fineout-overholt, E. (2018). *Evidence-based practice in nursing & healthcare: A guide to best practice* (4th ed.). Lippincott Williams And Wilkins.

Nagelhout, J. J., & Elisha S. (2018). *Nurse anesthesia.* (6th ed.). Elsevier

Naguib, M., Brull, J. S., Hunter, M. J., Kopman, F. A., Fulesdi, B., Johnson, B. K., & Arkes, R. H. (2019). Anesthesiologists' overconfidence in their perceived knowledge of neuromuscular monitoring and its relevance to all aspects of medical practice: An international survey. *International Anesthesia Research Society, 128*(6), 1118 –1126.

Naguib, M., Brull, S. J., Kopman, A. F., Hunter, J. M., Fulesdi, B., Arkes, H. R., Eistein, A., Todd, M. M., & Johnson, K. B. (2018). Consensus statement on perioperative use of neuromuscular monitoring. *Anesthesia & Analgesia*, *127*(1), 71-80. https://doi.org/10.1213/ANE.0000000000002670

Polit, D. F., & Beck, C. T. (2017). *Nursing research: Generating and assessing evidence for nursing practice* (10th ed.). Wolters Kluwer.

Robertson, J. M., Dias, D. R., Yule, S., & Smink, S. D. (2017). Operating room team training with simulation: A systematic review. *Journal of Laparoendoscopic & Advanced Surgical Techniques, 27*(5), 475–480. http://doi.org/10.1089/lap.2017.0043

Rouleau, G., Gagnon, M., Cote, J., Payne-Gagnon, J., Hudson, E., Dubois, C., & Bouix-Picasso, J. (2019). Effects of e-learning in the continuing education context on nursing care: Systematic review of systematic qualitative, quantitative, and mixed-studies review. *Journal of Medical Internet Research, 21*(10), http://doi.org/10.2196/15118

Rudolph, M. (2017). Cognitive theory of multimedia learning. *Journal of Online Higher Education, 1*(2). 1–15.

Rudolph, M. I., Chitilian, H. V., Ng, P. Y., Timm, F. P., Agarwala, A. V., Doney, A. B., Ramachandran, S. K., Houle, T. T. & Eikermann, M. (2018). Implementation of a new strategy to improve the peri-operative management of neuromuscular blockade and its effects on postoperative pulmonary complications. *Anaesthesia, 73*, 1067-1078. http://doi.org/10.1111/anae.14326

Sager, L., Maiese, E. M., Bash, L. D., Meyer, T. A., Minkowitz, H., Groudine, S., Philip, B. K., Tanaka, P., Gan, T. J., Rodriguez-Blanco, Y., Sotol, R., & Heisel, O. (2019). Incidence, risk factors, and consequences of residual neuromuscular block in the United States: The prospective, observational, multicenter RECITE-US study. *Journal of Clinical Anesthesia, 55*, 33-41. http://doi.org/10.1016/j.jclinane.2018.12.042

Shamim, M. (2018). Application of cognitive theory of multimedia learning in undergraduate surgery course. *International Journal of Surgery Research and Practice*, (*5)*065. http://doi.org/10.23937/2378-3397/1410065

Shayan, J. S., Kiwanuka, F., & Nakaye. Z. (2019). Barriers associated with evidence-based practice among nurses in low- and middle- income countries: A systematic review. *Sigma Theta Tau International, 16*(1), 12–20. http://doi.org/10.1111/wvn.12337

Sorin J. B., & Kopman, F. A. (2017). Current status of neuromuscular reversal and monitoring: Challenges and opportunities. *American Society of Anesthesiology, 126*(1), 173-190. http://doi.org/10.1097/ALN.0000000000001409

Tajaate, N., Schreiber, J., Fuchs-Buder, T., Jelting, Y., & Kranke, P. (2018). Neostigmine-based reversal of intermediate acting neuromuscular blocking agents to prevent postoperative residual paralysis: A systematic review. *European Journal of Anesthesiology, 35,* 184-192. http://doi.org/10.1097/EJA.0000000000000741

Thilen, S. R., Ng, I. C., Cain, K. C., Treggiari, M. M., & Bhananker, S. M. (2018). Management of rocuronium neuromuscular block using a protocol for qualitative monitoring and reversal with neostigmine. *British Journal of Anaesthesia, 121*(2), 367-377. http://doi.org/10.1016/j.bja.2018.03.029

Todd, M. M., Hindman, J. B., & King, J. B. (2014). The implementation of quantitative electromyographic neuromuscular monitoring in an academic anesthesia department. *Anesthesia & Analgesia, 119*(2), 323–331. http://doi.org/10.1213/ANE.0000000000000261

Unk, J. A., & Brasington, R. (2014). Efficacy study of multimedia rheumatoid arthritis patient education program. *Journal of the American Association of Nurse Practitioners, 26*(7), 370–377. https://doi.org/10.1002/2327-6924.12064

Wiatrowski, R., Martini, L., Flanagan, B., Freeman, K., & Naomi, S. (2018). AANA Journal course – residual neuromuscular blockade: Evidence based recommendations to improve patient outcomes. *American Association of Nurse Anesthetists, 86*(2), 156 – 167.

https://www.aana.com/docs/default-source/aana-journal-web-documents-1/aana-journal-course-residual-neuromuscular-blockade-evidence-based-recommendations-to-improve-patient-outcomes-april-2018.pdf?sfvrsn=fe505fb1_4

Young, T., Rohwer, A., Volmink, J., & Clark, M. (2014). What are the effects of teaching evidence-based healthcare care (EBHC)? Overview of systematic reviews. *PLoS ONE, 9*(1), 1–13. http://doi.org/10.1371/journal.pone.0086706

Melnyk, B., & Fineout-overholt, E. (2018). *Evidence-based practice in nursing & healthcare: A guide to best practice* (4th ed.). Lippincott Williams And Wilkins.

Appendix A

Cognitive Theory of Multimedia Learning

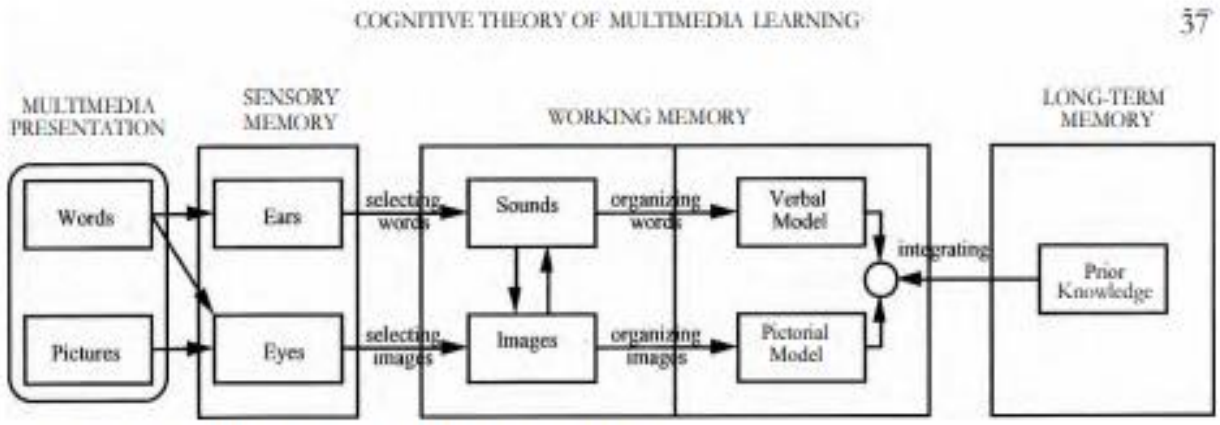


Figure 3.2. Cognitive theory of multimedia learning.

Source: (Mayor, 2005, p. 37)

Appendix B

Institutional Review Board (IRB) Approval

IRB Committee Response - Proposal Number 2020-263

Flag for follow up. Start by 6/20/2020. Due by 6/20/2020.

M

mycedarcrest@cedarcrest.edu
Thu 6/18/2020 4:40 PM
To: Daniel Byorick
Cc: Catherine Zurawski; Hakeem Sanou **+2 others**

The IRB Committee has reviewed your proposal and has made the following response:

Proposal Name:	Effectiveness of a Multimedia Educational Module on Best Practices of Anesthesia Patient Safety
Lead Researcher:	Daniel Byorick
Project Advisor:	Catherine Zurawski
Additional Researcher(s)	Hakeem Sanou Anthony Hernandez John Lohman
Committee Response:	Approved by IRB
Comments:	5/28/2020: 6/18/2020:

This document contains personal information from a student's educational records. It is protected by the Family Educational Rights and Privacy Act (20 U.S.C. 1232g) and may not be re-released without consent of the parent or eligible student.

Reply | Reply all | Forward

Appendix C

Collaborative Institutional Training Initiative (CITI)

CITI PROGRAM

Completion Date 22-Oct-2018
Expiration Date 21-Oct-2021
Record ID 29179004

This is to certify that:

Anthony Hernandez

Has completed the following CITI Program course:

Biomedical Research - Basic/Refresher (Curriculum Group)
Biomedical Research - Basic/Refresher (Course Learner Group)
1 - Basic Course (Stage)

Under requirements set by:

Lehigh Valley Association of Independent Colleges

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?w4bf41dfb-0405-4b64-94af-84763cd3c462-29179004

Appendix D

Pretest Questions

1. What is your primary role?

a. Anesthesiologist
b. Certified Registered Nurse Anesthetist
c. Student Registered Nurse Anesthetist

2. How many years have you been practicing?

a. 0 - 5 years
b. 6 – 10 years
c. 11 – 15 years
d. 16 – 20 years
e. ≥ 21 years

3. What is your current methodology to assess neuromuscular paralysis? (select all that apply)

a. Qualitative techniques (i.e., PNS)
b. Quantitative techniques (i.e., AMG, EMG, KMG)
c. Physical Assessment
d. No monitoring

4. What degree of paralysis is present when 4/4 twitches are elicited with a peripheral nerve stimulator?

a. 90%
b. 70%
c. 50%
d. 30%

5. Do you implement eye protection to patient's cornea's prior to or post mask ventilation/laryngoscopy?

a. Prior to mask ventilation
b. Post mask ventilation

6. What is the appropriate dose of Neostigmine to reverse a TOFr of 0.5 in a patient who weighs TBW:100kg and IBW:70kg?

a. 20mcg/TBW
b. 20mcg/IBW
c. 40mcg/TBW
d. 40mcg/IBW

7. What is the ideal recovery TOFr to achieve prior to extubation?

a. TOFr 0.1
b. TOFr 0.9
c. TOFr 0.8
d. TOFr 0.7

8. What is the recommended infusion rate for multimodal intraoperative lidocaine infusions?

a. 0 – 1 mg/kg/hr IBW
b. 1 – 2 mg/kg/hr IBW
c. 2 – 3 mg/kg/hr IBW

d. Not sure

9. Do you currently use multimodal intraoperative lidocaine infusions in your practice?

a. Yes
b. No

10. Which of the following is not a risk factor for corneal abrasion?

a. Dangling ID badge
b. Pulse oximeter on the index finger
c. Incomplete eyelid closure
d. Taping the eyelid after induction

Appendix E

Posttest Questions

1. Are you willing to change your practice based on the information you were presented about corneal abrasion prevention?

a. Yes, I will make changes based on the highlighted evidence-based recommendations
b. No, I will not make any changes

2. Based on the simulation, when is the best time to initiate eye protection?

a. Prior to intubation
b. After induction

3. What is the recommended infusion rate for multimodal intraoperative lidocaine infusions?

a. 0 – 1 mg/kg/hr IBW
b. 1 – 2 mg/kg/hr IBW
c. 2 – 3 mg/kg/hr IBW
d. Not sure

4. Are you willing to change your practice based on the information you were presented about multimodal intraoperative lidocaine infusions?

a. Yes
b. No

5. What is the appropriate dose of Neostigmine to reverse a TOFr of 0.5 in a patient who weighs TBW:100kg and IBW:70kg?

a. 20mcg/TBW
b. 20mcg/IBW
c. 40mcg/TBW
d. 40mcg/IBW

6. What is the ideal TOFr to achieve prior to extubation?

a. TOFr 0.1
b. TOFr 0.9
c. TOFr 0.8
d. TOFr 0.7

7. Are you willing to make a change in your practice based on the information you were presented about timing and dosing of reversal agents?

a. Yes
b. No

8. What degree of paralysis is present when 4/4 twitches are elicited with a peripheral nerve stimulator?

a. 90%
b. 70%
c. 50%
d. 30%

9. What modality is the MOST accurate at depicting the depth of neuromuscular paralysis?

a. Qualitative techniques (i.e. PNS)
b. Quantitative techniques (i.e. AMG, EMG, KMG)
c. Physical Assessment (i.e. HR, Vt, RR, etc.)

d. Sustained head lift for 5 seconds

10. Which of the following is not a risk factor for corneal abrasion?

a. Dangling ID badge
b. Pulse oximeter on the index finger
c. Incomplete eyelid closure
d. Taping the eyelid after induction

Appendix F

Recruitment Email

Dear Participant,

One behalf of the Cedar Crest College: School of Nursing and Nurse Anesthesia Program, we are cordially inviting you to participate in a doctoral project proposed by four student registered nurse anesthetists. Our project was unfortunately transitioned from a clinical setting-based implementation to a virtual platform due to today's unprecedented times amidst the COVID-19 pandemic. We ask that you participate in our project to help continuously advocate for implementing evidence-based practice into the clinical setting in order to improve upon anesthesia patient safety practices.

If you choose to voluntarily participate, you can follow the link below to our custom website for our project. Here, there will be a simple 3-step process to follow for participation. **Step 1** will consist of a brief 10-question pre-survey. After completion of the pre-survey, **Step 2** will be to watch our educational module on best practices of anesthesia patient safety. This module consists of four individual topic presentations that are approximately 10 minutes each. After the presentation segment, a robust simulation scenario will be performed. The entire duration of the module is approximately 1 hour. After viewing the module, you can proceed to **Step 3** of participation. Here, a 10-question post-survey will be administered to help us gather pertinent data on this doctoral project. Although this is 100% voluntary, completion and submission of the online survey is an indication of your consent to participate within the project. You can stop participation at any time up until submission of the post-survey during Step 3.

Institutional Review Board (IRB) approval was obtained prior to the project's implementation. Each DNP student author from the module completed Collaborative Institutional Training Initiative (CITI) training. It is anticipated that participants will be at no physical, psychological, or emotional risk at any time during this research. We assure that all survey data is anonymous and will be collected and stored on an encrypted and password protected electronic device.

Your participation is crucial to the implementation of this project and would be greatly appreciated! Provided below is a link to the website. We hope that you are as interested as we are in advocating for the improvement of evidence-based practices on anesthesia patient safety.

Please feel free to contact any of us with any question, comments, or concerns regarding this project.

WEBSITE LINK:

https://athernan2.wixsite.com/website

Sincerely,

Anthony Hernandez, BSN, RN, CCRN, SRNA
Principal Investigator
Doctor of Nursing Practice Candidate
Cedar Crest College: School of Nursing Nurse Anesthesia Program
athernan@cedarcrest.edu
Phone: (347) 255-5133

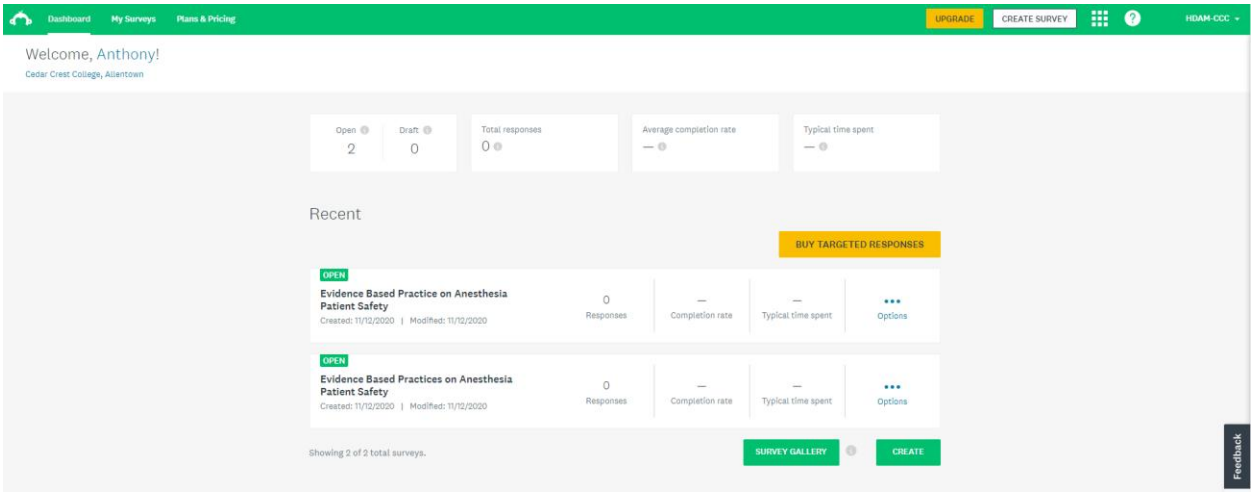
Dan Byorick, BSN, RN, CCRN, SRNA
Principal Investigator
Doctor of Nursing Practice Candidate
Cedar Crest College: School of Nursing Nurse Anesthesia Program
dbyoric@cedarcrest.edu
Phone: (570) 574-1642

J. Matt Lohman, MBA, BSN, RN, CCRN, SRNA
Principal Investigator
Doctor of Nursing Practice Candidate
Cedar Crest College: School of Nursing Nurse Anesthesia Program
Jmlohman@cedarcrest.edu
Phone: (610) 914-7502

Hakeem Sanou, BSN, RN, CCRN, SRNA
Principal Investigator
Doctor of Nursing Practice Candidate
Cedar Crest College: School of Nursing Nurse Anesthesia Program
Hsanou@cedarcrest.edu
Phone: (267) 298-8511

Appendix G

SurveyMonkey Website for Data Collection



Source: https://www.surveymonkey.com/r/6SNDJ8W (Pretest Survey)

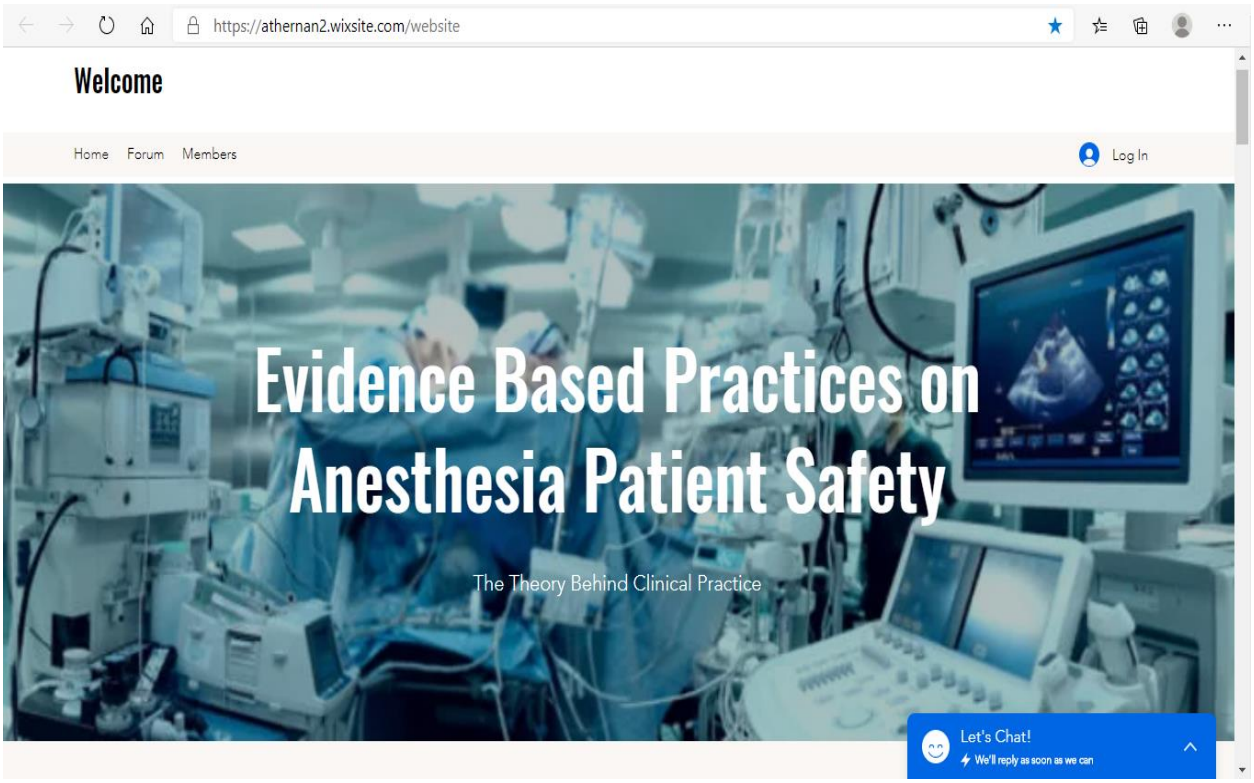
Source: https://www.surveymonkey.com/r/63VRM9C (Posttest Survey)

QR CODE (Pretest Survey)

QRCODE (Posttest Survey)

Appendix H

Wix Website Builder for Individual Projects and Simulation Video



Source: https://athernan2.wixsite.com/website

Appendix I

SPSS Analysis of Question 3

Pretest Question: What degree of paralysis is present when 4/4 Train of four twitches are elicited with a peripheral nerve stimulator?

Posttest Question: What degree of paralysis is present when 4/4 twitches are elicited with a peripheral nerve stimulator?

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Test * Conditon	48	100.0%	0	0.0%	48	100.0%

	Test	Conditon	Freq
1	Pretest	Correct	17.00
2	Pretest	Incorre	7.00
3	Postest	Correct	18.00
4	Postest	Incorre	6.00

Test * Conditon Crosstabulation

			Conditon		
			Correct	Incorre	Total
Test	Postest	Count	18	6	24
		% within Test	75.0%	25.0%	100.0%
	Pretest	Count	17	7	24
		% within Test	70.8%	29.2%	100.0%
Total		Count	35	13	48
		% within Test	72.9%	27.1%	100.0%

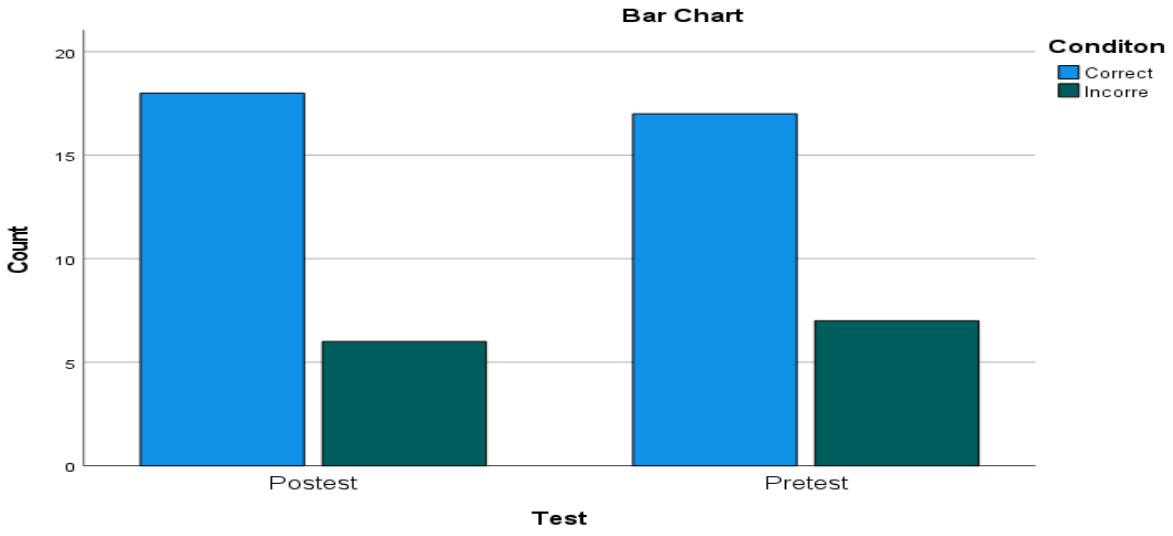
Chi-Square Tests

	Value	Exact Sig. (2-sided)
McNemar Test		1.000[a]
N of Valid Cases	24	

a. Binomial distribution used.

Risk Estimate

	Value	95% Confidence Interval	
		Lower	Upper
Odds Ratio for Test (Postest / Pretest)	1.235	.345	4.426
For cohort Conditon = Correct	1.059	.750	1.496
For cohort Conditon = Incorre	.857	.337	2.177
N of Valid Cases	48		



Appendix J

SPSS Analysis of Question 4

Pretest Question 4: What is the ideal recovery TOFr to achieve prior to extubation?

Posttest Question 4: What is the ideal TOFr to achieve prior to extubation?

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Test * Condition	48	100.0%	0	0.0%	48	100.0%

	Test	Condition	Freq
1	Pretest	Correct	22.00
2	Pretest	Incorre	2.00
3	Postest	Correct	23.00
4	Postest	Incorre	1.00

Test * Condition Crosstabulation

			Condition		
			Correct	Incorre	Total
Test	Postest	Count	23	1	24
		% within Test	95.8%	4.2%	100.0%
	Pretest	Count	22	2	24
		% within Test	91.7%	8.3%	100.0%
Total		Count	45	3	48
		% within Test	93.8%	6.3%	100.0%

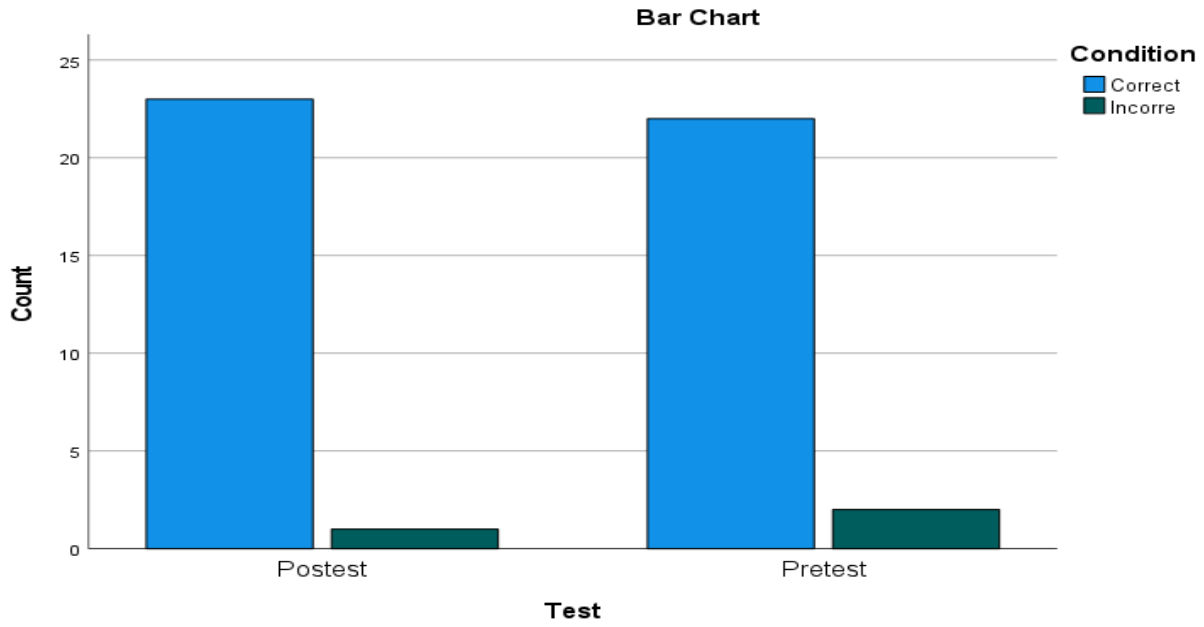
Chi-Square Tests

	Value	Exact Sig. (2-sided)
McNemar Test		1.000[a]
N of Valid Cases	24	

a. Binomial distribution used.

Risk Estimate

	Value	95% Confidence Interval	
		Lower	Upper
Odds Ratio for Test (Postest / Pretest)	2.091	.177	24.734
For cohort Condition = Correct	1.045	.903	1.211
For cohort Condition = Incorre	.500	.049	5.154
N of Valid Cases	48		



Appendix K

SPSS Analysis of the Educational Module

	Test	Condition	Freq
1	Pretest	Correct	90.00
2	Pretest	Incorre	54.00
3	Postest	Correct	128.00
4	Postest	Incorre	16.00

Chi-Square Tests

	Value	Exact Sig. (2-sided)
McNemar Test		.[a]
N of Valid Cases	288	

a. Both variables must have identical values of categories.

Case Processing Summary

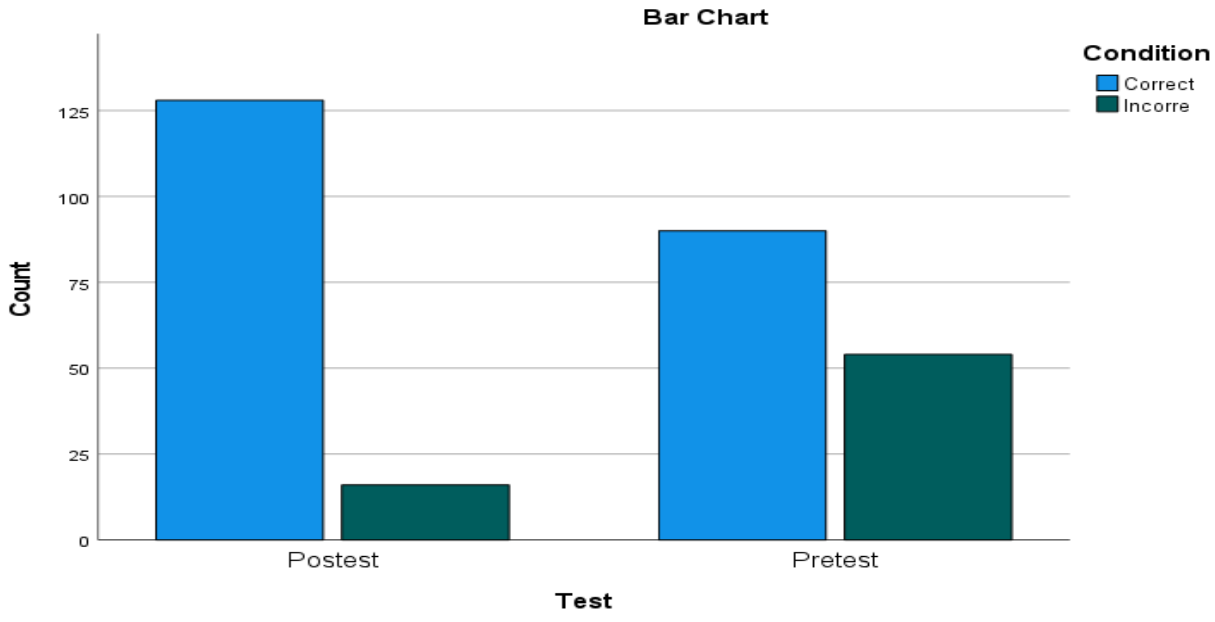
	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Test * Condition	288	100.0%	0	0.0%	288	100.0%

Test * Condition Crosstabulation

			Condition		
			Correct	Incorre	Total
Test	Postest	Count	128	16	144
		% within Test	88.9%	11.1%	100.0%
	Pretest	Count	90	54	144
		% within Test	62.5%	37.5%	100.0%
Total		Count	218	70	288
		% within Test	75.7%	24.3%	100.0%

Risk Estimate

	Value	95% Confidence Interval	
		Lower	Upper
Odds Ratio for Test (Postest / Pretest)	4.800	2.583	8.919
For cohort Condition = Correct	1.422	1.238	1.634
For cohort Condition = Incorre	.296	.178	.492
N of Valid Cases	288		



Appendix L

AACN DNP Essentials

DNP Essentials

1. **Scientific Underpinnings for Practice:**
   - Integrate nursing science and theory with knowledge and theory from ethics, the biophysical, psychosocial, cultural, and organizational sciences to develop and evaluate new practice approaches.
2. **Organizational and Systems Leadership for Quality Improvement and Systems Thinking**
   - Demonstrate leadership in the development and evaluation of care delivery approaches that meet current and future needs of patient populations from findings of nursing and other clinical sciences, as well as organizational, political and economic sciences.
   - Develop and evaluate effective strategies and ensure accountability for leading organizations, addressing quality improvement and patient safety initiatives, and managing ethical dilemmas inherent in patient care and research.
3. **Clinical Scholarship and Analytical Methods for Evidence-Based Practice**
   - Use analytic methods to critically appraise existing evidence to determine best practices.
   - Apply relevant findings and use quality improvement methods to develop recommendations to improve practice and the practice environments
   - Disseminate findings from evidence-based practice and research to improve health care outcomes.
4. **Information Systems/Technology and Patient Care Technology for the Improvement and Transformation of Health Care**
   - Evaluate programs that monitor outcomes of care, care systems, and quality improvement including consumer use of health care information systems.
   - Provide leadership in the evaluation and resolution of ethical and legal issues within health care systems relating to the use of information, information technology, communication networks and patient care technology.
5. **Health Care Policy and Advocacy in Health Care**
   - Demonstrate leadership in the critical appraisal, development, and/or implementation of institutional, local, state, federal, and international health policy.
6. **Interprofessional Collaboration for Improving Patient and Population Health Outcomes**
   - Collaborate using communication, consultative, and leadership skills, with intraprofessional and interprofessional teams to improve quality and safety in health care.
7. **Clinical Prevention and Population Health for Improving the Nation's Health**
   - Analyze scientific data and synthesize concepts related to clinical prevention and population health in developing, implementing, and evaluating interventions to address health promotion and disease prevention efforts.
8. **Advaned Nursing Practice**
   - Design, implement, and evaluate therapeutic interventions based on nursing science and other sciences

Source: (American Association of Colleges of Nursing, 2006)

Appendix M

Eastern Nursing Research Society Virtual Conference Poster Presentation