Implementation of a Cognitive Aid to Increase the Use of Neuromuscular Monitoring in the Operating Room

Hannah Parker DNP, MSN, RN, CCRN, SRNA

Cedar Crest College School of Nursing

Author Note

This paper is based on data from DNP project completed as partial fulfillment of the Doctor of Nursing Practice degree with the guidance and supervision of the following:

Dr. Bimpe Adensui, PhD, APRN, CRNA, CNE – Program Director of the Nurse Anesthesia Program

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

Dr. Jill Hanisak, DNP, CRNA - DNP Chair

DNP Project Site: Lehigh Valley Health Network – Cedar Crest

Correspondence concerning this paper should be addressed to Hannah Parker, Cedar Crest College School of Nursing, Allentown, PA. Email: HEParker@cedarcrest.edu

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Abstract

Providers of anesthesia, such as certified registered nurse anesthetists (CRNAs), are entrusted to maintain patient safety by staying up to date on the most recent evidence-based practices. Residual neuromuscular blockade (rNMB) can cause a myriad of patient health concerns. By following evidence-based practice guidelines, the profession can continue to maintain patient safety by utilizing neuromuscular monitoring in the operating room. This project was guided by Kurt Lewin's Change Theory to ensure the most descriptive outcomes. The purpose of this project was to identify if implementing a cognitive aid will increase the use of a quantitative neuromuscular monitor (QNM). The assessment was a comparison of before and after the implementation of a cognitive aid with the QNM. The use of the QNM increased by 27 percent after the cognitive aid was implemented.

Key words: quantitative, neuromuscular monitoring, anesthesia, cognitive aid

Chapter I: Introduction and Overview of the Problem of Interest

Background and Significance

The goal of general anesthesia is to provide analgesia, sedation, hypnosis, amnesia, and sometimes neuromuscular blockade (Sorin & Kopman, 2017). The medications that have been developed since the invention of anesthetics have become safer to use. This includes the use of neuromuscular blocking agent (NMBA) to maintain akinesia during the operation for the best surgical conditions. The inadequate or incomplete reversal of a NMBA leads to a phenomenon called rNMB (Ledowski et al., 2015). In patients undergoing surgery who require neuromuscular blockade during surgery, 20 to 60% will experience rNMB (Wiatrowski et al., 2018). Unintended consequences in patients who have rNMB include hypoventilation, hypoxia, hypercarbia, airway obstruction, silent aspiration, reintubation, post operative respiratory failure. These adverse respiratory events can lead to poor outcomes and even death (Dunworth et al., 2018).

The duration and effectiveness of neuromuscular blocking agents (NMBA) is monitored most frequently by a peripheral nerve stimulator (PNS) to monitor the train of four (TOF). Using a qualitative neuromuscular monitor (QLNM) to assess the TOF is a common way of guiding the anesthesia provider to the correct dose and timing of the reversal of the NMBA. A PNS and QLNM are terms that can be used interchangeably. The QLNM stimulates the patient's nerve to have up to four potential muscle twitches in a row. At two hertz of power, they are activated with a one half second pause in between (Nagelhout & Elisha, 2018). These twitches are notated as T1 to T4. When there are zero out of four possible twitches, this indicates that the patient's receptors are totally blocked. This means they are completely paralyzed. When there are all four twitches of equal strength, the most certain an anesthesia provider can be is that there is at 70% or 0.7 of the receptors are not blocked. The more precise way to determine recovery from paralytic is via a train of four ratio. The TOF ratio is only able to be obtained by a QNM monitor. Only when the patient reaches a TOF ratio of 90% or >0.9 are they able to maintain their own airway from a NMBA standpoint (Bash et al., 2021).

Though the twitch count can be somewhat straightforward, there is more subjective data that must be observed and assessed. The notion of fade is defined as the inability to sustain a response to repetitive nerve stimulation and is indicative of drug-induced paralysis (Nagelhout & Elisha, 2018). The fade determines the degree of which the patient is still under the influence of the NMBA. The QLNM stimulator is qualitative and subjective, leading to different interpretations among providers. These varied analyses are attributed to the poor reliability between analyzers and the clinician's ability to detect fade (Dunworth et al., 2018).

The ambiguity of the QLNM used to determine the TOF is demonstrated by its inability to determine the TOF ratio. It is only able to determine the TOF count. The definition of full recovery from the NMBA is the TOF ratio ≥0.9. This can only be completed by utilizing a QNM to assess the TOF ratio. The QLNM provides a qualitative representation of the TOF, whereas the QNM assesses both the TOF and the TOF ratio.

The TOF ratio is beneficial to the anesthesia provider because it can determine whether they will re-dose the paralytic, hold the dose of paralytic or reverse the NMBA. The variability of interpretation of the subjective peripheral nerve stimulators has caused multiple issues. These include improper NMBA doses, increased dosing, and lack of adequate reversal (Sorin & Kopman, 2017). One of the most significant issues caused by subjectivity is the incidence of rNMB. If a patient's airway is not protected, and they do not have a TOF ratio of >0.9, they will not have the airway strength to maintain a safe and patent airway, and that causes significant risk to the patient. With the current status of practice, the TOF ratio is not able to be assessed by the QLNM.

PICO Question Guiding Inquiry

The risks of rNMB are great, and they increase with the use of a subjective, QLNM to monitor the TOF to determine the reversal of the NBMA. There is a need for a better way to quantitatively assess the level of paralysis. While various types of QNM monitors do exist, there is a need for consistency of use to protect the population. There has been an inconsistency in the implementation of new devices due to the apprehensiveness of colleagues to endure changes in their current routine (Shahbaz et al., 2019). The use of cognitive aids has varied widely from use in emergent situations to daily routine tasks. These aids can assist in consistency and safety of use (Brindley et al., 2020).

There is increased risk to the patient if their NMBA is not fully reversed, such as aspiration, reintubation, and respiratory distress (Fortier et al., 2015). The patient population in the operating room needs to be protected from a physical health standpoint, a cost standpoint, and a legal standpoint. The timeline of this project is condensed to allow for a substantial amount of data collection in an abbreviated period of time. The PICO question is as follows: In anesthesia providers, does the use of a troubleshooting cognitive aid in the OR increase the use of a QNM?

Systems and Population Impact

The project site that was utilized for this project is the Cedar Crest Campus of Lehigh Valley Health Network. It is a facility with twenty-four operating rooms that serve the surrounding community. In 2021, there were approximately 72,000 acute admissions and 1.4 million outpatient registrations (LVHN, 2021). The stakeholders in this project were the patients, anesthesia staff and the executives of LVHN who were responsible for cost analysis. The participants that were directly involved in this project were the CRNA providers who were utilizing nondepolarizing NMBAs for intubations in the operating room. They were selected based on providers that were assigned to the operating rooms that had the QNM. Inclusion criteria consisted of surgery requiring the use of NMBA in the operating room that had the QNM. If NMBA were given but the QNM is not used, that was included as well. Exclusion criteria included surgeries that did not require NMBA and operating rooms that were not equipped with the QNM.

Lehigh Valley Health Network had a significant number of sites where surgery is performed. This could range from ambulatory surgery to acute intervention requiring hospitalization. Since this was a new monitor that was implemented into the network, the assessment was confined to two rooms to best evaluate the usage and results. There are over 130 CRNA providers in the network that rotated through this implementation operating room based on clinical scheduling. This project was supported by the administrator of Lehigh Valley Anesthesia Services and facilitated by the Anesthesia Education Director. There were no barriers to the success of this project other than the actual use by the CRNAs themselves. The monitoring device was paid for by the network and was implemented in the fall of 2022.

Purpose and Objectives

The purpose of this DNP project was to implement a cognitive aid to increase the utilization of QNM during anesthesia cases that require NMBA. The aim was to change the current practice from the QLNM that was originally being used to the evidence-driven method of QNM. The objective of this project was to enhance knowledge about QNM used in the patient population who received NMBA during their surgery. Another objective was to facilitate the use of the QNM by applying a cognitive aid. The objectives were measured by comparing pre- and post- implementation data. To obtain this objective assessment, there were two retrospective chart reviews. A pre- and post- intervention evaluation was completed to identify the change of use of the QNM before and after the intervention of the cognitive aid. Analysis of a practice change was performed over sixty days after the cognitive aid has been implemented.

Chapter II: Review of Evidence/Literature

Search Methodology

A broad review of the current literature was conducted using primarily Google Scholar. To gain more specific evidence a few different databases were utilized. These include PubMed, Cochrane library, and EBSCO host. The most commonly searched key words were "neuromuscular," "quantitative," "blockade," "residual," and "education." Of the publications that were originally published, there were 20-40 that met the inclusion criteria. Inclusion criteria mainly consisted of the QNM implementation along with articles regarding the benefit of a cognitive aid. All articles chosen were less than ten years old.

Quantitative Monitoring

By definition, full recovery from muscle relaxants is defined as a TOF ratio of >0.9, which is only provided by the QNM, not the QLNM (Nagelhout & Elisha, 2018). Comparatively, objective measurements using QNM are much more precise. QNM can measure a finer degree of receptor site saturation, as precise as less than one percent (Nagelhout & Elisha, 2018). When the TOF ratio is less than 0.9, there will be a degree of rNMB present, which can put the pharyngeal and laryngeal muscles at a risk for weakness and further airway complications post-operatively (Dunworth et al., 2018).

Population with rNMB

In the review of literature, there are a few groups of patients that had an increased risk for rNMB. The most commonly found surgical cases with increased incidence of rNMB were laparoscopic intra-abdominal surgical cases. In these cases, there was an increased probability that there would be rNMB at extubation (Sager et al., 2019). Further at-risk surgical cases include breast cases, extremity surgeries, and open abdominal cases (Khamtuikrua et al., 2017).

Additionally, patients with higher ASA scores more frequently resulted in an incidence of rNMB (Sager et al., 2019). In the study done by Khamtuikrua et al., the probability of having rNMB was around 50% (2019).

Effects of rNMB

Surgical paralysis is reversed at the end of the case by the anesthesia provider. A study by Rudolph et al. was conducted, and neostigmine/glycopyrrolate was the most common reversal found to be used (2018). In this same study, the findings correlated with a decrease in pulmonary complications after the QNM was implemented. Additionally, there was shown to be a decrease in cost and length of hospital stay (Rudolph et al., 2018). The assessment of the NMBA must be accurate to ensure the anesthesia provider has the correct data to determine the dose, timing, and requirement of a reversal agent.

Post-operative rNMB

The most common incidence of rNMB causing problems is in the post anesthesia care unit (PACU) where a patient is not monitored on a 1:1 ratio with comprehensive monitoring. Compared to the operating room, there are no assigned anesthesia staff, higher ratios of nurses to patients, and less complicated monitoring (Grabitz et al., 2019). Understanding where and when the complications happen with the rNMB is beneficial in helping aid in its prevention. In a study done by Sager et al., more than 65% of postoperative patients had a TOF ratio of <0.9 and 31% had a TOF ratio of <0.6 (2016). Additionally, on arrival to the PACU, over 55% of patients in this study had rNMB (Fortier et al., 2015). Knowing the location and timing of the most common incidence of rNMB, anesthesia providers are paramount in avoiding extubation until the TOF ratio is >0.9.

Cognitive Aids

The origin of cognitive aids started in aviation in the 1920s when there was a need for standardized procedures when the tasks became increasingly more difficult (Marshall, 2013). In anesthesia specifically, cognitive aids have been presented and utilized for cardio-pulmonary arrest and malignant hyperthermia. In these situations, the team functions more efficiently with a reader of the cognitive aid to ensure there is clear communication in the group (Gaba, 2013). While cognitive aids have their place in emergency situations, they can also be useful in less stressful circumstances, such as the utilization of a tool. In a study done by Drzymalski et al., there was a reduction in morbidity and mortality when utilizing a cognitive aid in the operating room (2019). The efficacy of a cognitive aid was observed in this project.

Limitations

Although there was sufficient evidence that identified the effectiveness of using cognitive aids to enhance the use of a device, there were limitations that needed to be addressed. A few of the major articles were greater than 5 years old with the oldest article originating from 2014. This lack of results were most likely due to a lack of ample research in this specific operating room patients who receive NMBA. Another limitation included the lack of a specific relation between a cognitive aid and the QNM. While there was ample positive evidence of implementation of a cognitive aid, and ample evidence of QNM being beneficial, there was a shortage of articles or research that addressed the two together. This project married the two to provide a comprehensive assessment of the benefit of a cognitive aid in increasing the use of a QNM.

Conclusions

The clinical problem of rNMB has been a high risk to patient safety. With the ability to prevent this, the implementation of the QNM was beneficial. The evidence and literature explain clearly that the use of QNM for NMBA monitoring was superior to QLNM. To maintain safety, competency, and competition within the surrounding area, it was vital to ensure the monitoring methods were up to date with the most recent evidence-based practice. This DNP project was key in implementing a cognitive aid to increase the use of a QNM that more clearly and distinctly informed the anesthesia provider of the data they needed to prevent rNMB.

Chapter III: Organizational Framework of Theory

Theoretical Framework

Nursing theories can be utilized to assist people in creating guidelines to advance the work of research (Watkins, 2020). Theories and conceptual frameworks assisted throughout this process by finding a closely aligned method to the suggested clinical change. The conceptual framework chosen for this project was Kurt Lewin's Change Theory (see Appendix A). This three-stage model includes unfreezing, change then refreezing (Zimbardo, 2016). Unfreezing means finding a method to allow people to let go of the past ways of doing things. Change includes the implementation of the new process. Refreezing is the stage where the new habit is re-established (Hussain et al., 2018). In this DNP project specifically, the unfreezing included letting go of using only the QLNM to monitor the recovery from the NMBA. The change was the implementation of the cognitive aid about the QNM to increase its use, and the refreezing included the new normal practice of utilizing the QNM routinely.

There were also practicalities that are involved in introducing new technology and practices into the operating room. These included cost, feedback, resistance, and persistence (Todd et al., 2014). The cost of a new implementation impacts the bottom line of a health network and can be a major barrier to implementation. Additionally, the rounds of review and follow up can be time consuming for the people performing them along with participating staff members. Also, there can be resistance to change from the providers themselves. Finally, it is vital that there are people who are in charge of the implementation to ensure it is seen through from start to finish (Todd et al., 2014).

Chapter IV: Project Design

Institutional Review Board Approval

This DNP project was a quality improvement project. After collaboration and review with the staff at Lehigh Valley Health Network (LVHN), it was determined that the lack of QNM was a point of interest. There was a significant amount of literature that is available regarding the use of QNM over the use of the QLNM. Submissions of the protocol and procedure for the project were submitted to the Lehigh Valley Health Network Institutional Review Board (IRB) in September of 2022. After submission, the IRB deemed the project unnecessary for IRB approval per 45 CFR 26.102(d), since the project does not fit the regulatory requirements for human research secondary to no direct patient risk. Since the implementation site did not require IRB approval, Cedar Crest College accepted their determination, and did not require approval.

Implementation Plan

The QNM was implemented in two operating rooms at LVH-CC during the fall of 2022. The QNM was rotated throughout available operating rooms depending on case volume and requirements. The pre-evaluation of the data was a retrospective chart review after the QNM had been introduced to the operating room. The only educational materials that went with this original presentation of the QNM by LVHN was the in-service by the sales representative and a company provided instruction guide in the OR. This retrospective chart review included sixty days of data to establish a baseline. The intervention of a set-up guide was then placed in the OR with the equipment. This was in place for sixty days, and at the end of that time, there was an additional retrospective chart review to assess changes in use.

Data Collection Tools

The pre-data was collected for sixty days in the early fall of 2022 following the in-service to the anesthesia colleagues by the Phillips' educator on September 22nd, 2022. The cognitive aid was implemented in between the pre-data and post-data. The post-data period was for sixty days after the implementation of a cognitive aid. The data assessed included 120 days total. The data was collected via retrospective chart review to assess how many CRNAs utilized the new tool during each of these timeframes. A data review was completed to determine if there was an increase in usage of the equipment with the addition of cognitive aid.

Budget Justification and Resources Needed

In this particular project, the main cost was time. The development of the cognitive aid and the review of the electronic medical record was extensive and required a significant amount of time. The potential benefit to the site included a reduction in complications related to rNMB (rNMB). If there were fewer incidents relating to rNMB, then one could postulate that there would be a decrease in cost. Anesthesia management at the site previously had the intention to set up meetings with the sales staff to bring the devices into the OR. One QNM was purchased by the network, and one was loaned for the duration of the project by the Phillips company.

Chapter V: Implementation Procedures and Process

The QNM was introduced to the anesthesia staff during an in-service on September 22nd, 2022. This was done by the Philips company sales representative and the clinical educator. This established a knowledge base for the staff for the operation of the QNM. The QNM is a modular unit that can be moved between rooms and is compatible with each main patient monitor.

There were two QNMs provided in the operating rooms at LVH-CC for 120 days total from November of 2022 to January of 2023. There was pre-data gathered before implementation of the cognitive aid, and the post-data collection was performed after the implementation. The implementation of the cognitive aid was provided at the midpoint. The data was stored in the established computer system of EPIC. If the QNM was being used correctly, the data would transfer directly to EPIC. The specific data that was transferred is the train of four count and the train of four ratio. The number of cases that the QNM was used was able to be isolated by the computer system. This computer system is password protected, providing the privacy of all involved. The number of uses of the QNM before and after the implementation of the cognitive aid were compared at the end of the 120-day total pre- and post- implementation period.

Participants for this project were chosen based on their assignment to a room with a QNM. Some operations do not require a NMBA, therefore would not be an ideal operating room to utilize the QNM. The Phillips company provided the network with two QNMs that are able to be moved to different operating rooms at the Cedar Crest location depending on case need/requirement. Inclusion criteria include the use of NMBA during the case and the actual use of the new Phillips QNM. Exclusion criteria include cases that do not require NMBA and CRNAs that do not utilize the new QNM. The participation number was based on the number of CRNAs that utilize the QNM in appropriate cases. An appropriate case is defined as a case that requires NMBA and the QNM is in the room. The project was communicated to the staff via a mass email that reached all CRNAs in the anesthesia department and made them aware. Additionally, there was an in-service provided by the Philips company for basic education on September 22, 2022, prior to the introduction of the QNM into the operating rooms.

The implementation consisted of a two-sided, laminated cognitive aid providing information to the operation of the device. The quick guide included tips regarding calibration, monitoring, reset capability and common error messages. The cognitive aid simplified the most common issues seen by the company and assessed by staff during the pre-implementation phase. Copies of the cognitive aids were hung prominently in each of the operating rooms. The cognitive aid was implemented after sixty days of pre-intervention data collection. At the end of the pre- and post- intervention data collection these data sets were compared. This was done through a retrospective chart review. The pre-data consisted of CRNA use of the QNM in an appropriate case before the implementation of the cognitive aid. The post data consisted of CRNA use of the QNM in an appropriate case after the implementation of the cognitive aid.

Chapter VI: Evaluations and Outcomes

Evaluations

This project spanned over four months. The first sixty days were reflective of the pre-intervention data and the last sixty days were reflective of the post-intervention data. The intervention was the implementation of the cognitive aid in each operating room at Lehigh Valley Health Network- Cedar Crest Campus. On September 22nd, 2022, there was an in-service done by the Phillips company to present the monitors to the anesthetists at the campus. This was unrelated to the project, as it was presented by the sales representatives to educate the CRNAs about how to use the monitor. This gave the project a starting date, since after the in-service, the new QNMs were present in the operating rooms.

Considering the cost of the QNM to the health network, one monitor was purchased, and one monitor was on loan for the duration of the project. This limited the total possible implementation of the new QNMs to two operating rooms per day. The QNMs are mobile, so the cognitive aid was implemented in every operating room at the campus in case the monitor changed rooms depending on the case need. The QNMs and the standard QLNM would only be necessary in an operative case that required a non-depolarizing NMBA.

The pre-intervention period ran from September 28th, 2022, to November 27th, 2022. Data was retrieved from the electronic medical record system, Epic. There were eleven data points recorded during the pre-intervention phase that had both non-depolarizing NMBA ***and*** at least one use of the new QNB during the calendar day. In the sixty days of the pre-intervention period, there were 27 operative cases of non-depolarizing NMBA with these basic requirements. These cases included the use of the new QNM ***and/or*** the use of the original QLNM. Out of the 27 cases of non-depolarizing NMBA used during the pre-intervention phase, there was one case of no documentation of recovery from the non-depolarizing NMBA. This is an incidental finding that was further discussed later in the report.

The implementation of the cognitive aid was completed on November 28th, 2022 (see Appendix A). For the implementation, the SRNA created, laminated, and attached the cognitive aid to the anesthesia machine in each operating room. The cognitive aid outlined the set-up and calibration of the equipment. Additionally, there were quick tips and reset information along with the reference to the IntelliVue Patient Monitoring NMT Quick Guide supplied by the Philips company, which was the manufacturer of the QNM. This implementation served as a simple set-up guide to ensure the new QNM was as simple to set up and utilize as possible.

The post-data was collected from November 29th, 2022, to January 28th, 2023. This data was compared to identify the efficacy of the implementation of the cognitive aid. There were eight data points recorded during the post-intervention phase that had both non-depolarizing NMBA ***and*** at least one use of the new QNM during the appropriate calendar days. In the sixty days during the post-intervention, there were 14 operative cases of non-depolarizing NMBA being used. These cases include the use of the new Philips QNM ***and/or*** the use of the original QLNM. Out of the 14 cases of non-depolarizing NMBA used during the post-intervention phase, there was again one case of no documentation of recovery from the non-depolarizing NMBA.

Outcomes

Out of the 27 possible cases in the pre-intervention period, 52 percent of CNRAs used the standard QLNM. For the QNM, 44 percent of CRNAs utilized this tool (see Table 1). Incidentally, it was found that 4 percent of CRNAs did not document the recovery from non-depolarizing NMBA at all. Out of the 14 possible cases in the post-intervention data, 21 percent of the CRNAs used the standard QLNM while 71 percent of CRNAs used the QNM. There were 7 percent of cases that did not document the recovery from non-depolarizing NMBA at all.

From the pre-intervention data to the post-intervention data, there was a 31 percent decrease in the use of the standard QLNM. For the pre-intervention to the post-intervention regarding the QNM, the use increased by 27 percent. Both pre- and post-intervention data sets include one instance that did not document recovery from non-depolarizing NMBA with neither the QNM nor the QLMN.

Discussion

The data is indicative of the cognitive aid being useful in increasing the utilization of the QNM. There were multiple components to the assessment of this data, such as the difference between the pre- and post- data CRNA use of the QNM along with the lack of documentation. Additionally, since the QNMs were mobile, there was a period of time that one of the monitors was not able to be located. Finally, the consideration of outlier CRNA use was excluded in the data.

The pre-intervention data included 27 total possible cases that had both non-depolarizing NMBA ***and*** at least one use of the new QNM during the calendar day. The post- intervention only had 13 of these types of cases in the same amount of the sixty days. This is indicative of a decrease of CRNA utilization of the standard QLNM. This could be due to a number of reasons. One could be the timing of the major holidays, therefore less scheduled cases. Secondly, the duration of case length could have been shorter which could prompt a CRNA not to familiar with the newly implemented QNM and use what they are familiar with. The lack of documentation remained stable throughout the pre- and post- implementation data. There was one CRNA in both of these data sets that did not document quantitative nor qualitative recovery from non-depolarizing NMBA. This could be significant regarding legal implications.

The new QNMs are mobile, which allows them to be compatible and usable in any operating room on the campus of implementation. This was beneficial but was also found to be an obstruction in data collection. The use of the monitor required a CRNA to actively seek out the monitor and bring it to their room for use. This could be seen as a major barrier to the implementation, as it relies on CRNA initiation to use the new monitor, since they are not present in every operating room. Additionally, there was a period of time that only one monitor was able to be located. This could be contributory towards the smaller number of records in the post-intervention data collection.

In total, there were 13 CRNAs that utilized the new QNM a total of 43 times that were included in the pre- and post- intervention data. Of the 43 times the new QNM was used, 20 of those times were by one CRNA. This CRNA utilized the data equally pre- and post- intervention, which nullified their data in contribution to the project. This CRNA was determined to be an outlier and was excluded from the data interpretation.

Chapter VII: Implications for Nursing Practice

Implications for Practice

Evidence based practice is the guide for decisions that are made in the clinical setting, though there are remaining barriers to implementing and applying the findings (Lehane et al., 2019). In this project, there was a decrease in percentage of usage of the QLNM after the quick guide was implemented. This project served as an evidence-based example that a cognitive aid could increase the use of a monitor. This can be applied to other areas of practice such as emergency situations, commonly misused items, or for newly implemented equipment. The proof that cognitive aids are effective in increasing the usage of a monitor can be repeated in future projects.

Strengths of Project

There were strengths and limitations to this project. One strength was the amount of literature that has been published regarding the use of QNM over the QLNM. A gap analysis at this site revealed there were no QNMs present, which opened an opportunity to implement them based on best practice. The cognitive aid itself was a physical copy that was present in each operating room. It was attached to the machine to decrease the instance of being misplaced. Additionally, the project was relatively low-cost and did not require the cooperation of a large group of people.

Limitations of Project

While there are a significant number of strengths related to this DNP project, there are a few limitations that need to be addressed. The most prominent limitation is the relatively small sample size due to only being two monitors available for use. The maximum number of rooms the DNP project could be implemented in at the same time is two. This limits the amount of

CNRAs who are exposed to the monitor and were able to use it. To remedy this limitation, the healthcare network could have purchased more monitors – but that would have increased the cost burden of the project. Additionally, there were days in both the pre- and post- intervention that there were no QNMs used. Because the QNM was only in two operating rooms, it took some self-starting on the CRNAs to seek out the monitor if they had an appropriate case and wished to use it in their room. Finally, the implementation time could have been extended to allow for more participants and therefore a larger sample size.

Linkage to DNP Essentials

There are eight DNP essentials that are listed on the American Association of Critical-Care Nurses (AACN, 2006). These DNP essentials dictate the requirements for fundamentals that must be met during the doctoral program. During this DNP project, the goals, proficiencies and foundations have been met. The DNP essentials that were met in this project include DNP Essential I through DNP Essential VIII. The succeeding section will iterate how the DNP essentials were met based on the actions completed while completing this DNP project.

Essential I

The first DNP essential is the "Scientific Underpinning for Practice." This project utilized research and literature findings in the project design. This is crucial, as the premise for evidence-based practice is the involvement of scientific underpinnings in research. This project also incorporated a theoretical framework which also have a basis in scientific research. Choosing what to implement was indicated by the needs assessment. The needs assessment of the site was compared to the current evidence-based patient safety practices in the current literature.

Essential II

The second DNP essential is "Organizational and Systems Leadership for Quality Improvements and Systems Thinking." The DNP project allowed the author to collaborate with leaders in the healthcare network to make decisions. The author functioned as a leader during this project to ensure the quality of the project was maintained throughout. The author was able to gain personal clinical knowledge regarding the equipment and therefore improve the safety of patients undergoing general anesthesia.

Essential III

The third DNP essential is" Clinical Scholarship and Analytical Methods for Evidence Based Practice Projects." An extensive literature review was conducted at the initiation of this project. Additionally, there was critical appraisal of the current data from randomized controlled trials, systematic reviews, and other clinical practice guidelines. The knowledge gathered from the literature review was then synthesized into an evidence summary to focus the related research. The evidence synthesis allowed for the interpretation of current best practice regarding the QNM.

Essential IV

The fourth DNP essential is" Information Systems/Technology and Patient Care Technology for the Improvement and Transformation of Health Care." The cognitive aid was drafted and created utilizing technology. The main way this DNP essential was displayed in the project was through the data collection on the patient medical records. The data was narrowed down and then interpreted via this computer system. The evaluation of the data was driven by technology in the development of graphs, tables, and figures. Collaboration between those involved with the project occurred via a multimodal approach, thus allowing for prompt continuation of the project.

Essential V

The fifth DNP essential is “Healthcare Policy and Advocacy in Health Care.” The appraisal of the most recent evidence-based practice was compared with the current practice at the institutional level. There was an analysis of the current status, and a plan was synthesized to address the possible patient safety concerns. The implementation was available to a significant number of CRNAs, therefore the prompt for change was able to reach a relatively extensive group of people. The project will also be disseminated among colleagues in the profession to continue to educate on the latest evidence-based practices.

Essential VI

The sixth DNP essential is “Interprofessional Collaboration for Improving Patient and Population Health Outcomes.” There were many instances of interprofessional collaboration in this project. These groups included anesthesia providers, leadership teams, representatives from the monitoring company, and information technology. Involving these groups allowed for the DNP project to minimize gaps in safety and risk management. Additionally, the collaboration allowed for the most applicable and appropriate intervention. Due to the expertise of the professionals involved, the implementation was catered to be site specific and was presented in a uniform way in both the operating rooms.

Essential VII

The seventh DNP essential is “Clinical Prevention and Population Health for Improving the Nation’s Health.” The outcomes of this project allow for follow-up projects to be completed, which can have a major impact on the population’s health. As stated previously, QNM use decreases the incidence of rNMB and the complications that can accompany it (Dunworth et al., 2018). This project affirms the current data regarding the efficacy of QNM. This could possibly be involved in the future widespread change in practice will improve the nation's health by avoiding unnecessary clinical issues. Evidence based practice projects are effective at preventing poor clinical occurrences and improving the nation's health.

Essential VIII

The last DNP essential is "Advanced Nursing Practice." The author created, designed, implemented, and evaluated the effectiveness of a cognitive aid to increase the use of QNMs. The author also performed as a SRNA, a precursor to a CRNA, which is an advanced practitioner during the duration of the project. Evidence based practice was utilized daily to make informed decisions regarding patient care. The importance of continuing to be well-informed on the latest evidence-based practices is imperative to ensure the most appropriate and safe patient care.

Chapter VIII: Summary of Project

Summary and Conclusions

The evidence that was uncovered during this project demonstrated the high risk of rNMB after extubation (Rudolph et al., 2018). Also, the knowledge of the efficacy of QNM demonstrated a need for increased education and possible practice changes in the clinical setting. These complications of rNMB can include major patient safety concerns. Based on these complications, rNMB is considered a public health issue. QNM should be utilized to minimize the amount of risk to the patient (Rudolph et al, 2018). The subjectivity of the QLNM increases the risks of these post-operative complications, though they are still utilized in many institutions. In addition to increasing patient risk post-operatively, the incidence of rNMB increases cost for the health network. The additional costs include increased length of stay, unanticipated multi-disciplinary involvement in care, morbidity, and mortality (Sager et al., 2019)

Kurt Lewin's change theory was utilized to guide the direction and implementation during this project. The theory consists of unfreezing the normal standard of practice which is the QLNM. Then, it is vital to change or transition to the new way of practice. In this case, this involved the cognitive aid for the newly implemented QNM. Finally, the project is in the re-freezing stage of utilizing the device and cognitive aid in daily clinical practice. The data suggests a 27 percent increase in use when compared before and after the cognitive aid intervention. This indicates unfreezing had taken place and CRNAs were willing to use the QNM more after the implementation of the cognitive aid.

Dissemination

This project was disseminated on April 20th, 2023, at the Cedar Crest College School of nursing Practice Scholarly Project Presentations. A poster was created to provide a visual display of the evidence, findings, and conclusions of this DNP project. (see Appendix C). This poster was presented as an appendix when completed. This avenue of presentation allowed the DNP student to spread the evidence to a larger group of professionals. These professionals included students, college faculty, program directors and the dean of Cedar Crest College School of Nursing and the Provost of Cedar Crest College.

Future Plans

A reduction of preoperative morbidity and mortality can be achieved by avoiding rNMB (Dunworth et al., 2018). By reducing morbidity and mortality, the health networks that implement these changes can create cost savings. The goal of this project was to evaluate the implementation of a visual aid to assess the use of the QNM in the operating room setting. Additional studies should be conducted to evaluate the attitudes of CRNAs towards new monitoring devices and ways that those obstacles can be addressed. Additionally, there needs to be a network wide policy regarding the use of QNMs. This DNP project was able to maintain and assist in the forward progress towards safer anesthesia care.

References

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

Bash, L. D., Turzhitsky, V., Black, W., & Urman, R. D. (2021). Neuromuscular blockade and reversal agent practice variability in the US inpatient surgical settings. Advances in Therapy, 38(9), 4736-4755. https://doi.org/10.1007/s12325-021-01835-2

Brindley, P. G., Mosier, J. M., & Hicks, C. M. (2020). Pandemic airway management: A cognitive aid to increase safety and team cohesion during intubation, donning, and doffing. Journal of the Intensive Care Society. https://doi.org/1751143720931614.

Drzymalski, D. M., Schumann, R., Massaro, F. J., Trzcinka, A., & Azocar, R. J. (2019). Effect of a cognitive aid on reducing sugammadex use and associated costs: A time series analysis. *Anesthesiology*, *131*(5), 1036-1045.https://doi.org/10.1097/ALN.0000000000002946

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

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 rNMB. Anesthesia & Analgesia, 121(2), 366-372. http://doi.org/10.1213/ANE.00000000000 00757

Gaba, D. M. (2013). Perioperative cognitive aids in anesthesia: What, who, how, and why bother? *Anesthesia & Analgesia*, *117*(5), 1033-1036. http://doi.org/10.1213/ANE.0b013e3182a571e3

Grabitz, S. D., Rajaratnam, N., Chhagani, K., Thevathasan, T., Teja, B. J., Deng, H., Eikermann, M., & Kelly, B. J. (2019). The effects of postoperative rNMB 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.000000000000 4028

Hussain, S., Lei, S., Akram, T., Haider, M., Hussain, S., & Ali, M. (2018). Kurt Lewin's change model: A critical review of the role of leadership and employee involvement in organizational change. Journal of Innovation & Knowledge. 3(3), 123-127. https://doi.org/10.1016/j.jik.2016.07.00

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

LVHN by the numbers. (2021). Annual report. Retrieved April 23, 2022 from https://www.lvhn.org/about-us/annual-report/lvhn-numbers

Marshall, S. (2013). The use of cognitive aids during emergencies in anesthesia: A review of the literature. *Anesthesia & Analgesia*, *117*(5), 1162-1171. http://doi.org/10.1213/ANE.0b013e31829c397b

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

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. Anesthesia, 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

Shahbaz, M., Gao, C., Zhai, L., Shahzad, F., & Hu, Y. (2019). Investigating the adoption of big data analytics in healthcare: The moderating role of resistance to change. Journal of Big Data, 6(1), 1-20. https://doi.org/10.1186/s40537-019-0170-y

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

Todd, B., Hindman, M., & King, B. (2014). The implementation of quantitative electromyographic neuromuscular monitoring in academic anesthesia department. Anesthesia & Analgesia, 119(2), 323-331. http://doi.org/10.1213/ANE.00000000000261

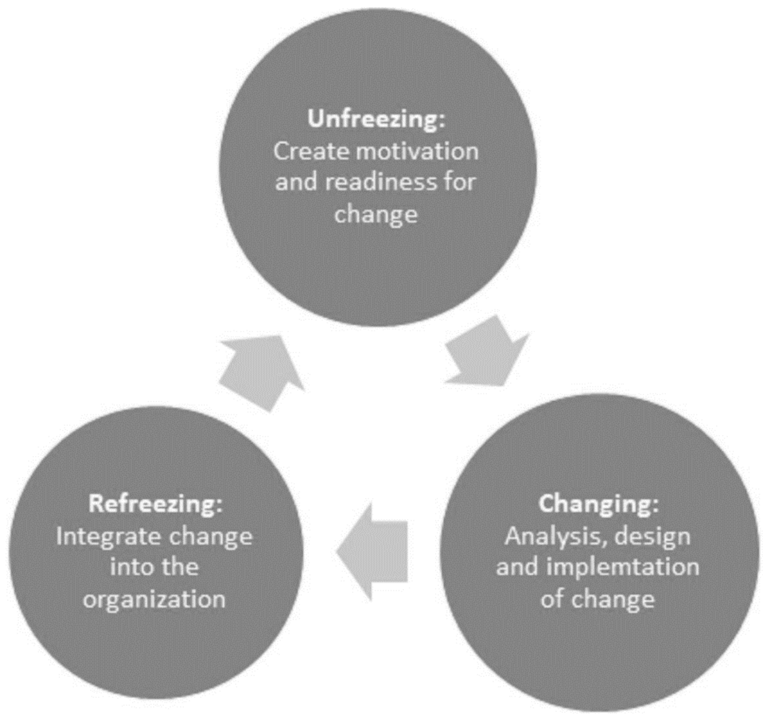
Watkins, S. (2020). Effective decision-making: Applying the theories to nursing practice. British Journal of Nursing, 29(2), 98–101. http://doi.org/10.12968/bjon.2020.29.2.98

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

Zimbardo, P. G. (2016). Carrying on Kurt Lewin's legacy in many current domains Lewin Award 2015. Journal of Social Issues, 72(4), 828–838. https://doi.org/10.1111/josi.12196

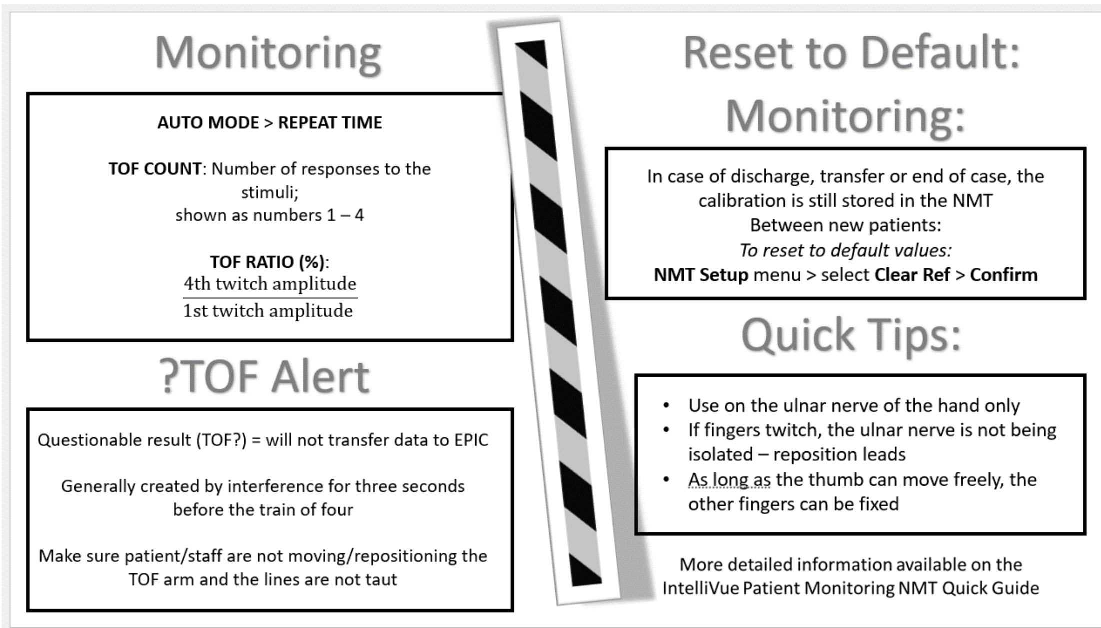
Appendix A

Kurt Lewin's Change Theory



Appendix B

Cognitive Aid Implementation



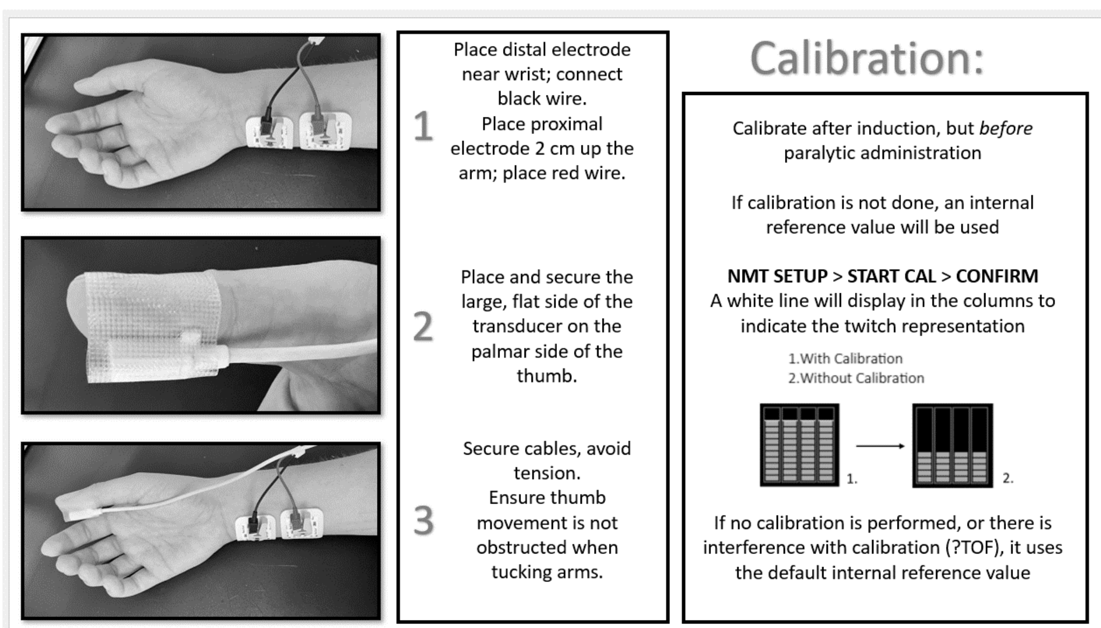


Table 1 *Numbers and percentages of cases*

	Pre-Intervention n	Pre-Intervention %	Post-Intervention n	Post-Intervention %
Total Cases:	27	100	14	100
Quantitative Cases:	12	44	10	71
Qualitative Cases:	14	52	3	21
Not Documented:	1	4	1	7

Note. n = amount of cases / percentage of cases