Marian University

Leighton School of Nursing

Doctor of Nursing Practice

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The Effects of Educational Training of Succinylcholine Dosing on Myalgia Pain

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Abstract

Succinylcholine is a well-known depolarizing muscle relaxant used for endotracheal intubation in the perioperative setting. Due to its depolarizing properties, many patients complain of myalgia pain postoperatively. Patients describe this muscle pain as muscle stiffness or soreness, similar to what one feels after extraneous physical activity. Evidence-based research has shown that increasing the dose of succinylcholine to 1.5mg/kg can help reduce myalgia pain in patients. The importance of adequate pain control during the postoperative period facilitates early recovery and a better perioperative experience. Poor postoperative pain control can lead to decreased patient satisfaction and increased respiratory complications. The purpose of this quality improvement project is to provide formal education on how certified registered nurse anesthetists (CRNAs) can lessen myalgia pain through an online learning workshop. The goal is to educate CRNAs and assess the likelihood of a practice change. This was assessed through a quantitative pre-and post-survey. The survey asked Likert-based questions based on the pathophysiology, impact/prevalence, and the dose given in practice. The online workshop consisted of three modules. The results showed a significant difference $Z= -1.0$, $p < .05$, where the post-survey showed that CRNAs were willing to change their practice. Participants were able to complete the module over one month in a self-paced manner. Some of the limitations encountered were technical difficulties, sample bias, and small sample size. The educational module results displayed an increase in willingness to increase their dose and the participants' knowledge base on this commonly used muscle relaxant.

Keywords: succinylcholine myalgia, succinylcholine dose of myalgia, succinylcholine myalgia in outpatients, effect of post-anesthesia myalgia, post-anesthesia myalgia complications, effect of postoperative myalgia on patient recovery, and succinylcholine induced fasciculations.

The Effects of Educational Training of Succinylcholine Dosing on Myalgia Pain

The postoperative period can be stressful for many patients as they worry about the associated complications of every surgical procedure. Not only must patients overcome surgical pain resulting from their incisions, but they may also experience side effects from many anesthetic medications. A prominent side effect of the depolarizing muscle relaxer succinylcholine is myalgia. Myalgia is described as muscle stiffness or soreness, similar to how one would feel after exercising (Wong & Chung, 2000). The pain can range from mild to severe and sometimes debilitating. It can present itself with varying degrees of characteristics that can prevent patients from participating in their daily activities. If the pain is severe, it can lead to fatigue and depression (Southern Pain and Neurological, 2020). The importance of adequate pain control during the postoperative period facilitates patients to participate in physical therapy. Poor postoperative pain control can lead to increased morbidity, impaired function, longer recovery times, respiratory complications, prolonged opioid use, and increased medical costs (Gan, 2017). Due to these negative consequences, minimizing myalgia pain is imperative for the success of patient recovery. Certified registered nurse anesthetists (CRNAs) play an active role in preventing myalgia pain, as increasing the dosage can help lessen the pain patients experience. This project aims to educate CRNAs on the benefit of using higher dose succinylcholine to lessen succinylcholine-induced myalgia pain.

Background

Succinylcholine is the only depolarizing muscle relaxant licensed for use in the United States, thus rendering it a popular drug for endotracheal intubation in the perioperative setting. The drug's mechanism of action is classified as an agonist-antagonist, where the drug's molecule binds to the motor endplate causing the sarcomere to contract. These contractions are known as fasciculations. Once the drug is bound, it provides paralysis by preventing acetylcholine molecules from binding to the motor endplate and initiating another response. The mechanism of action

between myalgia and fasciculations is not well defined. This theory is due to the asynchronous activity of muscle fibers, which cause filaments to rupture. The contraction occurs in synchrony when administering a higher dose, reducing damage to muscle spindles (Wong & Chung, 2000). Further research on this phenomenon is needed to provide a better understanding of succinylcholine-induced myalgia pain.

The asynchrony of muscle fibers' activity causes muscle pain in the subcostal region, trunk, neck, upper abdominal muscles, and shoulders (Nagelhout & Elisha, 2018). Myalgia pain incidence can range from 50% to 90% in surgical patients and lasts up to ten days (Shafy et al., 2018). Patients describe experiencing the worst pain during the first 24-hour period; however, severity may range from individual to individual. Those at greatest risk of experiencing myalgia are nonpregnant females, those who do not participate in muscular activity, and those who undergo minor operations (Nagelhout & Elisha, 2018; Wong & Chung, 2000). Studies have shown ways to reduce myalgia are by pretreating with 10% of the ED95 (*effective dose* required to achieve the desired effect in 95% of the population) of a nondepolarizing neuromuscular blocker (e.g., Rocuronium), nonsteroidal inflammatory drugs (NSAIDs), and sodium channel blockers (e.g., Lidocaine). While NSAIDs and sodium channel blockers have been shown to provide a therapeutic effect, the nondepolarizing agent poses a risk of respiratory depression in patients. A change in practice is needed to help decrease postoperative myalgia pain through safer practices.

The lack of research and the accompanying risks of succinylcholine administration has prevented providers from delivering higher doses. Many anesthesia providers may administer a lower dose due to the uncertainty of the higher dose’s effects on potassium levels, intragastric, intraocular, and intracranial pressures (Nagelhout & Elisha, 2018; Wong & Chung, 2000). Provider comfortability may also pose a challenge to this change in practice.

Problem Statement

Anesthetists are well aware that succinylcholine use is affiliated with postoperative myalgia in surgical patients. Not only does it have a high incidental prevalence, but the risk is increased in specific populations. The importance of reducing overall pain during recovery is essential to the patient's overall rehabilitation. Though anesthesia providers cannot control the severity of surgical pain, succinylcholine-induced myalgia is a modifiable anesthesia practice that providers can adjust in the intraoperative period. The goal is to provide formal education on how CRNAs can lessen myalgia pain through higher dosing of succinylcholine.

The approach taken was a prospective evidence-based online learning module. CRNAs completed the learning module, along with a pre-and post-test. The resulting post-test scores were compared to the pre-test scores. Comparing scores between the tests will assess the willingness of a practice change.

Gap Analysis

There is no universal best practice guideline for the dose of succinylcholine. The acceptable range for succinylcholine administration is .5-1.5mg/kg (Nagelhout & Elisha, 2018). The current practice at a 218-bed hospital in a southern state uses the 1mg/kg dosing. The quality improvement project was examined utilizing the change theory as an evidence-based practice framework. The learning module was distributed through e-mail and completed through an online learning system, Canvas. Research has suggested that using a higher dose of succinylcholine will reduce postoperative myalgia incidence (Schreiber et al., 2005). By comparing pre-and post-test scores, the results will reflect whether CRNAs are more willing to use higher dose succinylcholine.

Literature Review

Search Methodology

A review of all published studies conducted between 1950 and 2020 was performed using PubMed and Google Scholar. Excluding any language restrictions, the search strategy consisted of keywords that included: *succinylcholine myalgia, succinylcholine dose of myalgia,*

succinylcholine myalgia in outpatients, effect of post-anesthesia myalgia, post-anesthesia myalgia complications, effect of postoperative myalgia on patient recovery, and *succinylcholine induced fasciculations*. The Boolean phrase used in this literature review was *fasciculation* and *myalgia.* Exclusion criteria for articles were those published in a language other than English, participants under 18, and those receiving pre-medications. Inclusion criteria included articles published in English, patients receiving succinylcholine, and patients over 18 years old. Forty-four thousand one hundred seventy-two journals were found using the keywords. Of those identified, journals that met the exclusion criteria were eliminated. Of those that met the inclusion criteria, 124 abstracts were examined, and 73 of those records were excluded because they did not assess myalgia according to different doses of succinylcholine or did not provide adequate information on myalgia and recovery. Fifty-one full-text articles were assessed for eligibility. The reference lists of the potentially relevant papers were also reviewed by hand to identify additional articles. Seventeen journals focusing on different doses of succinylcholine and myalgia effects were used for the literature review.

Postoperative Myalgia Pain

The incidence of succinylcholine-induced myalgia is a phenomenon that is frequently encountered in the postoperative period. Researchers agree that there is a causative relationship between succinylcholine and postoperative myalgia. Myalgia is defined as muscle stiffness or soreness similar to how one would feel after physical activity, specifically found in the neck, shoulders, back, and abdomen (Schreiber et al., 2005; Shafy et al., 2019; Jain et al., 2019). The majority of the studies have determined this is a minor side effect of the drug and is often an unfortunate consequence of minor surgery among patients (Findlay & Spittal, 1996; Schreiber et al., 2005; Wong & Chung, 2000; Stewart et al., 1991; Schreiber et al., 2003). It also has been shown that the prevalence of symptoms varies widely from 1.5% to 89%, with 50% being the most probable (Findlay & Spittal,

1996; Nimmo et al., 1995; Wong & Chung, 2000; Shafy et al., 2019). The wide range is due to multifactorial risk factors.

The Impact of Myalgia Pain

As a result of the undesirable and unwanted side effects, anesthesia providers tend to avoid succinylcholine administration unless necessary, rendering it among the top 30 causes of anesthesia side effects (Macario et al., 1999). Not only do anesthesia providers acknowledge the need to decrease succinylcholine side effects, but when patients were asked if avoiding postoperative myalgia is important, 89% of patients concurred and would even pay an out of pocket fee to avoid this experience (Macario et al., 1999; Allen et al., 2007). In addition to the short-term debilitation feeling, two of the seventeen reports described postoperative myalgia as unacceptable in modern practice (Jain et al., 2019; Wong & Chung, 2000).

A case report examining the etiology and prevention of myalgia stated that the severity of the condition could increase to levels that interfere with normal daily living activities, such as returning to work or school (Shafy et al., 2019). Since ambulation increases the possibility of myalgia and its intensity, ambulatory patients are at the highest risk for these complications (Nasseri & Arvien, 2016). Conversely, some researchers suggest that succinylcholine may not be appropriate for ambulatory surgical patients since it may impede the return to regular activity (Mikat-Stevens et al., 1997). Evidence among various reports proves conflicting, as seen in this analysis.

The combination of incisional pain and muscle stiffness reduces ambulation after surgery. A report investigating the effect of activity found that patients were more active on the second day than the first day after surgery. On the first day, 47% of patients were up in a chair, 21% had limited mobility, and 32% had unrestricted mobility (Oxorn et al., 1992). Comparably, an analysis exploring the limitations to self-care in ambulatory patients stated that myalgia might be more severe than incisional pain. Patients reported back pain and the inability to perform

activities of daily living such as preparing food, walking to the restroom, and washing their hair to be the most debilitating after surgery. Because myalgia may be delayed and last up to ten days, self-care deficits can lead to anxiety and frustration, further delaying recovery (Lupien et al., 2000).

Lastly, a cost-identification analysis reported that the amount of money spent treating myalgia pain exceeds the cost of one dose of succinylcholine. Similarly, another study examining the same subject matter found that the cost of a succinylcholine dose from a patient's perspective equals the drug's acquisition cost plus the cost of its adverse effects (Allen et al., 2007; Dexter et al., 2001).

The Impact of Higher Doses of Succinylcholine on Myalgia Pain

Four of seventeen studies showed a decrease in postoperative myalgia when providers administered a higher dose of succinylcholine. The hallmark study by Waters and Mapleson (1971) discovered that the amount of muscle pain should show an inverse relationship to the dose of succinylcholine administered. It explained that those who received doses between 100mg and 200mg had less pain than those who received a lower dose. Similarly, a randomized control trial looking at the influence between .5mg/kg, 1.5mg/kg, and 3mg/kg on myalgia showed that those who received the .5mg/kg and 3mg/kg dose had an overall incidence of 40% and 50%, respectively, while the 1.5mg/kg dose had an incidence of 70% (McLoughlin et al., 1994). Wong and Chung (2000) also reported that higher doses of succinylcholine resulted in reduced postoperative myalgia pain.

Contrary to these studies, a meta-analysis of randomized trials suggested evidence to show less myalgia with the 1.5mg/kg dose compared to the 1mg/kg. The average incidence of myalgia was 44.6% with the higher dose compared to 62.8% with the lower dose (Schreiber et al., 2005). There is ambiguity about whether the higher dose is determined per kilogram or total overall dose, although all four sources agreed that higher doses would lessen myalgia pain.

The Impact of Lower Doses of Succinylcholine on Myalgia Pain

While four studies expressed a lower incidence of myalgia with higher doses, three reports described the opposite. In a double-blind study of 67 participants, succinylcholine-associated muscle pain was more common in the group who received the 1.5mg/kg dose on induction ($p < 0.05$) than the 0.5mg/kg group (Stewart et al., 1991). A similar study found no significant difference in myalgia pain when lower doses of succinylcholine were administered (Nimmo et al., 1995). Myalgia incidence was 41% in the 0.5mg/kg category, compared to 20% in those who received 0.25mg/kg (Findlay & Spittal, 1996). Although studies showed these doses lowered myalgia pain, they did not provide adequate relaxation for endotracheal intubation.

Pathophysiology of Succinylcholine Induced Myalgia

The mechanism of succinylcholine-induced myalgia remains unknown. There have been multiple theories behind this phenomenon; however, the hypothesis that the pain results from muscle fibers contracting asynchronously is the most popular among researchers. Five out of the seventeen articles explained this as the primary mechanism of action, along with other modalities (Nimmo et al., 1995; McLoughlin et al., 1994; Wong & Chung, 2000; Waters & Mapleson, 1971; Schreiber et al., 2005). Investigations researching biochemical markers of muscle damage did not correlate with myalgia incidence (Schreiber et al., 2005; Wong & Chung, 2000). Among the other research findings, the following were described as probable causes: lactic acid build-up, the release of free fatty acids, activation and degradation of phospholipids, and inflammation (Wong & Chung, 2000; Nimmo et al., 1995; Schreiber et al., 2003; Jain et al., 2019). Though many theories have been explored, the exact reason remains unknown.

Theoretical Framework

The framework used to guide this evidence-based quality improvement project is the change theory of nursing developed by Kurt Lewin (Nursing Theory, 2020). The framework is well

suited for the research question because it encourages professionals to facilitate change. It was created as a three-step model where nurses are guided to let go of old patterns, change thoughts or behaviors, and establish new habits. For a visual depiction of the change theory, reference Appendix A.

The change theory framework incorporates three distinct stages: unfreezing, change, and refreezing. The initial stage or unfreezing involves educating others to let go of an old pattern viewed as counterproductive or inefficient. A barrier often encountered in this stage is individual resistance ad conformity. The change stage, also known as the movement stage, encompasses a change in thought or behavior that leads to productivity. Lastly, the refreezing stage embraces the implemented change as routine so that it becomes standard practice.

Alignment between the Change Theory and Project Components

Step 1: Unfreezing

The common practice among CRNAs at a southern hospital is to use the 1mg/kg dose of succinylcholine. Lower doses of this paralytic increase the incidence of myalgia. Thus, this quality improvement project aims to educate CRNAs to let go of this old pattern and use the higher dose of the paralytic agent.

Step 2: Change

This DNP (Doctorate of Nursing Practice) project aims to inform CRNAs on the benefit of using higher dose succinylcholine by educating them on the pathophysiology behind the fasciculation theory, the impact myalgias have on patients, and evidence-based research on myalgia outcomes when using the opposing doses. Through proper education, the goal is to elicit a practice change in behavior.

Step 3: Refreeze

The goal in this final stage is for CRNAs to implement using a higher concentration of succinylcholine, educate others, and for this new change to become the accepted standard in their practice.

Goals, Objectives, and Expected Outcomes

This quality improvement project was to provide formal education on how CRNAs can lessen myalgia pain through higher dosing of succinylcholine. This will not require a change in the provider's anesthetic plan. The principal investigator will develop and implement an evidence-based online learning module to educate CRNAs and assess the likelihood of a practice change. The objective is to have the CRNAs complete the online learning module over one month. Assessing the likelihood of a practice change was measured through a quantitative pre-and post-study survey. No identifying information was obtained or reported. Participation in this study was voluntary, and all participants and their answers will remain anonymous. Anonymity was maintained using Qualtrics, an online survey software. The expected outcome is to have CRNAs willing to administer a higher dose of succinylcholine, as evidenced by their responses on the post-survey.

Project Design/Methods

The quality improvement practice design is an educational intervention. This design is an educational intervention because the project aims to educate CRNAs on how higher doses of succinylcholine can result in less postoperative myalgia pain for patients. It was an online workshop that used evidence-based research to promote best practice guidelines. It included a pre-survey, three educational training modules, and a post-survey. The pre-and post-surveys evaluated their knowledge and confidence levels on myalgia and succinylcholine facts. In addition, it inquired about their willingness to change their practice before and after the educational workshop (Appendix B).

The succinylcholine-induced myalgia pain educational workshop was made available to CRNAs via Canvas. The first module contained the pre-survey, a review and video of the pathophysiology of succinylcholine, a visual and explanation of the fasciculation theory, and a reflection discussion forum. The topic for module two was understanding the impact and prevalence of fasciculations on surgical patients. This module included two reading assignments and a discussion board. The third and last module focused on using evidence-based research to educate the participants on the benefit of using higher dose succinylcholine to prevent myalgia pain and contained the post-survey. The post-survey contained the same questions as the pre-survey. Reminder e-mails were sent out weekly to increase compliance levels. Once surveys have been completed, a statistical analysis was performed to evaluate whether the educational module helped elicit a practice change.

Project Site and Population

The project took place online via e-mail to CRNAs employed at hospital "A," a 218-bed facility in a southern state. The only necessary resources were computer and internet access. These CRNAs were chosen because succinylcholine is the main paralytic used in their practice. Exclusion criteria were those who did not use succinylcholine daily.

Measurement Instrument

In order to measure the outcomes of this DNP project, the following instrument was used: a self-created pre-and post-survey was issued to all participants (Appendix B). Demographic information collected in the surveys included age, years of experience, hospital setting, level of education, gender, and the dose of succinylcholine given. Both surveys assessed their knowledge and confidence levels on myalgia and succinylcholine facts. It also inquired about their willingness to change their practice before and after the educational workshop. Responses were measured using a five-point Likert scale designed as follows: (1) Strongly Disagree (2) Slightly Disagree (3) Undecided: neither agree or disagree with the statement (4) Slightly Agree (5) Strongly Agree, or

(1) Extremely unconfident (2) Somewhat unconfident (3) Neither confident or unconfident (4) Somewhat confident (5) Extremely confident, and (1) Extremely unwilling (2) Somewhat unwilling (3) Neither willing or unwilling (4) Somewhat willing (5) Extremely willing.

Data Collection Procedure

Pre-intervention

An educational module was created using the university's learning management system, followed by a pre-and post-survey. The primary investigator sent the chief CRNA an e-mail with the link to the Canvas module. The chief CRNA forwarded the link to all the CRNAs on the hospital's roster. The link was utilized to invite the participants to the workshop. The workshop was available to the CRNAs for four weeks.

Intervention

To begin the educational module, participants were first required to create an account and complete the pre-survey available via Qualtrics located during the first module. Consent was obtained during the pre-survey. Upon completion of the pre-survey, participants were able to access the three modules. The course was able to be completed in one sitting or throughout the time allotted of one month. Participants watched educational videos, reflected on prompted questions, and read reading assignments. The chief CRNA sent weekly e-mails to increase compliance levels.

Post-intervention

Once all three modules were completed, the participants took the post- survey. Upon conclusion of the four weeks, data was collected from Qualtrics, and an analysis using SPSS software was executed.

Ethical Considerations/Protection of Human Subjects

The Marian Internal Review Board (IRB) approval was obtained prior to initiating the DNP project. This research project provided minimal risk to participants since it did not entail

biospecimens, vulnerable populations, or address sensitive subject matters. In addition, it did not involve more than minimal risk with concern to mental/physical health. This project did not use patients or protected personal health information in the study group. Due to this, exemption through category two was sought and established (Appendix C). Category two consists of surveys where the obtained information remains unidentifiable and provides minimal risk to subjects. No personal identifiers were obtained in this research project, and the research results were kept in a password-protected computer in the investigator's possession. Participants filled out a pre-survey before starting the course. Before accessing the survey, information regarding the survey and research project was given, and consent was obtained (Appendix D). Participants were allowed to stop at any time.

Data Analysis and Results

Surveys were sent to 15 CRNAs with five responses for a 33.3% completion rate. Of the five that completed the module, two were female (40%), and three were male (60%). The average age for the group was 56, with 47 being the minimum and 64 the maximum. Among the five participants, one had their certificate in anesthesia (20%), while the rest had their master's degree (80%). This group's average years of experience was 24.6, with 12 being the minimum and 32 being the maximum. Regarding survey question number six, *What dose of succinylcholine do you give?* 60%, or three participants, reported that they used the 1mg/kg dose. Overall, all participants were willing to change their practice, as evidenced by the survey results. Some participants were more likely than others. Out of those three, the pre-test showed two (67%) said they were somewhat willing to change their practice, while the other (33%) said they were extremely willing. The other two participants used the 1.25mg/kg dose, and pre-survey results showed they were somewhat willing to increase their dose to 1.5mg/kg.

The post-survey results showed an increase in the *extremely willing* category of 20%. The data was analyzed by completing a Wilcoxon test. The Wilcoxon test was performed using SPSS

statistical analysis software. It compared the means of the two surveys to determine whether the educational module elicited a practice change. The test examined the results of the pre-test and post-test surveys. A significant difference was found in the results $Z = -1.0$, $p < .05$. The post-test was better than the pre-test results; thus, the educational module did help elicit a practice change. The bar graph in Figure 1 illustrates an increase of one individual in the *extremely willing* category in the post-test from the pre-test.

Module one focused on the pathophysiology and the fasciculation theory. CRNAs were asked to rate their confidence levels before and after the learning module based on these topics. The surveys asked the participants to assess their knowledge on the theory behind using higher dose succinylcholine on preventing myalgia. Confidence levels significantly increased in this category. The pre-test showed that most CRNAs (60%) felt somewhat unconfident in their knowledge behind this theory. After the learning intervention, 60% felt extremely confident. The bar graph in Figure 2 indicates a significant difference found in the results ($Z = -1.6$, $p < .05$). The post-test had an increase of 40% in the *extremely confident* section.

Additionally, pre-test findings suggested that 60% of participants felt somewhat confident on the mechanism of action by which succinylcholine produces myalgia. The rest of the participants felt neither confident or unconfident (20%) or extremely confident (20%). Upon completing the learning module, 60% felt extremely confident, while 40% felt somewhat confident.

The second module assessed their knowledge of the impact and prevalence of fasciculations on surgical patients. Participants were asked to agree or disagree with statements on these topics on a Likert-based scale. The assumption is that CRNAs would have a solid foundation on the impact and prevalence of succinylcholine-induced myalgia pain on their patients. The pre-test results indicated otherwise for all questions asked. When asked if ambulatory patients were at a higher

risk for myalgia pain than inpatients, the pre-test results showed mixed outcomes: 40% stated they slightly agreed, 20% were undecided, slightly degreed, and strongly disagreed.

Furthermore, when asked if myalgia interfered with activities of daily living, 40% were undecided or slightly agreed, and one participant or 20% strongly agreed with this statement. Likewise, when asked if myalgia pain can last up to ten days, pre-test survey outcomes revealed that 60% were undecided, 20% slightly disagreed or strongly agreed. Figure 3 demonstrates a visual depiction of the CRNAs answers in the pre and post-survey to the questions mentioned above. Upon concluding the learning module, there was an increase among all three categories.

Figure 1

Result of Wilcoxon Test: "How likely are you to increase your dose to 1.5mg/kg?"

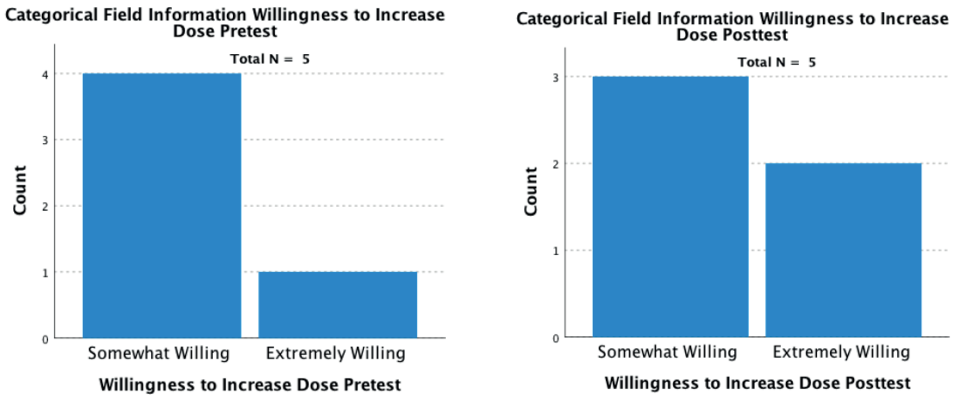


Figure 2

Result of Wilcoxon Test: "How confident do you feel on the theory behind using higher dose succinylcholine?"

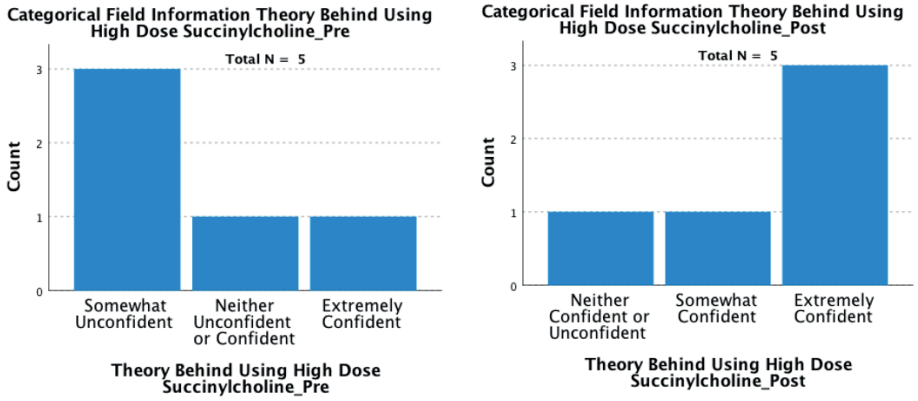
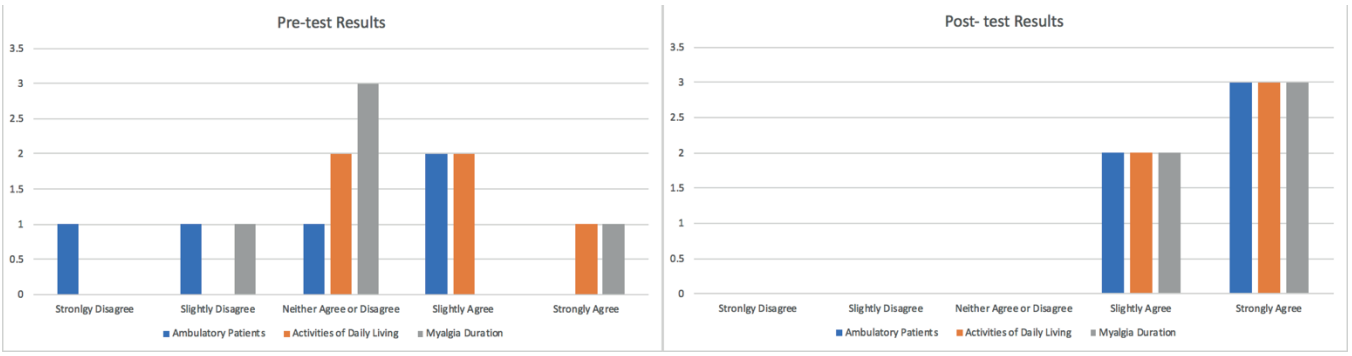


Figure 3

Result of impact and prevalence questions.



Discussion

The study had a few strengths. They include ease of access to the modules from home and the ability to complete them in a self-guided/self-paced method throughout the month. Participant comfortability allows participants to delve into the module without external pressures. Likewise, the modules were arranged in an organized way with relatable information and evidence-based research. The information presented in the modules served as a helpful review of information one may not have remembered since graduating from anesthesia school. Overall, the results showed an increase in every category, with a significant difference in willingness to increase the dose of succinylcholine. The implication is to share this knowledge with other anesthesia providers to elicit a practice change and help decrease succinylcholine-induced myalgia among surgical patients.

Limitations of the research project include small sample size, sample bias, data collection process, timing, and setting. 15 CRNAs were invited to the Canvas module, and five completed the

learning exercise. A greater sample size would have been more reflective of accurate data. The study also had a sample bias since only CRNAs were included in the study. A way to have eliminated this is by having anesthesiologists and anesthesiologist's assistants included in the research project. The data collection process required volunteers to create accounts with Canvas to access the module. Many of the volunteers felt the onboarding difficult, which could explain the small sample size. In addition to the technological difficulties, the one-month time frame may have limited the number of participants. Perhaps more participants would have joined regardless of the complex onboarding process if the time frame had been extended. Lastly, all CRNAs who participated in the study worked at the same hospital. Diversifying the setting would have been ideal. Recommendations for future research include analyzing a larger sample size for long periods, diversifying the setting and anesthesia providers, and easier access to the module.

Conclusion

Succinylcholine-induced myalgia pain is an wanted and unacceptable side effect in modern practice. Surgical patients have added stress due to the surgical procedure being performed, and overall hospital stay and decreasing myalgia from their problem list is a measure anesthesia providers can play an active role in. Myalgia pain affects each patient differently and can lead to undesired consequences. For example, it delays postoperative rehabilitation, leads to depression, and increases medical costs. Research by Wong and Chung (2000) demonstrated that by using a higher dose, 1.5mg/kg, of succinylcholine, the contraction of muscle fibers would occur in synchrony, reducing muscle spindles' damage, thereby reducing overall myalgia pain. Because this is a modifiable practice change anesthesia providers can partake in, the goal is to educate other anesthesia providers to use the higher dose of succinylcholine to increase positive outcomes among surgical patients. This DNP project helped educate CRNAs on the importance of decreasing succinylcholine-induced myalgia and assessed the willingness to elicit a practice change. The data

analysis indicated a significant increase after the learning exercise. The goal is that this education is shared with other anesthesia providers to change their practice as well.

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Appendix A

Theoretical Framework: Change Theory

Wojciechowski, E., Pearsall, T., Murphy, P., & French, E. (2016). A case review: Integrating Lewin's theory with lean's system approach for change. *The Online Journal of Issues in Nursing, 21*(2), 1. https://:doi:10.3912/OJIN.Vol21No02Man04

Appendix B

Survey

1.) What is your age?
- ____

2.) How many years of experience do you have?
- 1-5 years
- 5-10 years
- 10-15 years
- 15-20 years
- >20 years

3.) What type of setting do you work in?
- Ambulatory outpatient
- Inpatient
- Mixed

4.) What is your level of education?
- Certificate
- Masters
- Doctorate

5.) Gender?
- Male
- Female

6.) What dose of succinylcholine do you usually give?
- .5mg/kg
- 1mg/kg
- 1.25mg/kg
- 1.5mg/kg
- Over 1.5mg/kg

7.) On a scale of 1-5, how willing are you to increase succinylcholine dosing to 1.5mg/kg?

- Extremely unwilling
- Somewhat unwilling
- Neither willing or unwilling
- Somewhat willing
- Extremely willing

8.) On a scale of 1-5, how strongly do you agree with the following statements:

	1: Strongly Disagree	2: Slightly Disagree	3: Undecided: neither agree or disagree with the statement	4: Slightly Agree	5: Strongly Agree
Ambulatory patients are at higher risk for myalgia pain than inpatients.	○	○	○	○	○
Myalgia interferes with activities of daily living.	○	○	○	○	○
Myalgia pain is unacceptable in modern practice.	○	○	○	○	○
Securing a patient's airway is more important than myalgia pain.	○	○	○	○	○
I avoid succinylcholine because of myalgia pain.	○	○	○	○	○
Myalgia pain lasts up to ten days.	○	○	○	○	○
I often see myalgia pain in PACU.	○	○	○	○	○
Myalgia pain can lead to fatigue and depression.	○	○	○	○	○
I consider/will consider myalgia pain when dosing succinylcholine.	○	○	○	○	○

9.) On a scale of 1-5, please rate your confidence level with your knowledge in the following areas:

	Extremely unconfident	Somewhat unconfident	Neither confident or unconfident	Somewhat confident	Extremely confident
The mechanism of action which succinylcholine causes myalgia.	○	○	○	○	○
The impact succinylcholine-induced myalgia has on patient recovery.	○	○	○	○	○
The prevalence of myalgia.	○	○	○	○	○
The theory of using higher dose succinylcholine on preventing myalgia pain.	○	○	○	○	○
Understanding how CRNAs can help reduce myalgia pain.	○	○	○	○	○

Appendix C

IRB Approval

MARIAN UNIVERSITY
Indianapolis ®

Institutional Review Board

DATE:	05-18-2021
TO:	Tiffany Cabeca
FROM:	Institutional Review Board
RE:	IRB #S21.278
TITLE:	The effects of educational training of succinylcholine dosing on myalgia pain
SUBMISSION TYPE:	New Project
ACTION:	Determination of Exempt Status
DECISION DATE:	05-18-2021

The Institutional Review Board at Marian University has reviewed your protocol and has determined the procedures proposed are appropriate for exemption under the federal regulations. As such, there will be no further review of your protocol and you are cleared to proceed with your project. The protocol will remain on file with the Marian University IRB as a matter of record. Please be mindful of the importance of reporting only de-identified, HIPAA-compliant information about the patient in any exhibit or publication.

Although researchers for exempt studies are not required to complete online CITI training for research involving human subjects, the IRB **recommends** that they do so, particularly as a learning exercise in the case of student researchers. Information on CITI training can be found on the IRB's website: http://www.marian.edu/academics/institutional-review-board.

It is the responsibility of the PI (and, if applicable, the faculty supervisor) to inform the IRB if the procedures presented in this protocol are to be modified or if problems related to human research participants arise in connection with this project. Any procedural modifications must be evaluated by the IRB before being implemented, as some modifications may change the review status of this project. Please contact me if you are unsure whether your proposed modification requires review. Proposed modifications should be addressed in writing to the IRB. **Please reference the above IRB protocol number in any communication to the IRB regarding this project.**

Amanda C. Egan, Ph.D.
Chair, Marian University Institutional Review Board

Appendix D

Consent

You are invited to participate in an investigative study titled The Effects of Educational Training of Succinylcholine Dosing on Myalgia Pain. This study is being conducted by Tiffany Cabeca, a doctoral student in the Nurse Anesthesia track at Marian University. You were selected to participate in this study because you are a CRNA who routinely uses succinylcholine.

The purpose of this project is to educate CRNAs on the benefit of using higher dose succinylcholine to lessen succinylcholine-induced myalgia pain. If you agree to take part in this study, please complete the survey on the next page. This survey will ask about demographics, and your current knowledge on succinylcholine and myalgia pain. It will take you approximately 3 minutes to complete. Your answers in this study will remain confidential and results will be reported in the aggregate. Any risks to breach of confidentiality will be minimized by storage of all data in a password-protected computer kept in the home of the primary investigator and the deletion of all data upon completion of the study. Your participation in this study is completely voluntary and you can withdraw at any time. You are free to skip any question you choose.

If you have questions about this study or if you have a study-related problem, you may contact the primary investigator, Tiffany Cabeca at (718) 791-3016. If you have any questions concerning your rights as a study subject, you may contact the Marian University Institutional Review Board Chair, Dr. Amanda C. Egan at aegan@marian.edu or irb@marian.edu.

By completing the pre-survey, you are indicating that you are at least 18 years old, have read and understood this consent form, and agree to participate in this study.