Assessing Anesthesia Providers' Perceptions of Adequacy of Endotracheal Tube Cuff Occlusion Assessment Techniques: A DNP Project

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Submitted in partial fulfillment of the requirements for the degree of

Doctor of Nursing Practice

Finalized on December 7, 2021

Abstract

Current literature describes subjective and objective endotracheal tube cuff pressure measurement techniques and their effectiveness. However, current literature does not assess anesthesia providers' perceptions of the perioperative usefulness of subjective assessment (tactile) and objective assessment (manometer) of occlusive volume for endotracheal tube cuffs. For this project, five Certified Registered Nurse Anesthetists completed a pre-implementation survey, viewed an educational video, trialed the use of a manometer device over a two week period, and then completed a post-implementation survey. Analysis of responses to the pre- and post-implementation surveys revealed an increase in participants' perceptions of the adequacy of manometry for assessing endotracheal tube pressures as well as intended use of this objective measurement technique in future practice. The limitations of this study include a small sample size, time limitations for the project and not all participants responding to every survey. Future studies involving greater numbers of participants and longer trial periods would provide better understanding of anesthesia provider perceptions of endotracheal cuff pressure measuring techniques.

Keywords: anesthesia, endotracheal tube, endotracheal cuff, pressure, pressures

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Section I. Introduction

Background

The management of the airway during a surgical case is one of the primary responsibilities of the anesthesia provider. Certified Registered Nurse Anesthetists (CRNAs) are considered airway experts and must practice with accuracy, precision, and efficiency when managing advanced airways. Of the various types of advanced airways, the device used most often is the cuffed endotracheal tube (ETT). These tubes are inserted into the trachea just beyond the vocal cords and secured using an inflatable cuff. The cuff serves to occlude the airway so positive pressure ventilation can be provided, and functions to protect the airway from aspiration. To achieve this function, the cuff must be inflated and maintained at a pressure great enough to occlude the airway, yet low enough to avoid tracheal damage. If the cuff is underinflated or overinflated, it can lead to numerous adverse outcomes for patients. It is known that under-inflation increases the risk of air leakage as well as aspiration of oral pharyngeal and gastric secretions (Bulamba et al., 2017). Over-inflation has been shown to cause less serious side effects such as cough, dysphagia, and sore throat as well as serious complications like tracheal ischemia with pressures above 50 centimeters of water (Bulamba et al., 2017).

Organizational Needs Statement

The partnering hospital where this quality improvement project was completed is located in the southeast United States. This facility performs around 47,000 surgical procedures a year, ranging from minimally invasive surgeries to complex neurological and cardiac cases. The existing policy addressing cuff pressure management is intended to guide respiratory therapists in providing care for intubated patients throughout the hospital. This policy does not specifically include guidelines for anesthesia providers managing ETTs in the operating room setting.

It is important to have an established, evidence-based standard of care to guide practice and protect patients from unintentional injury. Standards of care, including the safe management of cuff pressures, should be developed and implemented to improve safe and efficient care. Mendelson and Mukdad (2018) found that intraoperative cuff pressures are regularly outside of the recommended inflation parameters when no intraoperative cuff pressure monitoring is being performed. As previously mentioned, this can lead to negative side effects for patients and can cause unfavorable outcomes including sore throat, vocal cord damage, dysphagia, and coughing (Fritz-et al., 2020). The frequency and severity of these types of postoperative issues can be diminished by ensuring the ETT cuff is properly inflated and maintained at appropriate pressures.

Creating a specific policy for measuring cuff pressures can be challenging given the multiple variables that can impact the technique used by providers. In the operating room these variables may include patients' acuity, time constraints, ease of use, length of the case and demands placed on the provider to perform more pertinent interventions. Although there is currently no specifically recognized national standard of care in regard to measurement of cuff pressures in surgical settings, the American Society of Anesthesiologists recommends using manometry to maintain pressures between 20 and 30 cm of water (Papiya et al., 2004).

The Institute for Healthcare Improvement (IHI) has set a Triple Aim for improving healthcare, with one of the goals being to enhance the experience of care for individuals (2020). This goal focuses on assuring patients have the best healthcare experience possible while they are receiving care. Health care quality is also a major focus of the Office of Disease Prevention and Health Promotion (2020), whose stance is that ensuring patient safety is crucial to achieving high quality health care for all Americans. The Anesthesia Patient Safety Foundation also

maintains the vision that no one will be harmed by anesthesia care (2021). These entities encourage providers to deliver high quality care to patients.

One way to accomplish this is to avoid possible adverse side effects known to be associated with medical interventions. In regard to the management of ETT cuffs, ensuring proper inflation can help avoid negative side effects for the patients receiving care. The American Association of Nurse Anesthetists (AANA) also sets standards of care for anesthesia providers that relate to managing ETTs. Standard 9 for anesthesia care relates to monitoring and included in that standard is the monitoring of ventilation (AANA, 2021). To ensure adequate ventilation, the cuff needs to be inflated to a volume that will occlude the airway and make positive pressure ventilation possible. To ensure appropriate occlusion pressures there are a variety of techniques that may be used. Little is known about the perceptions of anesthesia providers regarding use and adequacy of the various ETT cuff pressure measurement techniques available for use during surgical procedures.

Problem Statement

There is a lack of knowledge in understanding anesthesia providers' preferences and perceptions of various techniques used to assess adequate ETT cuff pressures.

Purpose Statement

The purpose of this quality improvement project is to assess anesthesia providers' perceptions of perioperative usefulness of subjective assessment (tactile) and objective assessment (manometer) of occlusive volume for ETT cuffs.

Section II. Evidence

Literature Review

A literature search was performed using various combinations of keywords and subject headings for the following concepts: endotracheal tube, cuff pressure, and anesthesia or surgery. The databases used to search the current literature were PubMed and Cumulative Index to Nursing and Allied Health Literature (CINAHL). The search engine Google Scholar was also used. MeSH terms (PubMed) and Subject Headings (CINAHL) utilized included anesthesia, endotracheal tube, and pressure. Limits applied in the databases were articles published in English and within the last 10 years (2011-2021). See Appendix A for search concepts. The literature searches retrieved 469 articles. After abstract review, 33 articles were identified as relevant and 13 deemed to be meaningful resources for this project after a full article review was completed. The Google Scholar search was limited to articles published in the last five years (2015-2020), with the first 10 pages reviewed and one additional pertinent article identified. If deemed relevant, the entirety of the article was assessed for findings and strength of evidence. Two sources were found by examining the related articles section or the source list from the articles deemed pertinent. See Appendix B for search strategies by source.

Current State of Knowledge

The literature used to guide this quality improvement project was comprised mostly of quality improvement projects, as well as a few articles ranging from levels 2 through 6 on the Melnyk and Fineout-Overholt level of evidence hierarchy (2015). A literature matrix including specific details and levels of evidence for each pertinent article can be found in Appendix C.

Current Approaches to Solving Population Problem

Anesthesia providers currently use various techniques to assess the pressure in the cuff of the ETT. Approaches identified in the literature for improving the accuracy of ETT cuff pressures include education on manometer use, training and education on tactile pilot balloon skills, loss of syringe resistance methods, charting reminders, and visual prompts in the electronic anesthesia record (Bulamba et al., 2017; Seyed et al., 2015; Turner et al., 2020). Education on these topics encourages providers to focus on increasing the accuracy of the ETT cuff pressure measurement and keeping pressures within the recommended range.

Multiple studies identify use of manometers as the ideal technique to use when assessing and adjusting ETT cuff pressure. In one quality improvement study, anesthesia providers were given manometer education and training with the expectation that it would result in an increase of cuff pressures maintained in the recommended range (20-30 cm of water). After educating, training, and supplying manometers to the providers, the researchers found that the median cuff pressure measurements decreased from a mean measurement of 38.5 centimeters of water to 30 centimeters of water, resulting in improved cuff pressure ranges (Stevens et al., 2018). Fritz et al. (2020) assessed how the use of manometers would affect patients' post-operative reports of sore throat, hoarseness, and dysphagia postoperatively. They found manometer use reduced the incidence of patients reporting moderate-to-severe postoperative sore throat from 35 patients to 31 patients, ($p = 0.045$), moderate to severe hoarseness 30 patients to 13 patients, ($p = 0.0001$), and moderate-to-severe dysphagia 13 patients to 5 patients ($p = 0.03$) (Fritz et al., 2020). Ozer et al. (2013) performed a study involving 250 general anesthesia cases to assess how providers' clinical experience affected ETT cuff pressures when manometers were not used. Provider experience level showed no effect on obtaining appropriate ETT cuff pressures when methods

other than manometry were used. Results were similar for all participants with ETT cuff pressures falling within the appropriate pressure range (10-20 centimeters of water) about 50% of the time. However, within the existing literature there is little discussion of anesthesia providers' perceptions of the usefulness of the different techniques available. No information was revealed regarding anesthesia providers' preferences or reasoning behind selection of a particular ETT cuff pressure measuring technique, including subjective versus objective techniques chosen to assess the cuff pressure.

Evidence to Support the Intervention

An effective intervention supported by the literature for maintaining safe ETT cuff pressures includes education and training on appropriate ETT cuff pressures and techniques used to measure the ETT cuff. Seyed et al. (2015) found that education and training on the pilot balloon palpation technique among anesthesia providers using tracheal models increased the rate of ETT cuff pressures within a safe range in patients from 24.2% to 39.7%. Maboudi et al. (2013) conducted a study involving ICU nurses, with participants asked to assess ETT cuff pressure using the pilot balloon palpation technique. The researchers found that they were initially in the suggested safe pressure range of 20-30 cm H2O only 41.3% of the time. After education and training, all of the participants' balloon palpation measurement technique increased in accuracy (Maboudi et al., 2013). Fritz et al. (2020) found that after an educational program on excessive cuff pressure complications and using a subjective ETT cuff measurement device, the incidence and severity of post-operative complications from ETT tubes were significantly lower than the pre-intervention outcomes.

Stevens et al. (2018) and Turner et al. (2020) conducted two similar quality improvement projects at separate military medical centers. Each consisting of an educational presentation and

availability of objective ETT measurement devices to anesthesia providers. Researchers found a significant increase in ETT cuff pressures measured in the safe range after the education and increased availability of objective measurement devices. (Stevens et al., 2018; Turner et al., 2020). Other researchers reported benefits of education and hands-on practice with cuff pressure monitoring methods increased knowledge among ICU nurses managing ETT cuffs (Mpasa et al., 2020; Murugiah et al., 2021). Educational intervention, physical reference cards, and prominent cuff pressure reminders in the electronic health record have all been shown to increase monitoring of the ETT cuff by providers and reduce mean cuff pressures intraoperatively (Ashman et al., 2017). Furthermore, Ozcen et al. (2017) found that after training participants in ETT cuff pressure management, the median cuff pressure decreased from 48 cm H20, down to 32 cm H20. It has also been reported in several studies that regardless of provider experience, cuff pressures were outside of the recommended safe range when using a non-objective measurement technique and that education can increase the percentage of time cuff pressures are within an appropriate safe pressure range. (Ozcen et al., 2017; Ozer et al., 2013).

Through identified literature included summaries on the effectiveness education and training had on improving anesthesia providers' ability to safely maintain ETT cuff pressure regardless of the technique being used, consideration of the factors that drive anesthesia providers' selection of the various techniques used to manage cuff pressure is also needed. The purpose of this quality improvement project was to gain a better understanding of providers' practice preferences and what factors affect those preferences.

Evidence-Based Practice Framework

Identification of the Framework

The theoretical framework guiding this project was Lewin's Change Model (Lewin et al., 1966). Lewin's Change Model involves three steps: unfreezing, changing, and refreezing. The first step is to unfreeze old habits and behaviors and give people a reason to change (Schultz, 2011). Providing research-based information to the participants in a short, educational presentation provided a reason for unfreezing and understanding of how change would affect their workflow and patient safety. The presentation was designed to help providers assess new methods and techniques and compare them to their currently preferred methods. This unfreezing of their current method or technique aided by the educational training included exposing providers to methods they might be less familiar with. The training experience also encouraged evaluation of their current practice preferences.

The second step of Lewin's Change Model is moving to a new level or pattern of behavior (Schultz, 2011). After education, the anticipated outcome was that providers would use the manometer and evaluate for themselves how education and training on this topic could improve their practice and ultimately their patient care. During this phase, assessment of participants' perceptions of the usefulness of this educational intervention were completed using a post education survey. It was anticipated that through the education and experience using the cuff measuring device providers would see the value of using evidence-based methods in delivering high-quality care. Ongoing education, training, and evaluation of new practice techniques may also support greater receptiveness to changes in practice. By implementing patterns of continually evaluating personal practice preferences and comparing these to new

techniques, improvement of practice techniques may be improved over time as new techniques are developed.

The third step, though not addressed in this project, would be to refreeze the behavior into a new way of operating so providers do not revert back to old practices (Schultz, 2011). After this educational intervention, the project group is optimistic that providers will see the value education and training can bring to their practice. One positive outcome from this project would be for providers to create intrapersonal and interprofessional ways to encourage continual assessment of practice habits. Ideally, the education, training, and the individual providers' experience during this project will encourage future assessment of practice preferences and influence continual professional development.

Ethical Consideration & Protection of Human subjects

This quality improvement project was deemed as exempt from full review through a process created in conjunction with the University Institutional Review Board (IRB) and the partnering medical center which can be viewed in Appendix D. All team members completed the Collaborative Institutional Training Initiative (CITI) modules on research ethics and compliance prior to beginning this project. No identifying participant information was gathered, and participants were exposed to no more than minimal risk while participating in the project. The suggested use of an objective measure of ETT cuff monitoring (manometer) during the project intervention period had the potential to minimally increase the work of the CRNA participants but fell within usual standards or procedures within this organization.

Section III. Project Design

Project Site and Population

The project site was a large hospital in the southeast United States. The hospital contains approximately thirty operating rooms where a large volume and a wide range of surgical procedures are performed. The participants in the project were CRNAs with varying levels of experience who potentially used different techniques to inflate and maintain the ETT cuff pressures during general anesthesia. Facilitators of this project included the pre-existing availability of cuff pressure measurement devices to the anesthesia staff in the hospital as well as the relationships of CRNA program faculty members with the current staff. Potential barriers to the project included staff involvement and time constraints placed upon the participants while practicing in the operating room. During the COVID-19 Pandemic of 2020-2021 there were limitations on group meetings and personal contact, so electronic delivery of the educational component of the project was utilized, which may not be as effective as in person educational presentation. The content of the educational video can be found in appendix E.

Description of the Setting

The setting for this quality improvement project was a group of operating rooms in a large level one trauma center that on average performs 90 surgeries a day. The surgical teams within the medical center perform a majority of their procedures under general anesthesia, which involves the use of ETTs. Volunteers for this project were recruited from the large team of over 100 nurse anesthetists who rotate among different surgical rooms within the medical center.

Description of the Population

The population addressed in this project was CRNAs who worked in a single medical center and utilized cuffed ETTs during procedures. The professional work experience of the

population of CRNAs employed in this medical center was known by the clinical CRNA program faculty member to range from less than one to multiple years of experience (T, Chabo, personal communication, March 1, 2021). The CRNAs rotated between different surgical suites as well as procedures, delivering care to a variety of age groups with a multitude of healthcare issues.

Project Team

The project team consisted of the author (primary SRNA project lead), three other SRNAs who worked collaboratively on initial development of the project, the project chair who also provided clinical support, the program director, and a project non-CRNA support faculty. The project chair oversaw the quality improvement project and recruited participants for the project. The program director approved and monitored all CRNA program projects. The non-CRNA support faculty used their knowledge and experience to assist with navigation through the project process. Additionally, the unit manager supported the project within the operating rooms. The primary SRNA performed the quality improvement project, synthesized the findings, and participated in creation of the educational video utilized in the project. The participants performed the clinical application of the project and provided valuable information from surveys they completed.

Project Goals and Outcome Measures

The goal of this quality improvement project was to assess the providers' perceptions of different techniques used to manage the ETT cuff. The techniques used can be divided into two groups, subjective and objective. Subjective techniques used include pilot balloon palpation, minimal occlusive volume, minimal leak, and air-return or loss of resistance technique. The objective technique used was a manometer to directly measure the ETT cuff pressure. Survey

questions were designed to gather participants' perceptions of the education presented and opinions of usefulness of various techniques used for ETT cuff pressure management. Questions also addressed reasons for choosing preferred methods to measure cuff pressures and why it was superior to other methods. The pre- and post-surveys contained several identical questions to allow for comparison of pre-versus post-participation responses.

Description of the Methods and Measurement

The method used to conduct this quality improvement project followed the Institute for Health Improvements' plan, do, study, act (PDSA) methodology (2021). The PDSA cycle is useful for measuring change when new interventions are implemented in healthcare settings. Information gathered using pre- and post-intervention surveys allowed for a better understanding of anesthesia providers' perceptions of tools used to inflate and manage ETT cuff pressures.

Qualtrics survey software was used for delivery of all surveys. The surveys were succinct, containing only five to eight questions each, and utilized a variety of assessment questions that included Likert scale, binary, and open-ended responses. For the convenience of the participants and due to COVID-19 restrictions, the educational video was attached to the introductory email. The delivery of the education utilized a time efficient video formatted to allow the participants to view it during a time convenient for them, accommodating their fast-paced work environment. Resources from the college of nursing were used to make the video.

Discussion of the Data Collection Process

To ensure confidentiality, data collection was completed using anonymous links through Qualtrics survey software. Pre- and post-educational questions were used to compare providers' use, knowledge, perceptions, and preferences of cuff pressure management techniques. Data was analyzed using Excel software.

Implementation Plan

The project team implemented the surveys and education during clinical rotations of the nurse anesthesia program. Because of COVID-19 restrictions and the previous relationship between the clinical CRNA faculty and clinical participants, recruitment of the participants was completed by the clinical CRNA faculty. The CRNA clinical faculty provided the primary SRNA student a list of clinical participants and email addresses. The first piece released to participants was a pre-education survey, which was used to assess their current practice preferences and strategies for measuring cuff pressures. Participants then received the research supported educational offering (appendix E) via an email link to view at their convenience. During the intervention period, participants were asked to assess and track different techniques used to measure ETT cuff pressures. Once the participants completed a two-week period of attempting and assessing different techniques for measuring cuff pressures, a post-intervention survey was sent. The post intervention survey results were collected via Qualtrics survey software and analysis of the data was completed using Microsoft Excel.

Timeline

Identification of the problem and the review of pertinent literature that informed development and implementation of this project were completed September of 2020 as the initial steps in this project. The project was approved by the program chair during the fall semester of 2020. The educational video script and the pre- and post-intervention survey questions were developed during the fall semester of 2020 by the student group who collaborated on the project. The surveys and educational material were approved by the program director and the project chair during the fall of 2020. A final review of current literature was completed by the primary SRNA during the spring semester of 2021. The project team of SRNAs recorded the video using

resources from the school of nursing during the spring semester of 2021. The project was introduced to the project participants and implemented during the spring semester of 2021. During the fall semester of 2021 the project paper was completed and submitted to The Scholarship, East Carolina University's digital archive. Also, during the fall semester of 2021, a project poster was created and presented by the lead SRNA in person to the faculty of the nurse anesthesia program, and the participants were invited to attend via internet streaming. See Appendix F.

Section IV. Results and Findings

Results

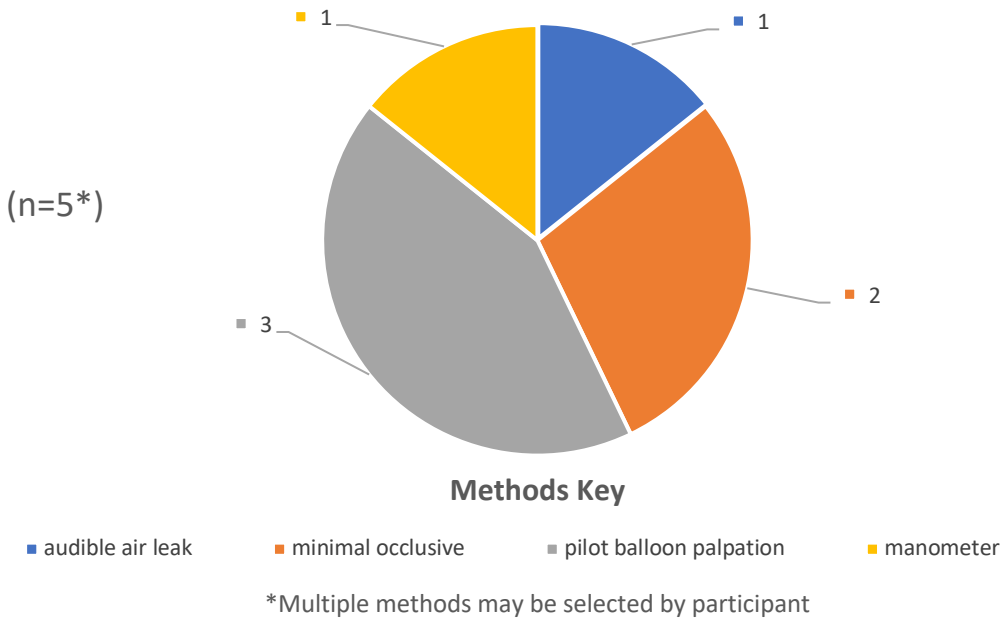
The initial data collection was completed using Qualtrics survey software. The pre-implementation survey was sent out after initial contact was made with the participants by the primary nurse anesthesia student. The post-implementation survey was sent after the two week project implementation period and the participants were able to respond over the next several weeks. The main parameters measured by the participants' responses to the surveys were their preferred technique or techniques, utilization of subjective versus objective measurement techniques, and their perceptions of adequacy of subjective versus objective techniques. The total number of pre-intervention surveys sent and completed was five, showing that all participants responded. The total number of post-implementation surveys completed was four, with one of the participants not responding. Copies of the pre-intervention survey and the post-intervention survey can be viewed in Appendix G and H respectively.

Analysis

The first survey question completed was the pre-intervention preferred method for assessing ETT cuff pressures, which included objective and subjective options. Results are summarized in Figure 1.

Figure 1

Pre-intervention preferred methods for obtaining ETT cuff pressures (n=5)



Note: Preferred methods of anesthesia providers for obtaining ETT cuff pressures. More than one preferred method could be selected since a provider may utilize more than one method in the practice setting.

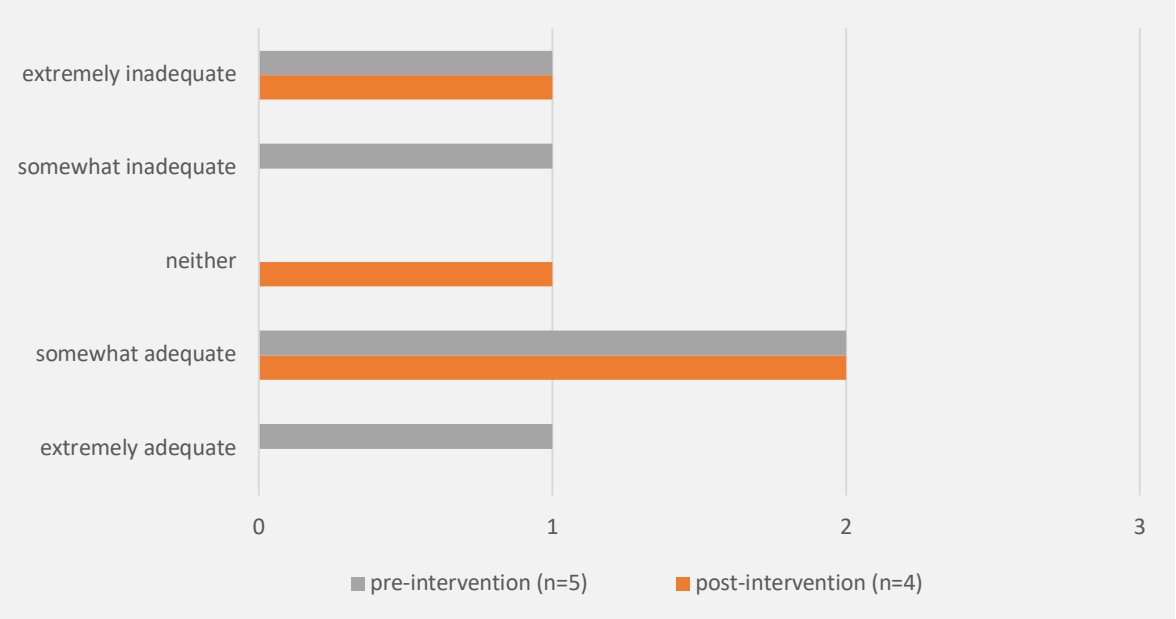
Other pre- and post-implementation survey questions related to the utilization of the different assessment techniques. The choice frequency in these questions ranged from always to never, with sometimes, most of the time, and half of the time as alternate options. The pre-implementation survey responses for subjective assessment technique had the response “always” selected three times, the response “most of the time” selected once, and the response “sometimes” selected once as well (n=5). While the post-implementation survey for subjective assessment techniques showed the response of “always” was selected two times, the response

"half of the time" was selected once, and the response "sometimes" was selected once. There was not a fifth survey completed after the intervention.

Both the pre-intervention and post-intervention survey assessed the providers' perceptions of the adequacy of the subjective and objective ETT cuff pressure measurement techniques. The pre-survey results showed most providers found subjective ETT cuff pressure measurement techniques adequate, with three out of five participants selecting either "somewhat adequate" or "extremely adequate" for this question (see Figure 2).

Figure 2

Adequacy of Subjective Measurement Techniques

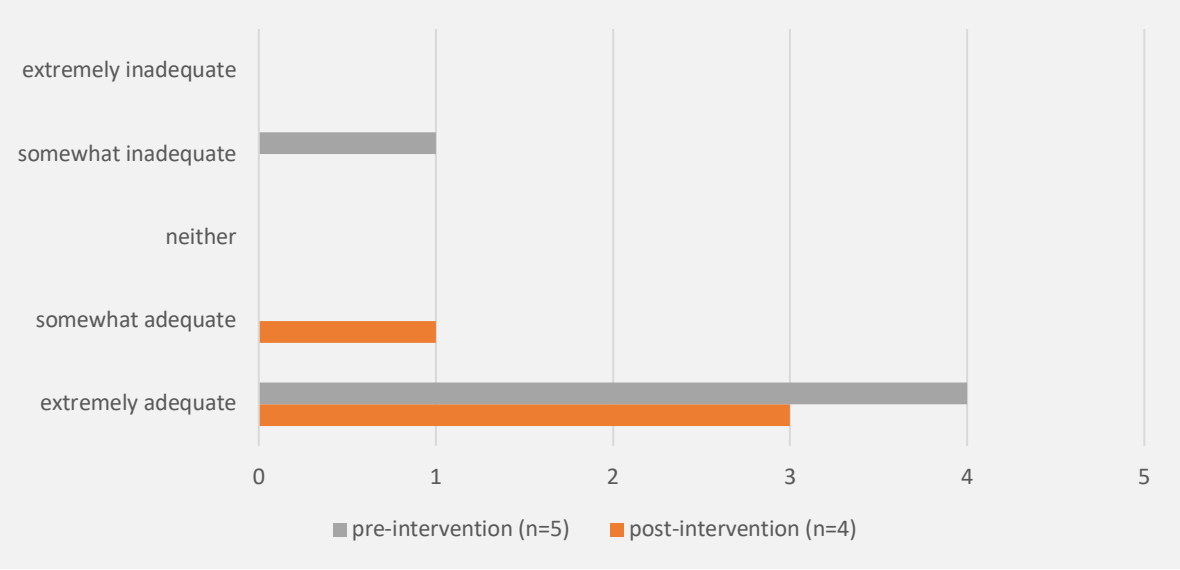


Note: This graph displays the participants perception of adequacy of subjective measurement techniques of the pre- and post-implementation phases of the project.

Perceived adequacy of the objective measurement techniques was also assessed during this project. The responses for the project pre-implementation survey showed that four out of five participants found the objective method to be “extremely adequate” and one “somewhat inadequate.” Three out of four post-implementation responses revealed the perception of this method to be “extremely adequate” and the remaining participant noted the method as “somewhat adequate.” The provider opinions of these techniques did shift some from the pre- to the post- implementation surveys. In regard to use of manometers, participants’ perception of adequacy of objective measurement techniques for the pre- and post-implementation phases of the project are shown in Figure 3. It is hard to conclude the overall effect of the project as there was one less post-survey than pre-survey response and the sample size was small.

Figure 3

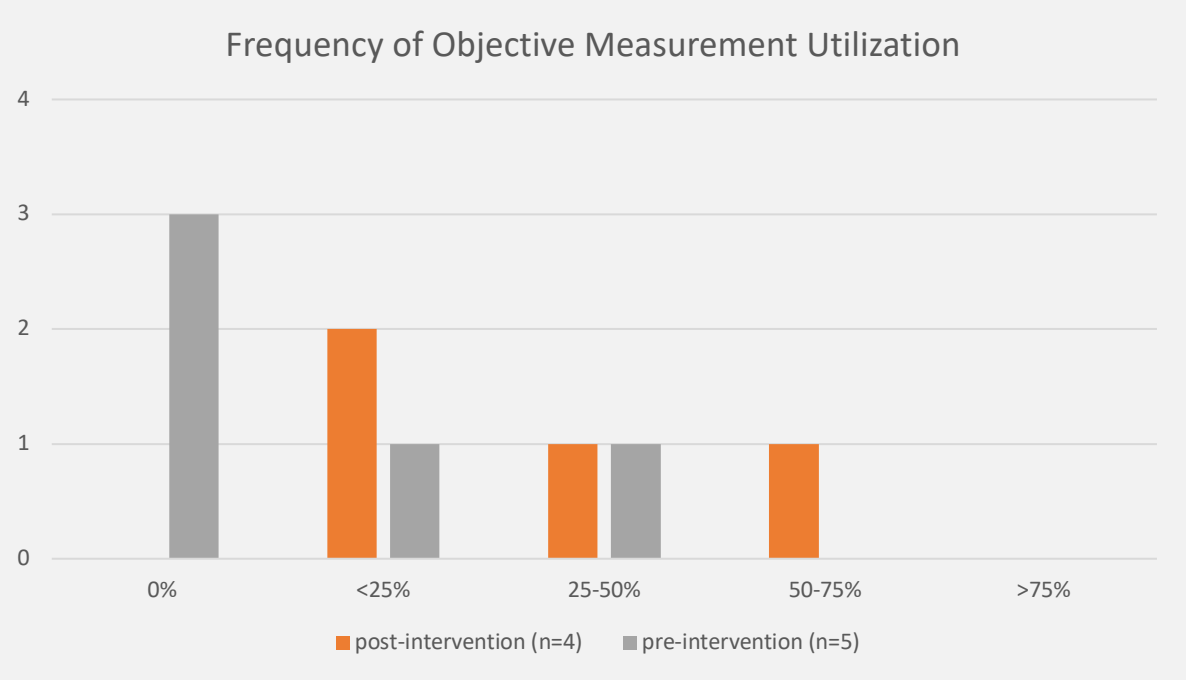
Adequacy of Objective Measurement



Possibly the most interesting data obtained from this project was in relation to the frequency of objective measurement utilization. Regardless of only receiving four responses for the post-implementation survey, the biggest shift was in the use of the objective tool by participants before and after the project. Pre-project implementation surveys revealed the frequency participants used the objective measurement tool was low, while post-implementation responses revealed increased intent to utilize the objective measurement tool in future practice (See Figure 4). From this it can be concluded that the project impacted practice change and the participants re-evaluated utilization of the objective measurement technique.

Figure 4

Frequency of Objective Measurement Utilization



Note: This graph displays the frequency participants utilized and plan to utilize the objective measurement tool

Section V. Interpretation and Implications

Cost Benefit Analysis

The project tool (manometer) is something the hospital already makes available to the participants. However, if more participants were involved and the study was completed on a larger scale this could affect cost due to increased use of the project tool. The cost of one of the devices is around $43 per unit or $430 for a pack of ten (Life Assist, n.d.).. The device can be used up to 100 times and can be used between different patients if cleaned properly. If the average times the device was used per patient was three, then one device could be used for 33 patients. If the average number of cases per provider per day is five, then the device would last about seven workdays. This would equate to the provider needing three devices per month to measure and manage the ETT cuff during cases, costing around $120 a month to supply per provider. The cost in terms of time is essentially no different for the staff, since evaluation of the ETT cuff pressure is something routinely done after tracheal intubation.

The benefit to the organization for implementing this project would be an increased awareness of ETT cuff pressures and the associated complications. The increased awareness would help to improve patient care and satisfaction by decreasing the level of post-operative tracheal irritation and other negative outcomes. Cost to the organization is related to the purchasing, stocking, and storage of the device as more would be needed to be available to the providers. This could be a financially burdensome practice change when other ETT cuff pressure measurement techniques could be used that do not require any additional supply costs.

Resource Management

The resources utilized were the participants' time and the objective measurement tool currently supplied by the organization. The time need was not significant since assessing the ETT cuff pressure is routinely done. The workload would not increase since the electronic health record already has an area to document the occlusion pressure of the ETT cuff and this is also routinely completed. The other main resource of this project was the objective measurement tool. By already having access to the project tool, the project team avoided having to gain approval for use of the tool in the hospital and logistical challenges that would have been required to acquire the tool for the project. Resources that might have been helpful to the project were longer periods of time for implementation and a greater number of participants. These challenges are addressed in the limitations section of this paper.

Implications of Findings

As previously discussed, post-survey participants did report planning to utilize the objective measurement tool (manometer) more frequently in their practice than was noted in pre-survey results. Ideally, the project may also have increased awareness of ETT cuff under and over pressurization complications and encouraged re-evaluation of providers' ETT cuff pressure management techniques. Overall, the project may additionally have helped to achieve the goals set by the IHI, Office of Disease Prevention and Health Promotion, and the Anesthesia Patient Safety Foundation; these entities aim to enhance the patient care experience and ensure patient's safety throughout their anesthesia care.

As previously discussed, the theoretical framework guiding this project was Lewin's Theory of Change. The first two steps, according to Lewin, involve unfreezing and moving to a new pattern of behavior, and this in part has been achieved. The education in this project and

trial period of the objective tool helped to unfreeze patterns of practice to allow for reevaluation of ETT cuff pressure management techniques. A new pattern of behavior may have been initiated as evidenced by the increased responses toward future utilization of the objective measurement tool by participants.

Implications for Patients

Possible implications for the patient in relation to this project relate to improved outcomes in reducing post-operative tracheal irritation, dysphagia, hoarseness, and in certain situations tracheal necrosis which can be caused by over inflation of the ETT cuff. Proper management of cuff pressures and avoiding underinflation may also help decrease aspiration, which may reduce rates of pulmonary infection that can be seen with longer intubation periods. By improving management of ETT cuff pressures by anesthesia providers, patient safety and health outcomes, including overall satisfaction with anesthesia care provided, can be improved.

Implications for Nursing Practice

Implications of this project for nursing care may include a renewed sense of vigilance for airway management. Regardless of technique used, this project may help bring attention to the surveillance of not only ETT cuff pressures but of all airway management devices utilized during anesthesia care. The project could also encourage reassessment of the providers' chosen technique and possible evaluation of new information that leads to a practice change and ultimately improved patient care and outcomes.

Impact for Healthcare System

The impact for the healthcare system could potentially be increased patient satisfaction with anesthesia care. This could lead to an improved image of healthcare within the community the system serves. The improved image could lead the surrounding communities to select this

healthcare system instead of other systems to meet their healthcare needs. The project could also help bring attention and awareness to ETT cuff pressure management and a renewed level of vigilance to managing ETT cuff pressures. The overall impact of the project by using a new tool or bringing attention to the management of ETT cuff pressures may benefit the population served by the hospital and the hospital itself.

Sustainability

The sustainability of this project would depend on the providers' decision to make a practice change. Lewin's change model addresses unfreezing patterns of behavior and moving to new ones. The providers would have to assess the techniques and make their own determination if an alternate technique was appropriate to implement. The educational component provided evidenced-based research regarding reasons to make a change. However, a provider's experience and practice with other techniques may limit change as these techniques may seem more reliable for them. The perceptions the providers have of seasoned techniques versus new or different techniques may be difficult to change since individual experiences and outcomes with preferred techniques become imbedded into practice as proven routines for care.

Dissemination Plan

Dissemination of the results of this project included placement in The Scholarship, East Carolina University's digital archive of scholarly work, as well as a poster presentation delivered via Zoom to other students and faculty members of the CRNA program as well as any project participants interested in joining. The project and its content may be used as an example for future students to use as a template for their own work.

Section VI. Conclusion

Limitations

Limitations of this project include small sample size, the data collection tool did not have reminders to reply, and time limits. Sample size was limited by the number of staff working at a given location and concurrent staff involvement in other projects. The data collection tool was useful but could have been enhanced by having it set up to send reminders to participants to submit surveys. A weekly reminder to the participants encouraging use of the implemented project tool could have been helpful as well. The timeframe was limited by the number of projects that occur at this location and to help retain staff involvement throughout the project. Busy schedules and operating room productivity demands may have altered participants' abilities to implement manometer use and possibly affected post-implementation results. Another limitation of the project was not receiving all post-survey responses, which made post-implementation analysis difficult.

Recommendations for Others

Recommendations for others in performing similar projects would include further investigation into techniques commonly used in the facility where the project will be performed as part of the planning stage. This would allow a more focused, and potentially more effective, project intervention. Implementation might be more streamlined through introduction of the lead investigator to potential participants during a departmental meeting (not an option during COVID 19) and scheduling an opportunity to meet with project participants as a group. Additionally, collection of data might be improved by setting up the analytic software to send reminders to participants who fail to complete surveys on schedule.

Recommendations for Further Study

Further investigation of ETT cuff pressure assessment techniques used in the facility and the outcomes from use of these techniques may help guide practice and establish updated ETT cuff monitoring standards. Patients could be assessed for symptoms of tracheal irritation during sign out from the PACU to provide a baseline of the effectiveness of currently utilized ETT cuff pressure assessment techniques. After determining baseline outcomes for the various subjective techniques used in actual practice, use of the objective tool could be implemented and then pre- and post-results compared. Further study might also focus on sustainability of using manometers based on the cost of the tool to the hospital. The manometer tool is already a stock item in the perioperative area within the partnering facility, however, increased use would contribute to cost and must be considered. It may be beneficial to assess the cost-benefit analyses of all possible techniques to reduce purchasing and redundancy issues.

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Appendix A

Keywords, PubMed MeSH, and CINAHL Subject Headings Used for Literature Searches

	Concept		
	Anesthesia	Endotracheal tube	Pressure
Keywords	Anesthesia	Endotracheal Tube, Endotracheal Cuff,	Pressure Pressures
PubMed MeSH	Anesthesia, anesthesia		Pressure
CINAHL Subject Headings	Anesthesia	Endotracheal Tube	Pressure

Note. Various combinations of the provided keywords, PubMed MeSH terms, and CINAHL subject headings were used to conduct literature searches in PubMed, CINAHL, and Google Scholar. Boolean operators were used in different combinations to yield reported search results.

Appendix B

Search Strategy

Search date	Database or search engine	Search strategy	Limits applied	Number of Results	Number Kept
2/25/2021	PubMed	(Endotracheal tube cuff) AND (Pressure)	In the last 10 years (2011-2021) English	398	7
02/25/2021	CINAHL	(Endotracheal cuff pressure) AND (pressure)	In the last 10 years (2011-2021) English	71	5
02/25/2021	Google Scholar	(Anesthesia) AND (Endotracheal Tube Cuff Pressure)	Last 5 years (2016-2021)	First ten pages reviewed	1

Appendix C

Literature Matrix

Year	Author, Title, Journal	Purpose	Design / level of evidence	Setting	Sample	Tool/s	Results
2004	Papiya Sengupta, M.D., Spencer Wells, B.S., Paul Maglinger, B.S., Anupama N. Wadhwa, M.D., Daniel I. Sessler, M.D (2004). Endotracheal tube cuff pressure. Anesthesiology 101, Abstract 509.	Study focused on testing finger palpation of ETT cuff pressures (manual estimation) of ETT cuff pressures and its accuracy	QI	One university teaching hospital and two private hospitals	93 patients ET cuff pressures inflated by Anesthesia team	manometer	Manual estimation of the cuff pressure by finger palpation of the pilot is inaccurate, and the volume of air needed to inflate the cuff to a safe pressure varies. Recommendation made that ET cuff pressure be set and monitored with a manometer.
2013	Maboudi, A., Abtahi, H., Hosseini, M., Tamadon, A., & Safavi, E. (2013). Accuracy of endotracheal tube cuff pressure adjustment by fingertip palpation after training of intensive care unit nurses. *Iranian Red Crescent medical journal*, *15*(5), 381–384.	Study focused on a training course and its effects of ETT cuff adjustment by palpation in attaining a safe cuff inflation pressure.	QI	16-bed ICU of Imam Khomeini Medical Center affiliated with Tehran University of Medical Sciences	Twenty-five volunteer ICU nurses enrolled in this study	cuff manometer (Mallinckrodt Medical, Athlone, Ireland	Using trained fingertip adjustment of the ETT cuff pressure throughout the nursing shift with protocols for the adjustment of out of range pressures at the beginning of each shift by cuff manometer could decrease the rate of ETT cuff over- and under-inflation.
2013	Ozer, A. B., Demirel, I., Gunduz, G., & Erhan, O. L. (2013). Effects of user experience and method in the inflation of endotracheal tube pilot balloon on cuff pressure. *Nigerian journal of clinical practice*, *16*(2), 253–257.	How effects of user experience and cuff pressure inflation methods affected tube cuff pressures after intubation and postoperative complaints	Level 5	N/A	250 patients planned for general anesthesia were included	Aneroid manometer	Study showed experience of users had significant effect on the ETT cuff pressure regulations, but inflation methods did not have any effect. The study also found ETT cuff pressure were higher than normal range with less experienced users. The major correlation was shown between cuff pressure and anesthesia duration with postoperative complaints.
2015	Seyed Siamdoust, S. A., Mohseni, M., & Memarian, A. (2015). Endotracheal Tube Cuff Pressure Assessment: Education May Improve but not Guarantee the Safety of Palpation Technique. *Anesthesiology and pain medicine*, *5*(3), e16163.	This study showed how education could increase the accuracy of a technique but not guarantee ETT cuff pressure ranged to be in a safe range	Level 5	Departme nt of Anesthesi ology, Rasoul Akram Medical Center, Iran University of Medical Sciences, Tehran, Iran	128 intubated patients were measured	noninvasive manometer (cuff controller digital 0 - 120 cm H_2O, VMB Medizintechnik GMBH, Germany	The survey included two series of blinded ETCP measurements in intubated patients before and two weeks after an in vitro educational intervention
2017	Ashman, R. E., Appel, S. J., & Barba, A. J. (2017). Effectiveness of Interventions to Increase Provider Monitoring of Endotracheal Tube and Laryngeal Mask Airway	Examining how or if a multistep intervention would increase the ET cuff pressure range to be within safer	QI	Naval Medical Center San Diego in San Diego, California	102 ET cuff pressure and 102 LMA pressure.	manometer	The interventions significantly increased the frequency at which providers monitored ET tube and LMA intracuff pressures and decreased intracuff pressures in both groups

	Cuff Pressures. *AANA journal*, *85*(2), 98–103.	ranges and out of high ranges					
2017	Bulamba, F., Kintu, A., Ayupo, N., Kojjo, C., Ssemogerere, L., Wabule, A., Kwizera, A. (2017). Achieving the Recommended Endotracheal Tube Cuff Pressure: A Randomized Control Study Comparing Loss of Resistance Syringe to Pilot Balloon Palpation. Anesthesiology Research and Practice 2017.	This study compared two techniques for tube cuff pressures: loss of resistance and pilot balloon palpation	Level 2	1500 bed, national hospital	172 patients	manometer (VBM, Medicintechnik Germany. Accuracy −2 cmH_2O)	ETT tube cuffs were in the pilot balloon palpation group were in the proper range (22%) to a lesser extent than the loss of resistance syringe group (66%)
2017	Mendelsohn, A.H., Mukdad, L. & Dhillon, A. High intraoperative endotracheal tube cuff pressure incidence and clinical impact. *Can J Anesth/J Can Anesth* **65,** 331–332 (2018).	To assess if there is a correlation between high endotracheal cuff pressures and post intubation negative outcomes.	Level 5	Surgical academic center	156 patients that did not include patients less than 16 or use of nitrous during the case.	NS 60-PBS 60 cmH_2O Vacuum/Pressure Gauge (Instrumentation Industries, Inc., Bethel Park, PA, USA)	Study showed that a large percentage of patient cuffs were overinflated and small amounts to be underinflated. The cuff in the proper range only measured to be 33%
2018	Özcan, A.T.D., Döğer, C., But, A. *et al.* Comparison of endotracheal tube cuff pressure values before and after training seminar. *Journal of Clinical Monitoring and Computing* 32**,** 527–531 (2018).	100 cuff pressures measured before a training seminar and 100 cuff pressures measured after a training seminar, to evaluate the effect of training on ETT cuff pressures.	Level 3	200 intubated patents by physician assistants	The cuff pressure values of 200 patients intubated following general anesthesia induction	Training seminar, manometer to measure	The training in this study led to meaningful difference between cuff pressure values before and after the training ($p < 0.001$). Average pressure measure for Group I was 54 cm H_2O, while average pressure in Group II declined to 33 cm H_2O
2018	Stevens, G. J., Warfel, J. W., Aden, J. K., & Blackwell, S. D. (2018). Intraoperative Endotracheal Cuff Pressure Study: How Education and Availability of Manometers Help Guide Safer Pressures. *Military medicine*, *183*(9-10), e416–e419.	Study assessed if education and access to manometers would result in an improved number of ETT cuff pressures in the recommended ranges	QI	San Antonio Military Medical Center (SAMMC)	100 pre-implementation and 100 post-implementation.	Manometers were supplied to OR rooms and departmental education was done on how to use manometer	Pre-implementation average cuff pressure were 48.92 with a mean of 38.5 cmH20. Post-implementation cuff pressure were 41.96 with a mean of 30 cm H20. Demonstrating improvement after QI project.
2019	Abubaker J, Zia Ullah S, Ahmed S, et al. Evaluating the Knowledge of Endotracheal Cuff Pressure Monitoring Among Critical Care Providers by Palpation of Pilot Balloon and By Endotracheal Tube Cuff Manometer. *Cureus*. 2019;11(7):e5061. Published 2019 Jul 1.	This study evaluated the knowledge of endotracheal cuff pressure monitoring with a manometer and manual palpation of pilot balloon among critical care providers.	Level 6	critical care area of National Institute of Cardiovascular Diseases (NICVD), Karachi	150 participants 66 doctors 84 staff	Portex manometer	In this study of knowledge and practice of ETT tube cuff pressure monitoring, authors found low knowledge levels. Also demonstrated was a poor agreement between the palpation method and the manometer method for assessing cuff pressure.

2020	Fritz, A. V., Mickus, G. J., Vega, M. A., Renew, J. R., & Brull, S. J. (2020). Detrimental Effects of Filling Laryngotracheal Airways To Excessive Pressure (DEFLATE-P): a quality improvement initiative. *BMC anesthesiology*, *20*(1), 46.	This was done to determine the incidence of post-op complications associated with cuffed airway devices.	QI	Single center	259 pre-education for baseline 299 for post educational evaluation.	Education and manometer	After education on appropriate cuff pressures and instruction on how to use the manometer there was a decrease in patient reported post-op complications including: soreness, hoarseness, and dysphagia.
2020	Mpasa, F., van Rooyen, D. R. M., Venter, D., Jordan, P., & ten Ham-Baloyi, W. (2020). Improving nurses' knowledge of managing endotracheal tube cuff pressure in intensive care units: A quasi-experimental study. *Health SA Gesonheid: Journal of Interdisciplinary Health Sciences, 25*, 1-10.	Study was done to show how an educational intervention could improve the knowledge of nurses regarding managing endotracheal tube cuff pressures	QI	Six functional ICUs (four public and two private) in Malawi	Nurses among six different ICUs	Educational intervention and Pre and Post-survey questionnaires	The project led to an improvement in knowledge and the practice changes were observed in the nursing care practices for the management of endotracheal tube cuff pressure for both groups following the educational intervention
2020	Turner, M. A., Feeney, M., & Deeds, L. (2020). Improving Endotracheal Cuff Inflation Pressures: An Evidence-Based Project in a Military Medical Center. *AANA journal*, *88*(3), 203–208.	The study focused on how interventions and education would affect cuff pressures and the management of ETT cuff pressures.	QI	A military medical center in the southwestern United States.	35 CRNAs and 5 Physician Anesthesiologists and 6 SRNAs.	ETT cuff manometer (Posey Cufflator 8199)	The intervention consisted of an education presentation, availability of cuff manometers in all operating rooms, a charting reminder to document cuff pressures, and a visual prompt in the electronic anesthesia record.
2021	Murugiah UR, Ramoo V, Jamaluddin MFH, Yahya A, Baharudin AA, Abu H, Thinagaran RRR. Knowledge acquisition and retention among nurses after an educational intervention on endotracheal cuff pressure. *Nursing in Critical Care.* 2021 Feb 10	This study's goal was to evaluate the effectiveness of an educational intervention about ETT cuff pressure management and help improve critical care nurses' knowledge.	Level 4	112 registered nurses (RNs) from a 24-bed adult general intensive care unit at a teaching hospital in Malaysia.	112 registered nurses (RNs)	Educational intervention and Pre and Post-survey questionnaires	Study showed a significant difference in mean knowledge scores of ICU nurses and was noted between the pre- (mean = 8.13; SD = 1.53) and post-intervention phases (3 months [mean = 8.97; SD = 1.57) resulting in increased knowledge

Note. Levels of evidence adapted from *Evidence-based practice in nursing & healthcare: A guide to best practice* (3rd ed.) by B. M. Melnyk, and E. Fineout-Overholt. Copyright 2015 by Wolters Kluwer.

Appendix D

Project Approval Documents

Center for Research & Grants

[redacted]

Quality Assurance/Quality Improvement Project vs. Human Research Study (Requiring IRB approval) Determination Form

This worksheet is a guide to help the submitter to determine if a project or study is a quality assurance/quality improvement (QA/QI) project or research study and is involving human subjects or their individually identifiable information and requires IRB approval as defined by the Health and Human Services (HHS) or Food and Drug Administration (FDA). Once completed, please email the form to the [redacted] CRG.Quality[redacted] A CRG team member will contact you with the results of their review and may request additional information to assist with their determination. The determination will be made in conjunction with the [redacted] office.

Please contact the [redacted] with any questions at 252-847-1177 or CRG.Quality@[redacted]

For more guidance about whether the activity meets the definition of Human Subjects Research see [redacted] or https://www.hhs.gov/ohrp/regulations-and-policy/decision-charts-2018/index.html#c1

Project Title: Assessing Anesthesia Providers' Perceptions of Adequacy of Endotracheal Tube Cuff Occlusion Assessment Techniques, A DNP Project		
Funding Source: None		
Project Leader Name: Adam Hobbs/ Travis Chabo	☐ Ed.D. ☐ J.D. ☐ M.D. ☐ Ph.D. ☐ Pharm.D. ☒ R.N. ☐ Other(specify):	
Job Title: ECU SRNA/ECU CRNA Faculty	**Phone:** [redacted]	**Email:** Chabot14@ceu.edu
	Primary Contact (If different from Project Leader): [redacted]	
	Phone: [redacted]	**Email:** hobbsad19@students.ecu.edu

Key Personnel/ Project Team members:

Name and Degree:	Department: (Affiliation if other than [redacted]t)	Email:
[redacted]		
[redacted]		
[redacted]		

QI/QA Assessment Checklist:

Consideration	Question	Yes	No
PURPOSE	Is the PRIMARY purpose of the project/study to: • IMPROVE care right now for the next patient? OR • IMPROVE operations outcomes, efficiency, cost, patient/staff satisfaction, etc.?	☑	☐
RATIONALE 1	The project/study falls under well-accepted care practices/guidelines or is there sufficient evidence for this mode or approach to support implementing this activity or to create practice change, based on: • literature • consensus statements, or consensus among clinician team	☑	☐
RATIONALE 2	The project/study would be carried out even if there was no possibility of publication in a journal or presentation at an academic meeting. (**Please note that answering "Yes" to this statement does not preclude publication of a quality activity.)	☑	☐
METHODS 1	Are the proposed methods flexible and customizable, and do they incorporate rapid evaluation, feedback and incremental changes?	☑	☐
METHODS 2	Are patients/subjects randomized into different intervention groups in order to enhance confidence in differences that might be obscured by nonrandom selection? (Control group, Randomization, Fixed protocol Methods)	☐	☑
METHODS 3	Will there be delayed or ineffective feedback of data from monitoring the implementation of changes? (For example to avoid biasing the interpretation of data)	☐	☑
METHODS 4	Is the Protocol fixed with fixed goal, methodology, population, and time period?	☐	☑
RISK	The project/study involves no more than minimal risk procedures meaning the probability and magnitude of harm or discomfort anticipated are not greater in and of themselves than those ordinarily encountered in daily life or during the performance of routine physical or psychological examinations or tests.	☑	☐
PARTICIPANTS	Will the project/study only involve patients/subjects who are ordinarily seen, cared for, or work in the setting where the activity will take place?	☑	☐
FUNDING	Is the project/study funded by any of the following? • An outside organization with an interest in the results • A manufacturer with an interest in the outcome of the project relevant to its products • A non-profit foundation that typically funds research, or by internal research accounts	☐	☑

If all of the check marks are inside the shaded gray boxes, then the project/study is very likely QI and not human subject research. Projects that are not human subject research do not need review by the IRB.

In order to assess whether your project meets the definition of human subject research requiring IRB review or may qualify as a quality improvement/assurance activity, please provide the following information:

1. **Project or Study Summary:**
   As a separate attachment, please provide a **summary of the purpose and procedures** as well address all of the following:
   a) The project question/hypothesis.
   b) The project design.
   c) Any interaction or intervention with humans.
   d) A description of the methods that will be used and if they are standard or untested.
   e) Specify where the data will come from and your methods for obtaining this data -please specify who/where (i.e. CRG will provide you with the data, or someone from a specific department will provide you with the data, or you will pull it yourself).
   f) Specify what data will be used and any dates associated with when that data was originally collected (i.e Patient Name, Diagnosis, Age, Sex), *If applicable, please attach your data collection sheet.*
   g) Where will the data (paper and electronic) for your project be stored? Please specify how it will be secured to protect privacy and maintain confidentiality. For paper data, please provide physical location such as building name and room number and that it will be kept behind double lock and key. For electronic data, please provide the file path and folder name network drive where data will be stored and specify that it is secure/encrypted/password protected. If using other storage location, please provide specific details.
   h) Please specify how long data will be stored after the study is complete? (Keep in mind that data collected/generated during the course of the project that includes protected health information (PHI) should have identifiers removed at the earliest opportunity.)
   i) Please specify how the collected data will be used (internal/external reports, publishing, posters, etc.).

   Please attach a summary and/or any other additional documentation describing your project

2. **If the Primary purpose of your project/study is for QA/QI, have you obtained approval from the operational leader within your department or health system:**
   ☒ **Yes** [Please specify here whom and obtain their signature in the signature section below]: [redacted]
   ☐ **No** [Contact the appropriate operational leader for approval.]

Please note:

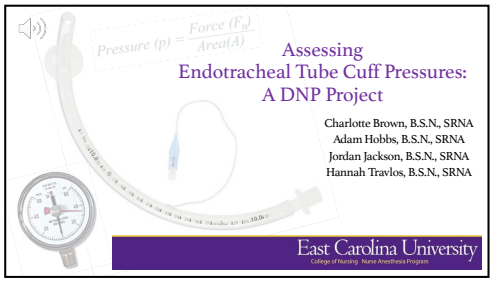
- By submitting your proposed project/study for QA/QI determination you are certifying that if the project/study is established to qualify as QA/QI project, you and your Department would be comfortable with the following statement in any publications regarding this project: "This project was reviewed and determined to qualify as quality improvement by the [redacted] for Research and Grants."
- If you are submitting a Poster to Media Services for printing, you will need to also submit this Quality Improvement Worksheet or proof of your IRB Application and IRB Approval.
- If the [redacted] CRG determines the activity is not human subject research, then any presentation, publication, etc. should not refer to the activity as "human subject research," "exempt research," or "expedited research."
- If you would like the [redacted] CRG to verify that a project/study is not human subject research, please provide this form completed with the summary of your activity and any additional information to the [redacted] CRG at CRG.Quality@[redacted] and the following will be completed and returned to you for your records.

[redacted]

[redacted]

Appendix E
Educational Video Content

9/29/21



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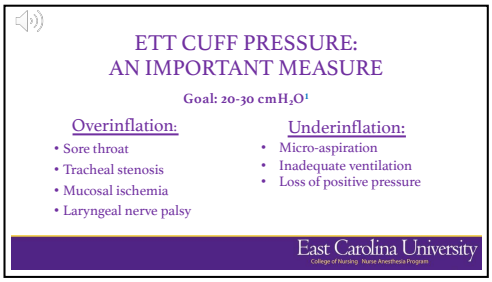

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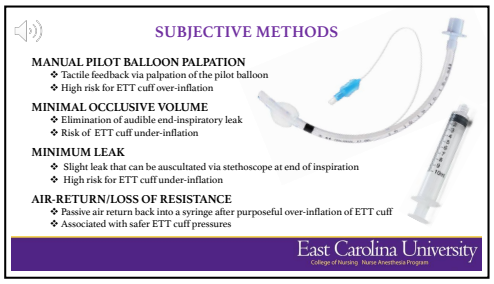

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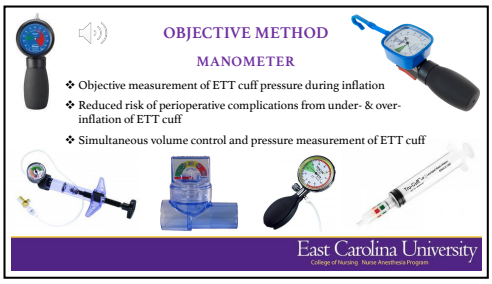

4

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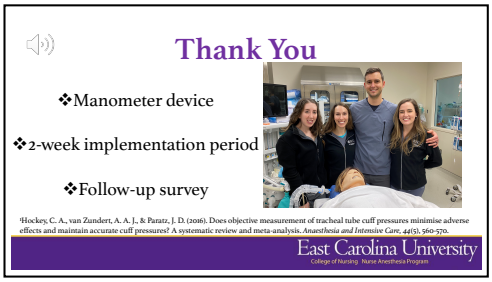

6

Appendix F

DNP Project Timeline

May 2020	Topic assigned: Explore project background
July 2020	Complete literature review
October 2020	Develop assessment tool, create educational video script
March 2021	Record video introducing the tool to the target audience
May 2021	Introduce the tool to the target audience via video and email
May 2021	Collect data on the tool utilization
June 2021	Perform data analysis
October 2021	Completed project paper
November 2021	Submitted paper to The Scholarship
November 2021	Completed project poster
November 2021	Presented project poster

Appendix G

Pre-Intervention Survey

Q1 In your current practice, which method(s) do you prefer for obtaining adequate ETT cuff pressure? (select all that apply)

- ○ Minimal occlusive volume (1)
- ○ Pilot balloon palpation (2)
- ○ Manometer (3)
- ○ Audible air leak (4)
- ○ Set volume (5)
- ○ Other (6) _____

Q2 In your opinion, is subjective assessment (tactile) adequate for obtaining appropriate ETT cuff pressure?

- ○ Extremely adequate (1)
- ○ Somewhat adequate (2)
- ○ Neither adequate nor inadequate (3)
- ○ Somewhat inadequate (4)
- ○ Extremely inadequate (5)

Q3 How often in your practice do you solely utilize subjective assessment (tactile) to obtain appropriate ETT cuff pressure?

- ○ Never (1)
- ○ Sometimes (2)
- ○ About half the time (3)
- ○ Most of the time (4)
- ○ Always (5)

Q4 In your opinion, is objective measurement (manometer) adequate for obtaining appropriate ETT cuff pressure?

- ○ Extremely adequate (1)
- ○ Somewhat adequate (2)
- ○ Neither adequate nor inadequate (3)
- ○ Somewhat inadequate (4)
- ○ Extremely inadequate (5)

Q5 How often in your practice do you utilize an objective measurement (manometer) for obtaining appropriate ETT cuff pressure?

- ○ 0% of the time (1)
- ○ < 25% of the time (2)
- ○ 25-50% of the time (3)
- ○ 50-75% of the time (4)
- ○ > 75% of the time (5)

Appendix H

Post-Intervention Survey

Q1 While participating in this quality improvement project, approximately how many times did you use the manometer over the last two weeks?

_____

Q2 In your opinion, is subjective assessment (tactile) adequate for obtaining appropriate ETT cuff pressure?

- ○ Extremely adequate (1)
- ○ Somewhat adequate (2)
- ○ Neither adequate nor inadequate (3)
- ○ Somewhat inadequate (4)
- ○ Extremely inadequate (5)

Q3 How often in your practice do you solely utilize subjective assessment (tactile) to obtain appropriate ETT cuff pressure?

- ○ Never (1)
- ○ Sometimes (2)
- ○ About half the time (3)
- ○ Most of the time (4)
- ○ Always (5)

Q4 In your future practice, how often do you think you will choose to solely utilize subjective assessment (tactile) for obtaining appropriate ETT cuff pressure?

- ○ Never (1)
- ○ Sometimes (2)
- ○ About half the time (3)
- ○ Most of the time (4)
- ○ Always (5)

Q5 In your opinion, is objective measurement (manometer) adequate for obtaining appropriate ETT cuff pressure?

- ○ Extremely adequate (1)
- ○ Somewhat adequate (2)
- ○ Neither adequate nor inadequate (3)
- ○ Somewhat inadequate (4)
- ○ Extremely inadequate (5)

Q6 In your future practice, how often do you think you will utilize an objective measurement (manometer) for obtaining appropriate ETT cuff pressure?

- ○ 0% of the time (1)
- ○ < 25% of the time (2)
- ○ 25-50% of the time (3)
- ○ 50-75% of the time (4)
- ○ >75% of the time (5)

Q7 Are there certain types of cases in which you think utilization of an objective manometer would be beneficial?

- ○ No (1)
- ○ If yes, which types of cases? (2) _____