Subjective Versus Objective Measurement of ETT Cuff Pressures in the Operating Room: A Quality Improvement Project

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Abstract

With a variety of adequate techniques to choose from, there is a lack of understanding of provider's preferences for selection of a subjective versus an objective measurement technique for monitoring ETT cuff pressures during surgical procedures requiring an ETT. The purpose of this quality improvement project was to assess anesthesia providers' perceptions of perioperative usefulness of subjective assessment (tactile) and objective assessment (manometer) of occlusive volume for ETT cuffs. Participants in this study were Certified Registered Nurse Anesthetists. Participation in this study involved taking a short pre-intervention questionnaire about their current practice of checking ETT cuff pressures, watching an educational video on the purpose of ETT cuff pressure measurement, completing a post-intervention questionnaire after a two week implementation period. Findings showed most participants thought their current technique of subjective measurement was sufficient and accurate in obtaining ETT cuff pressures. They reported the objective measurement strategy of using a manometer was adequate, however they reported their expected future use to be less than 50 percent of the time. The primary limitation of this project was related to the small sample size. With three participants, data is not necessarily reflective of the anesthesia profession as a whole. As this project was performed over a time period of only two weeks, the limited amount of time to assess anesthesia providers' preferences is also a significant limitation. For further study, a project that involves having participants use their preferred measurement strategy (likely subjective) followed by measurement with a manometer (objective) to assess the adequacy of their initial strategy for comparison is suggested.

Keywords: endotracheal tube, anesthesia, manometer, cuff pressure measurement

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Section I. Introduction

Background

Nurse anesthetists manage a multitude of devices and monitors continuously during each of their surgical cases. This meticulous manipulation and management is for the safety and well-being of their patients. Maintaining and securing the airway is a vital aspect of care nurse anesthetists control. This is usually accomplished with an artificial airway like an endotracheal tube (ETT), which is secured in place by an inflatable cuff. Currently, there is no single standard practice established for measuring these ETT cuff pressures. Although measuring ETT cuff pressures can be viewed as monitoring yet another device, maintaining an adequate pressure of the ETT cuff can have a positive impact on patient outcomes. By measuring cuff pressures and making needed changes to assure recommended pressures are maintained, there will be a greater consistency of in-range cuff pressures improving patient safety and satisfaction (Letvin et. al., 2018, Lui et al., 2010; Safdar et at., 2005; Seegobin & van Hasselt, 1984; Stevens et al., 2018; Touman & Stratakos, 2018).

The ETT cuff secures the ETT in the airway using the pressure of the inflated balloon against the trachea wall. ETT cuff pressure refers to the pressure inside the balloon cuff, usually measured in centimeters of water pressure (cm H_2O). Having an appropriately secured cuff is conducive to maintaining ideal ventilation pressures and prevents aspiration of gastric contents by creating a barrier which contents cannot pass through into the lungs. This balloon may become overinflated or underinflated, each of which has risk. Having a low cuff pressure contributes to a risk of stomach contents getting into the patient's lungs, called aspiration, and having high cuff pressures may lead to reducing blood flow to the tracheal tissue leading to tracheal ischemia (Letvin et. al., 2018, Lui et al.,2010; Safdar et at., 2005; Seegobin & van

Hasselt, 1984; Stevens et al., 2018; Touman & Stratakos, 2018). Tracheal ischemia and aspiration may both contribute to longer stays in the hospital and increase costs for the treatment of affected patients (Safdar et at., 2005).

The ideal pressure range for ETT cuff inflation, which may decrease the risk for complications, is 20-30 cmH_2O (Seegobin & van Hasselt, 1984). There are multiple ways to inflate the ETT cuff, with both subjective and objective assessments utilized to achieve optimal ETT cuff pressures.

One subjective method, the pilot balloon palpation technique, is a commonly used method that involves tactile feel of the small pilot balloon attached to the cuff, which mimics the pressure inside of the cuff (Tsaousi et. al., 2018). Providers lightly squeeze this balloon to estimate the pressure inside the cuff. An additional subjective technique is viewing air return into the syringe after cuff inflation. With this technique the provider intentionally overinflates the cuff with a five or ten milliliter syringe and then allows the excess air to return into the syringe, which suggests the pressure in the cuff is adequate to hold the ETT in place (Letvin et. al., 2018 & Tsaousi et. al., 2018). A third subjective method used for verifying balloon pressure is referred to as the *minimal occlusive volume* technique. This practice involves setting the adjustable pressure limiting valve to 20 cm H_2O and compressing the ventilation bag. These maneuvers are performed while the anesthetist slowly inflates the ETT until the audible leak of gases stops. Alternatively, if the cuff is overinflated a similar maneuver is used except air is withdrawn until the audible leak is heard, then the ETT cuff is reinflated to the point where the leak stops. The volume in the syringe where the audible leak is no longer heard can be documented as a reference point.

Objective measurements of ETT cuff pressures are accomplished using manometers. A manometer is a device used to measure closed-system pressures, in this case ETT cuff pressures, which can provide anesthetists with an objective pressure reading. There are several types of these objective measuring devices. Currently there are two devices used to measure ETT cuff pressures: a manometer with an inflation bulb and attached gauge, and a disposal syringe manometer (Stevens et al., 2018; Touman & Stratakos, 2018, Totonchi et. al., 2015). To utilize these devices, the provider attaches the manometer to the pilot balloon and views a digital readout of the pressure inside the balloon on the syringe screen or pressure gauge. The provider is then able to manipulate the pressure by using the manometer as a syringe. This gives a more precise measurement of the ETT cuff pressure.

Each of these measurement techniques takes less than one minute to perform and helps facilitate adequate ETT cuff pressures (Letvin et. al., 2018). In the anesthesia profession, each objective and subjective measurement techniques have been validated as appropriate measuring devices, and are widely used in operative settings. At this time, leading organizations such as the American Association of Nurse Anesthetists (AANA, 2019) and American Society of Anesthesiology (ASA, 2020) do not suggest one method over the other. However, these organizations have developed guidelines and made recommendations to improve patient safety and effectiveness in anesthesia care. Measuring ETT cuff pressures is one way to improve patient safety and effectiveness. The Anesthesia Patient Safety Foundation's mission is to improve the safety of patients during anesthesia by identifying safety improvements, including this movement to measure ETT cuff pressures (APSF, 2021).

Organizational Needs Statement

Within the participating medical center, there are numerous nurse anesthetists and anesthesiologists who provide general anesthesia via ETT intubation to surgical patients. These anesthesia providers utilize a variety of different techniques in various areas of their practice. One technique at the discretion of the provider is how they choose to measure ETT cuff pressure. There is a lack of understanding regarding provider choice of the method(s) used to measure ETT cuff pressures. Understanding of important factors in their decision making could, however, inform interventions aimed at improving practice.

Under the objective of Health Care Hospital and Emergency, Healthy People 2030 aims to improve hospital care by creating safe practice environments (Office of Disease Prevention and Health Promotion, 2020). This objective closely aligns with nurse anesthetists' goals of improving patient safety with more accurate measurement of ETT cuff pressures. The goals of the Institute of Healthcare Improvement (IHI) Triple Aim are to improve the population health, enhance patient outcomes and experience, and reduce per capita cost of care for the benefit of the communities (Berwick et al., 2008). Assuring more accurate maintenance of ETT cuff pressures addresses each of these goals.

Problem Statement

With a variety of adequate techniques to choose from, there is a lack of understanding of provider's preferences for selection of a subjective versus an objective measurement technique for monitoring ETT cuff pressures during surgical procedures requiring an ETT.

Purpose Statement

The purpose of this quality improvement project was 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 review of literature pertinent to ETT cuff pressure management was conducted using the electronic bibliographic databases PubMed and CINAHL, as well as East Carolina University Libraries' OneSearch Tool and Google Scholar. Primary keywords and subject headings searched included, but were not limited to, *operating room, ETT cuff measurement, intraoperative, anesthesia, ETT,* and *pressure* (Appendix A). Limiters applied, based on availability within each source, included publication within the last ten years, English language, and full text. Specific search strategies, limiters, and results are available in Appendix B. After deduplication and review by title and abstract, 53 papers were identified as pertinent for review. Papers were additionally identified through linking, references, searches of the websites of organizations, and Google searches. Upon full text review a total of 15 articles were deemed pertinent to this literature review (Appendix C).

Current State of Knowledge

Using the Melnyk and Fineout-Overholt Levels of Evidence, two Level II (one or more randomized control trial) and three Level VI (qualitative) studies addressing the use of a manometer were identified within the literature (Melnyk & Fineout-Overholt, 2015). An additional paper (Ashman, 2017) reported results of a quality improvement initiative that assessed impact of various interventions on monitoring of cuff pressures.

Current Approaches to Solving Population Problem

A common theme found in the identified literature was that education on, as well as the use of, a manometer improves the number of in-range ETT cuff pressures compared to ETT cuff pressures not measured by a manometer (Ashman, 2017; Lui, 2010; Özcan et al., 2018; Stevens,

2018). Researchers of these initiatives support the use of education of staff on the use of manometers to increase compliance with recommended ETT cuff pressures, which may result in increased patient safety (Ashman, 2017; Lui, 2010; Özcan et al., 2018; Safdar et at., 2005; Stevens, 2018; Touman & Stratakos, 2018)

One Level II study (one or more randomized controlled trial) on the MeInyk and Fineout-Overholt Levels of Evidence Model (2015), evaluated four techniques (pilot-balloon palpation, air return, Min-Leak, or audible leak) to determine which was the most accurate method in obtaining adequate ETT cuff pressures (Tsaousi et al., 2018). The authors concluded that there were no clear best-practice techniques among the four options assessed. They all varied in their accuracy to provide adequate pressures.

When trying to understand individual practice, it is helpful to understand motivators and deterrents in the particular setting. Currently there is limited understanding of provider preferences for obtaining adequate ETT cuff pressure. Since there is no standard or recommended measurement technique, anesthesia providers are making autonomous decisions to obtain adequate ETT cuff pressures. Understanding of how and why these decisions are made is needed to help make informed recommendations to improve or change practice standards.

Evidence to Support the Intervention

The intervention chosen for this project was an electronically delivered presentation to provide education regarding ETT cuff pressures and differences between subjective and objective monitoring strategies during general anesthesia. The use of an educational tool to promote positive changes in the monitoring of ETT cuff pressures during anesthesia has been shown to result in more cuff pressures falling within the recommended range (Ashman et al., 2017; Lui et al., 2010; Ozcan et al., 2018; Stevens et al., 2018; Totonchi et al., 2015). Stevens et

al. (2018) determined that providing departmental education opportunities and having manometers easily accessible for use improved maintaining of ETT cuff pressures within the normal range. A second quality improvement study (Ashman et al., 2019) found that education focusing on ETT cuff pressures and reminder cards were effective in improving providers ability to monitor of ETT cuff pressures, and the number of in-range cuff pressures increased. The educational interventions raised awareness of the importance of utilizing manometers.

Evidence-Based Practice Framework

The goal of this project was to understand current practice and possibly facilitate a change in practice. The intervention involved providing education on the recommended range of ETT cuff pressures and why the range is recommended. The result of this project was to have anesthesia providers perform a self-assessment and possibly create a change in their practice. This project was accomplished by creating a short, educational video highlighting the recommended range of ETT cuff pressure, followed by information regarding objective and subjective measurement strategies.

Lewin's theory of planned change (TPC) provided the theoretical framework to inform this practice change. Lewin's theory of planned change is a theoretical framework that can be used as a guideline to facilitate change at the personal level, yet also highlights change management strategies successful in executing organizational change (Lewin, 1997). Changing practice in health care requires diligent effort and should be based on evidence supporting why the change should be implemented.

The theory of planned change is composed of three elements: unfreezing, change, and refreezing (Lewin, 1997). Unfreezing is the first stage. It involves the preparation for change. Applying Lewin's framework to this project, addressing management of ETT cuff pressure, the

facilitator of change was the author, a Student Registered Nurse Anesthetist (SRNA) who addressed the management of ETT cuff pressures. It was identified that there was no current or specific policy addressing the management of ETT cuff pressures in the perioperative area. It was also determined there was no process outlined to determine if cuff pressures were out of the recommended range (20-30 cm H_2O). This could potentially harm patients. A plan to implement changes was facilitated with this finding.

Change, the second phase of Lewin's theory, involves viewing change as a continuous process instead of an event. This phase includes creating a detailed plan to engage the team to try out the proposed change (Lewin, 1997). The change phase of initiating the measurement of ETT cuff pressure included an educational video on the benefits of having the ETT cuff pressure within the normal parameters. This included decreasing negative sequalae due to under or over inflation and information regarding various objective and subjective ETT cuff measurement strategies.

The third and final phase is refreezing. This stage of the theory facilitates stabilizing the change so that it becomes embedded in the culture, policies, and practices of an organization (Lewin, 1997). This stage included follow-up with the anesthesia providers to assess their preferences and practices and identify any changes in their perception or practice after viewing the educational video and having the opportunity to try new methods. Although not included in this project due to the limited time frame, efforts to reinforce use of objective measuring methods would be ideal.

Ethical Consideration & Protection of Human subjects

This project was deemed quality improvement and thus exempt from full Institutional Review Board (IRB) review through an internal review process for student projects set up in

cooperation with the University and Medical Center IRB. It was also approved without full IRB review through a process for student projects set up by the partnering organization in cooperation with the University and Medical Center IRB (Appendix D). Additionally, the author completed the Collaborative Institutional Training Initiative (CITI) modules on research ethics and compliance in August of 2020, prior to beginning this project. This project did not involve patients or patient information as participation was limited to CRNA volunteers. There was no more than minimal risk associated with this project as the information and processes fell within usual practice standards in the organization. Identified risks included the potential for added stress or increased time demands on participants.

Section III. Project Design

Project Site and Population

Description of the setting

The partnering facility for this project was a small, rural hospital in the eastern United States located in an underserved area and serving approximately four counties. The facility has just over 100 beds with three operating rooms and one endoscopy suite. The facility schedules a variety of general and gynecological surgical procedures and serves a diverse population of patients. An anesthesia care team comprised of anesthesiologists and Certified Registered Nurse Anesthetists (CRNAs) provide anesthetic services during procedures performed. An existing relationship with the university facilitated the implementation of this project. The anesthesia providers work with nurse anesthesia students in an educational setting as they are part of a teaching hospital, and frequently facilitate the education of students of different disciplines.

Description of the population

The population of focus for this quality improvement project was the anesthesia providers practicing in the community hospital. Within this center the anesthesia providers include nurse anesthetists and anesthesiologists. Student nurse anesthetist also rotate to the facility for clinical case experiences. All anesthesia providers employed there are proficient in the management of anesthesia while patients are undergoing a variety of surgical procedures. They vary in experience and age and work autonomously (T. Chabo, personal communication, December 10, 2021). Within this group, experienced leaders helped facilitate the onboarding of this quality improvement project. These providers are very familiar with their practice and workflow. At times production pressure results in a high paced environment. This was perceived by the author as a potential barrier to project implementation. Additionally, there was a potential barrier due to

anesthetists' reluctance to add an additional step to their already streamlined process. Anesthesia providers have extensive responsibility and numerous tasks to complete while administering an anesthetic, another potential barrier to implementation of this project.

Project Team

The quality improvement project team consisted of the SRNA author, a clinical CRNA faculty member who served as the project chair and content specialist, and the CRNA program director. The organization's department head provided local support for the project. An additional non-CRNA faculty member coordinated development and implementation. Initial development of the project was accomplished in cooperation with three additional students addressing the same clinical issue in different settings. The primary SRNA took the lead in regard to implementing the educational tool, administering questionnaire s addressing and assessing participant perceptions, and analyzing the questionnaire data.

Project Goals and Outcome Measures

Description of the methods and measurement

This quality improvement project utilized a pre-test/post-test methodology and completed a single Plan, Do, Study, Act (PDSA) cycle (IHI, 2021). Initially participants completed a pre-questionnaire which included questions to identify their perceptions of the adequacy of both subjective and objective techniques. This was followed by the presentation of an educational video addressing the recommended range of ETT cuff pressures, and the importance of assessing for this range of pressure, which served as the intervention. Educational content included the risks of improper ETT cuff inflation, patient benefits of maintaining the ETT cuff pressure within the recommended range, and the variety of subjective and objective methods for assessing and maintaining ETT cuff pressures. Project participants were then provided a manometer and

given weeks to utilize these methods at their discretion and asked to complete a post-questionnaire to assess for changes in their perceptions and practice. Pre- and post-questionnaires including binary yes/no, Likert-type, and free response questions were used to assess participant perceptions of the adequacy of both subjective and objective techniques and any potential change in practice post implementation

Discussion of the data collection process

Recruitment of volunteers to participate in this quality improvement project was the first step in this process. The CRNA clinical faculty member spoke with CRNAs who work in the operative setting and provided the student project lead a list of names and work emails of those who agreed to participate. Once identified, these CRNAs received an email from the SRNA which included a link to a pre-intervention questionnaire created in Qualtrics (Appendix E). They were asked to fill out this questionnaire and then watch the educational video provided in the email (See Appendix F). After watching this video, each participant was given a manometer and asked to keep track of their techniques they used to measure their ETT cuff pressures for two weeks. The SRNA conducting this project was on-site over the intervention period to answer any questions. After the completion of the two-week implementation, the participants were emailed a link to a post-intervention questionnaire via Qualtrics (Appendix E). Responses to the Qualtrics questionnaires were confidential, with results gathered electronically then analyzed and reported in aggregate format.

Implementation Plan

Recruitment of participants for this project was accomplished by the clinical CRNA faculty member who had established relationships within the partnering organization. Upon launch of the project, an email containing an anonymous link to a Qualtrics pre-questionnaire

and educational video was sent to potential participants. They were asked to first complete the pre-intervention questionnaire. Immediately following completion of the pre-questionnaire, they were asked to watch the three to five minute educational video on the importance of recommended ETT cuff pressures, methods on how to keep the ETT cuff pressures within the recommended range, and how to use subjective and objective measurement strategies. After viewing this video, the anesthesia providers were given two weeks to practice and use their preferred methods of obtaining adequate ETT cuff pressures. At the end of the two-week period participants were sent a second email containing an anonymous link to the Qualtrics post-intervention questionnaire and were asked to complete it at that point.

Timeline

This project was initiated in August of 2020. After identifying the topic and problem within the setting, a literature search was performed using multiple databases and search engines in November of 2020. The first draft of the pre- and post- intervention questionnaires were created and then finalized in January 2021, and soon after the education video was scripted. Partnering organization approval was obtained in March of 2021 and in April nurse anesthetist volunteers were recruited. May 2021, the project was implemented with pre- and post-data collected and in July analysis of data was performed. The project findings were presented in a presentation with a poster display in 2021 via a small in-person and electronic Zoom. The participants were invited to attend as well as faculty and students from the university and the partnering organization. This project paper was uploaded into The Scholarship, the university's digital repository for scholarly works. See Appendix G.

Section IV. Results and Findings

Results

Data was collected via Qualtrics questionnaires completed by participants prior to and after the two week implementation period. The questionnaires measured the perception of the anesthesia providers' choices in obtaining adequate ETT cuff pressures, whether they preferred subjective or objective ETT cuff measurements, and their perception of adequacy of these measurement strategies. The majority of the questionnaire questions were in Likert-scale format and participants were able to choose one descriptor that they felt best represented their perception. The pre-intervention questionnaire inquired about participants' preferred method of obtaining ETT cuff pressures and their current views on the usefulness of an objective measurement tool. The post-intervention questionnaire addressed participants' post implementation perceptions of the usefulness of objective and subjective measurement tools, and their measurement method of choice. Overall, the pre-intervention questionnaire showed that participants preferred subjective methods of measurement including pilot balloon palpation, minimal occlusive volume, and audible air leak. The post-intervention questionnaires reported that even after exposure to objective measurement education and use, CRNAs preferred to use subjective measurement over objective measurement, and reported that they only planned to use objective measurement strategies in less than 25-75% of their future cases.

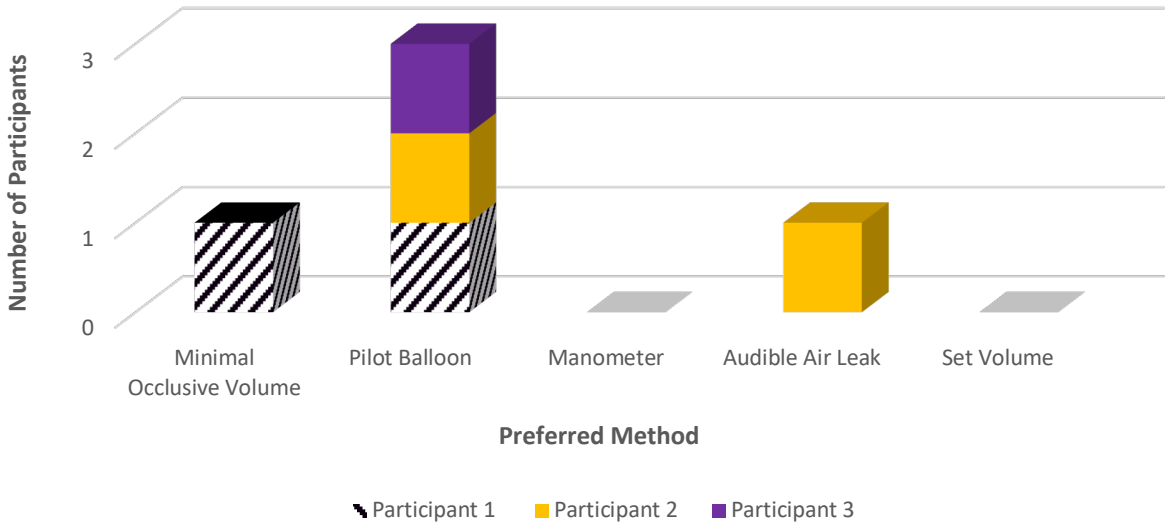
Analysis

The purpose of the pre-intervention questionnaire was to identify the current preferred practices and perceptions of the nurse anesthetists' ETT cuff measurement strategies. The pre-intervention questionnaire asked about their current practice of using subjective and objective ETT cuff pressure measurement strategies, their perception of adequacy of subjective and

objective measurements, and the frequency the participants used subjective and objective measurement strategies. Of the three participants, each reported using the subjective measurement strategy of pilot balloon palpation. In addition to each of them using pilot balloon palpation, one individual also reported using minimal occlusive volume, and another reported also using audible air leak (Figure 1). All participants responded that using these subjective measurements was somewhat adequate in obtaining appropriate ETT cuff pressure measurements and reported using subjective strategies most of the time. No participant reported using an objective measurement (manometer device), though all responded that they perceived using one would be somewhat or extremely adequate.

Figure 1

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

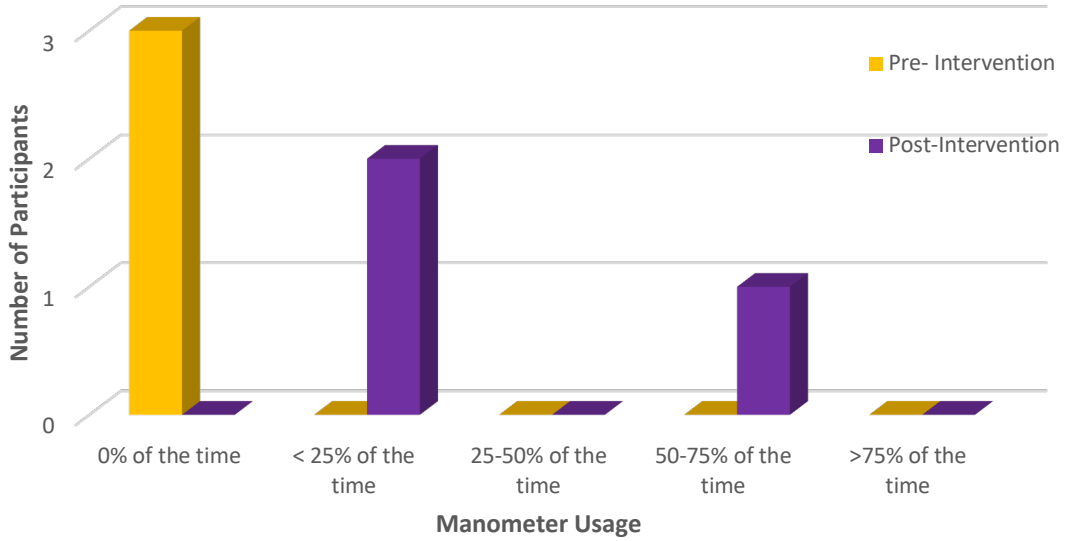


Note. N=3. Participants instructed to select all that apply.

The post-intervention questionnaire included similar questions, with additional ones about future practice. Participants reported using the manometer from 5 to 15 times during the two-week implementation period. They all reported that the subjective measurement was somewhat adequate, which was similar to the pre-intervention questionnaire, and the use of subjective measurement most of the time or always in their practice. After the implementation period, they reported that they would continue to choose to use a subjective measurement strategy most of the time, although one reported that they would use subjective measurement just some of the time. Use of a manometer (objective strategy) was evaluated as somewhat adequate to extremely adequate, yet only one participant predicted their future use of a manometers to assess ETT cuff pressure would be at least 50 percent of the time (Figure 2). When asked to report cases for which they thought using a manometer would be useful, responses included pediatric, prone, and neurosurgical cases.

Figure 2

Manometer Use: Pre-Intervention and Estimated Use Post-Intervention

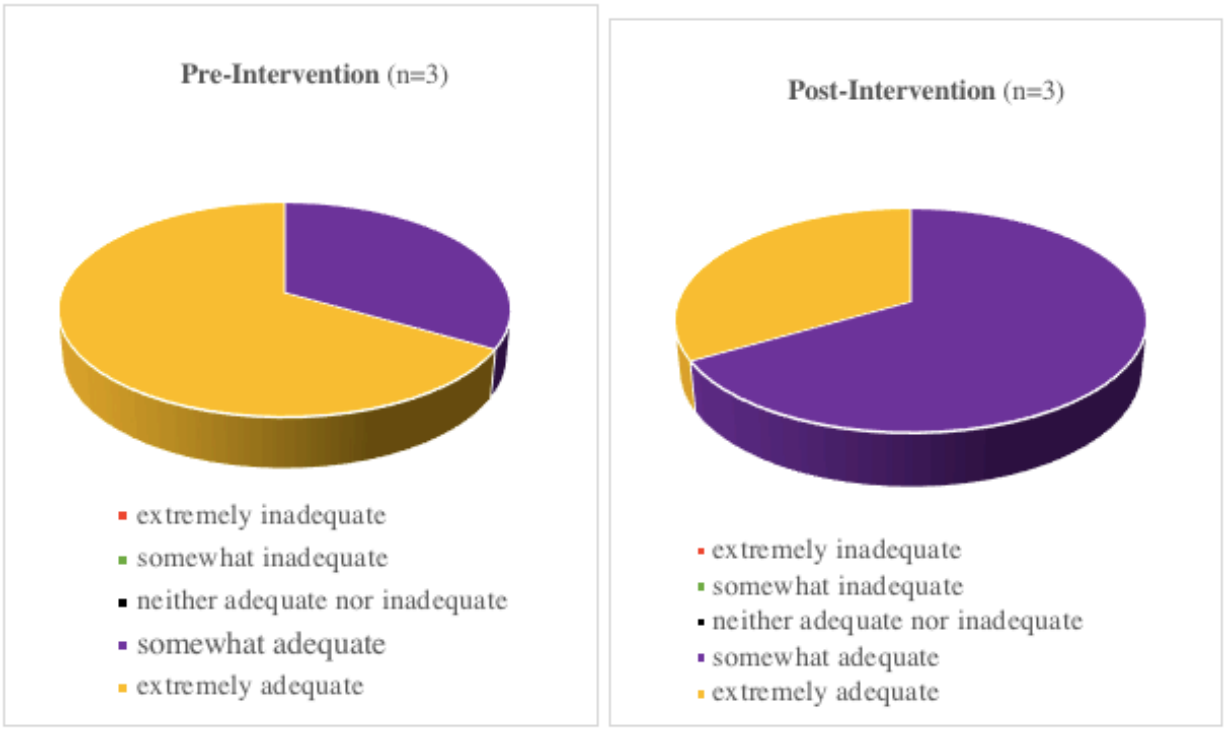


Note. N=3. The post-intervention is an estimate of the providers' future use of the manometer.

Comparison of pre- and post-intervention questionnaire responses indicated a slightly decreased perception of adequacy of objective (manometer) measurement (Figure 3). However, pre and post-intervention perceptions of adequacy of subjectively measuring ETT cuff pressures remained similar. Participants reported that they would continue to use subjective measurements some to most of the time in their future practice. Participants also reported they would choose to use the manometer between 25-75% of the time in future practice. While this is an increase in use from pre-intervention levels, it does not reflect that they plan to use the objective method (manometer) frequently.

Figure 3

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



Section V. Interpretation and Implications

Cost Benefit Analysis

This quality improvement project was focused on assessing anesthesia providers' perceptions of adequate measures of ETT cuff pressures. The purpose of effectively measuring ETT cuff pressures is to ensure to the provider that the ETT is safely secured in the airway without being over- or underinflated. Appropriately inflated ETT cuffs allow for adequate ventilation while not compromising blood flow which can lead to adverse events. Adverse events associated with inadequate ETT cuff pressures may include tracheal ischemia from overinflation, and aspiration pneumonia from underinflation.

The complication of tracheal ischemia from an overinflated ETT cuff is a costly adverse event that increases hospital length of stay and cost of care. Tracheal ischemia may lead to tracheal stenosis. In a retrospective study by Yin et al. (2018) laryngotracheal stenosis was found to have an estimated annual cost of over $4,000 due to increased lengths of hospital stay and treatments needed. Underinflation of the ETT cuff may lead to aspiration pneumonia, frequently referred to as ventilator associated pneumonia or VAP. The estimated cost of VAP can be anywhere from $10,000 to $40,000 per patient (Luckraz et al., 2017).

If an organization were to implement methods to measure effective ETT cuff pressures they would see, with relatively no cost to them, they could decrease adverse events and the economic burden associated with these events. This could potentially result in fewer ETT cuff pressure issues and patient complications, reducing health care costs and negative effects on patients. The manometers used to measure ETT cuff pressures for this quality improvement project cost approximately $40 per unit or $12 a piece when bought in bulk. These manometers are each good for 100 uses, making the cost per use to be $0.40. This price being less than a

dollar per patient suggests the economic benefit of implementing manometers use during anesthesia, potentially preventing thousands of dollars' worth of complications.

Manometers are already available at the partnering organization so acquisition is not an issue. If staff were to utilize these tools on a routine basis, the increase in number of manometers used would increase the cost of materials over time. This increased cost would, however, be offset by a reduction in costly adverse outcomes associated with over- and underinflation of ETTs.

Resource Management

Non-financial organizational resources contributing to this project included ETT manometers already in stock and easily accessible for use and a willingness of the anesthesia providers to participate in the quality improvement intervention.

Implications of Findings

The findings of this project focused on nurse anesthetist participants' perceptions of adequacy of measuring ETT cuff pressures. The term *adequacy* is important because the ETT cuff being secured at an appropriate pressure ensures the equipment is being used correctly and it is safe for the patient. Providers must deliver safe, evidence-based care to their patients which relies upon their confidence in the equipment used. Safe delivery of anesthesia coincides with the APSF's mission to improve the safety of patients during anesthesia by identifying safety improvements (APSF, 2021). This project identified that the providers surveyed felt their subjective measurement strategies were sufficient and therefore assume there is no identified need for improvement of their practice. Despite being *sufficient* at assuring ETT pressure, this may not coincide with the APSF's mission statement of providing safe and competent practice.

The model used to inform this quality improvement project was Lewin's theory of planned change. The initial phase was unfreezing, where the need was researched, identified, and found pertinent. The second phase, changes was where use of an objective measuring device was introduced. The third and final phase of the framework, not actively addressed in this project, would include moving forward with whether or not to introduce objective measurement into the organizational practice and ensuring that the practice becomes a part of the normal operations of the organization.

This project's results were on a small scale but differed from the literature findings. Findings in the literature supported the use of a manometer to improve the number of in-range ETT cuff pressures compared to the use of subjective measurement methods (Ashman, 2017; Lui, 2010; Özcan et al., 2018; Stevens, 2018). However, the participants of this study reported that the use of a manometer (objective measurement) was somewhat adequate, which is the same adequacy they reported for subjective measurement. This does not align with the findings in the literature, perhaps due to the small scale of the project. Using a larger number of a participants to implement this same quality improvement project would yield more and possibly different results. In the future, a quality improvement involving use of a manometer following initial assessment using participants preferred subjective method could influence change in practice. This would give the participants a way to compare how accurate their subjective measurements are and provide exposure to using a manometer.

Implications for Patients

Anesthesia providers' perceptions of adequate ETT cuff pressures directly impacts patient care. Patients have a right to be given the best and safest care from their anesthesia providers. This project's goal of assessing perceptions of adequate ETT cuff pressures affects

patients by encouraging the providers assess their practices to ensure they are delivering the best care to their patients. It is important for providers to feel confident in practice and also assure that their practices are adequate for delivering quality patient care. By providing quality care to their patients, they are improving patients' experiences and outcomes, which aligns with the IHI Triple Aim. The goals of the IHI Triple Aim are to improve the population health, enhance patient outcomes and experience, and reduce per capita cost of care for the benefit of the communities (Berwick et al., 2008).

Implications for Nursing Practice

The goal of this quality improvement project was to assess anesthesia providers' perceptions of perioperative usefulness of subjective assessment (tactile) and objective assessment (manometer) of occlusive volume for ETT cuffs. Assessing and analyzing current practices are vital to progressing the nursing profession. This project introduced an additional method for obtaining and assessing patient care equipment. Nursing practice should always be evolving and searching for the best way to provide quality and safe care for patients.

Impact for Healthcare System

Healthcare systems benefit from the safe and efficient practice of their practitioners. The project goal of assessing perceptions of adequate ETT cuff pressures was designed to assess the decision-making of providers. This functioned as a self-assessment for the anesthesia providers and directed them to choose a method they felt was the most adequate and safest for their patients. Having providers current in their practice and knowledgeable of a variety of techniques can help the entire healthcare system. This can help the healthcare system by ensuring members of the system are provided best practice information, and therefore confidence in caring for their patients, also facilitating prevention of adverse events.

Sustainability

Measuring ETT cuff pressures creates a sustainable practice and can be implemented in more departments throughout a healthcare organization due to its minimal cost and reliable benefit. Using a manometer to ensure adequate pressures as a standard of practice may lead to improved outcomes for patients. Increasing positive outcomes and decreasing adverse events helps support the use of objective measuring devices as a safe and sustainable option for ETT cuff pressure evaluation.

Dissemination Plan

Project findings were shared with others through a poster presentation delivered in person to a small audience as well as streamed simultaneously via Zoom . Faculty and students from the CRNA program as well as project participants were invited to attend. This project paper has also been submitted to The Scholarship, East Carolina University's online digital repository for scholarly works. Placement in The Scholarship assures materials are discoverable and available to others.

Section VI. Conclusion

Limitations

The primary limitation of this project is related to the small sample size. There were only three participants, so any data is not reflective of the anesthesia profession as a whole. As this project was performed over a time period of only two weeks, the limited amount of time to assess anesthesia providers' preferences is also a significant limitation.

Recommendations for Others

Recommendations for others interested in this project would be to include the partnering organization and participants from the beginning, in the development stages. Reluctance to participate was noted from some participants because they didn't believe the current practice was an issue. Getting interest in the participants before structuring the project could have increased enthusiastic participation. Another recommendation would be to perform this study at a larger facility with multiple CRNAs practicing in different specialties.

Recommendations for Further Study

For further study, a project that involves having participants use their preferred measurement strategy (likely subjective) followed by measurement with a manometer (objective) to assess the adequacy of their initial strategy for comparison is suggested. This could be done in a large operative setting with multiple CRNAs to yield a bigger sample size and possibly more volunteer interest.

References

Ashman, R., Appel, S., & Barba, A. (2017). Effectiveness of interventions to increase provider monitoring of ETT and laryngeal mask airway cuff pressures. *AANA Journal, 85*(2), 98-103.

Berwick D., Nolan T., & Whittington J. (2008). The Triple Aim: Care, health, and cost. *Health Affairs, 27(*3): 759-769. http://doi.org/10.1377/hlthaff.27.3.759

Institute for Healthcare Improvement. (2021). *QI essentials toolkit: PDSA worksheet*. [PDF file]. Retrieved from http://www.ihi.org/education/IHIOpenSchool/resources/Assets/PDSA_Worksheet(short).pdf

Letvin, A., Kremer, P., Silver, P., Samih, N., Reed-Watts, P., & Kollef, M. (2018). Frequent versus infrequent monitoring of ETT cuff pressures. *The Respiratory Care Journal, 63*(5), 495-501.

Lewin, K. (1997). *Resolving social conflicts and field theory in social science*. American Psychological Association. https://doi.org/10.4187/respcare.05926

Luckraz , H., Manga, N., Senanayake, E., Abdelaziz, M., Gopal, S., Charman, S., Giri, R., Oppong, R., & Andronis, L. (2017). Cost of treating ventilator-associated pneumonia post cardiac surgery in the National Health Service: Results from a propensity-matched cohort study. *Journal of Intensive Care Society, 19*(2), 94-100. https://doi.org/10.1177/17511437740804

Lui, J., Zhang, X., Gong, W., Li, S., Wang, F., Fu, S., Zhang, M., & Hang, Y. (2010). Correlations between controlled ETT cuff pressure and postoperative complications: A

multicenter study. *Anesthesia & Analgesia, 111*(5): *1133-1137*. https://doi.org/10.1213/ANE.0b013e3181f2ecc7

Melnyk, B. & Fineout-Overholt, E. (2011). *Evidence-based practice in nursing & health care: A guide to best practice* (2nd ed.). Wolters Kluwer/Lippincott Williams & Wilkins.

Office of Disease Prevention and Health Promotion. (2020). Medical product safety, Healthy People 2030. https://www.healthypeople.gov/2020/topics-objectives/topic/medical-product-safety

Özcan, C., Döğer, A., But, I., Kutlu, M., & Aksoy, S. (2018). Comparison of ETT cuff pressure values before and after training seminar. *Journal of Clinical Monitoring and Computing, 32*(3), 527-531. https://doi.org/10.1007/s10877-017-0046-7

Safdar, N., Dezfulian, C., Collard, H., & Saint, S. (2005) Clinical and economic consequences of ventilator associated pneumonia: A systematic review. *Critical Care Medicine, 33*(10), 2184-2193. https://doi.org/10.1097/01.ccm.0000181731.53912.d9

Seegobin, R. & van Hasselt, G. (1984). Endotracheal cuff pressure and tracheal mucosal blood flow: Endoscopic study of effects of four large volume cuffs. *British Medical Journal, 288*(6422), 965-968. https://doi:10.1136/bmj.288.6422.965

Stevens, G., Warfel, J., Aden, J., & Backwell, S. (2018). Intraoperative endotracheal cuff pressure study: How education and availability of manometers help guide safer pressures. *Military Medicine*, *193*(9-10), 416-419. https://doi.org/10.1093/milmed/usx127

Totonchi, Z., Jalili, F., Hashemian, S., & Jabardarjani, H. (2015). Tracheal stenosis and cuff pressure: Comparison of minimal occlusive volume and palpation techniques. *Tanaffos, 14*(4), 252–256.

Touman, A. & Stratakos, G. (2018) Long-term complications of tracheal intubation. *InTechOpen 5,* 89-112. http://dx.doi.org/10.5772/intechopen.74160

Tsaousi, G., Pourzitaki, C., Chlorou, D., Papapostolou, K., & Vasilakos, D. (2018). Benchmarking the applicability of four methods of ETT cuff inflation for optimal sealing: A randomized trial. *Journal of Perianesthesia Nursing, 33*(2), 129-137. https://doi:10.1016/j.jopan.2016.09.002

Yin, L., Padula, W., Gadkaree, S., Motz, K., Rahman, S., Predmore, Z., Gelbar, A., & Hillel, A. (2018). Health care costs and cost-effectiveness in laryngotracheal stenosis. *Sage Journal, 160*(4), 679-686. https://doi.org/10.1177/0194599818815068

Appendix A

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

	Concept	
	Operating Room	ETT cuff pressure
Keywords	Operating Room Operation Intraoperative	ETT ETT cuff measurement ETT cuff
PubMed MeSH	Operating Rooms Surgical Procedures, operative	Pressure
CINAHL Subject Headings	Operating rooms	ETTs

Note. Various combinations of the provided keywords, PubMed MeSH terms, and CINAHL subject headings were used to conduct literature searches in PubMed, CINAHL, East Carolina University Libraries OneSearch, 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
9/9/2020	PubMed	("operating rooms" OR "operating room" OR "surgery" or "surgical procedures, operative") AND ("endotracheal" AND "tube" AND "cuff" AND pressure)	10 years (2010-2020) English Full text	118	22
9/9/2020	CINAHL	((MH "ETTs") OR "ETT cuff pressures") AND ((MH "Operating Rooms") OR (MH "Anesthesia"))	15 years (2005-2020) English Full text	32	5
9/9/2020	Google Scholar	ETT cuff measurement AND surgery	2010-2020 Reviewed first 10 pages	17,000 Reviewed first 10 pages	16

Appendix C

Evidence Matrix Table

Authors	Purpose and take home message	Design/Analysis/Level of Evidence	Sample method	Comments/critique of the article/methods GAPS
Ashman, R.E., Appel, S.J., & Baraba, A.J. (2017). Effectiveness of interventions to increase provider monitoring of ETT and laryngeal *mask airway cuff pressures. AANA Journal, 85(2), 98-103.*	Providing education, reminder cards, and places to document in EHR, there was a significant improved compliance with intracuff pressure recommendations.	Quality Improvement	First phase was a baseline evaluation of the intracuff pressures of 51 ET tubes and 51 LMAs in surgical patients undergoing general anesthesia obtained as a convenience sample over a 10-day period, then education was provided to the providers. Then remeasured 51 ETT and 51 LMAs to determine a change in practice resulting in a change in correct cuff pressures.	This is a quality improvement study that will help with aligning our focus and giving ideas.
Letvin, A., Kremer, P., Silver, P., Samih, N., Reed-Watts, P., & Kollef, M. (2018). Frequent versus infrequent monitoring of ETT cuff pressures. The Respiratory Care Journal, 63(5), 495-501.	To determine if there is benefit in frequent monitoring of ETT cuff pressures against ventilator associated pneumonia (VAP) and respiratory complications from ETTs.	Level II - randomized control trial	Patients were randomly assigned into two groups, frequent measurement of cuff pressures or infrequent measurement (after intubation, and if suspected migration or air leak) of cuff pressures, then observed for complications such as VAP an VAE, aspiration events, mortality, and length of hospital stay.	The authors found no significance in frequent versus infrequent cuff pressure monitoring. *Synthesis:* Cuff pressures only being monitored after intubation, after manipulation, or when clinically indicated with a cuff leak could be set as a protocol. *Comments: no need to frequently monitor cuff pressures but monitoring them after intubation is important.*

Stevens, G., Warfel, J., Aden, J., & Backwell, S. (2018). Intraoperative endotracheal cuff pressure study: how education and availability of manometers help guide safer pressures. Military Medicine, 193(9-10) 416-419.	To determine if departmental education and easy access to a manometer would result in improvement in maintaining ETT cuff pressure within the goal range.	Level VI Descriptive Study	Measured cuff pressures pre-implementation and then again post implementation	The authors found that this study clearly demonstrated a statistically significant improvement in the proportion of in-range cuff pressures. The use of education and availability of manometers yields safer pressures for intubated patients. Synthesis: education and the use of manometers yields safer cuff pressures *Comments: this study solidified that there was a significant improvement of in range cuff pressures using a manometer, can reference this study.*
Totonchi, Z., Jalili, F., Hashemian, S. M., & Jabardarjani, H. R. (2015). Tracheal stenosis and cuff pressure: comparison of minimal occlusive volume and palpation techniques. Tanaffos, 14(4), 252–256.	To compare minimal occlusive pressure and the accuracy of palpation techniques in measuring ETT cuff pressure	Level VI - cross sectional study	At the first stage of this study, after the intubated patients were transferred from the operating room to the ICU, the nurses estimated their cuff pressure with the palpation technique taking the cuff cushion between their thumb and index fingers. They then reported whether the pressure was within the normal range or not. At the next stage, the cuff pressure was measured with a manometer. The optimal value was determined to be 20–30 cm H_2O. Then the results were compared to test the accuracy of the palpation technique.	Recommends that the best way to measure the ETT cuff pressure is to use a cuff manometer, and when there is no access to it, the minimal occlusive volume would be a better alternative compared to palpation technique, so that the cuff pressure is kept in within a proper and ideal range to avoid tracheotomy complications such as tracheal stenosis. *Comments: can help drive home the point that the best way to measure ETTCP is to use a manometer*

Tsaousi, G., Pourzitaki, C., Chlorou, D., Papapostolou, K., & Vasilakos, D. (2018). Benchmarking the applicability of four methods of ETT cuff inflation for optimal sealing: a randomized trial. Journal of Perianesthesia Nursing, 33(2), 129-137	To assess the comparable applicability of four different methods used to inflate ETT cuffs on the basis of optimal cuff pressures and presence of intubation related complications.	Level II - randomized control trial	Patients were randomly assigned into one of the four groups, pilot-balloon palpation, air return, Min-Leak, or audible leak (MinVol) groups. Then the cuff pressures were measured with a manometer and any respiratory complications were assessed.	This study used four different techniques to determine the best method to inflate ETT cuffs, which maximized the number of cuff pressures within normal range and minimized respiratory complications. *Comments: This one compared different techniques to inflate the balloon, stated that there was no best way. Has good data on the issues of over inflation and underinflation.*
Özcan, C. Döğer, A. But, I. Kutlu & ŞM. Aksoy. (2018). Comparison of ETT cuff pressure values before and after training seminar. *Journal of Clinical Monitoring and Computing, 32(3), 527-531. doi: 10.1007/s10877-017-0046-7*	See if ETT cuff pressures improved with educational seminar on manometers.	Level VI - prospective observational	Included in the study 200 patients aged between 18 and 60 years with ASA physical status classification I–II that were planned for elective surgery in supine position. Excluded patients scheduled for head-neck surgery. In addition to urgent or difficult intubation, with endotracheal tube with an inner diameter less than 7 mm or more than 8.5 mm, patients having Mallampati score of III–IV, with high aspiration risk (full stomach, pregnancy), diabetes mellitus, congenital, laryngotracheal and rheumatic diseases were excluded in the study	This study is good to highlight the influence that education can have on the outcomes. This study focuses only on the training and use of a manometer and shows how just training can get cuff pressures within the normal range.

Appendix D

Project Approval Forms

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 V[redacted] 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 UMCIRB office.

Please contact the [redacted]

For more guidance about whether the activity meets the definition of Human Subjects Research see https://rede.ecu.edu/umcirb/irb-faqs/definitions/ 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 asssessment techniques.		
Funding Source: None		
Project Leader Name: Jordan Jackson/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@ecu.edu
	Primary Contact (if different from Project Leader): Jordan Jackson	
	Phone: [redacted]	**Email:** jacksonjo12@students.ecu.edu

Key Personnel/ Project Team members:

Name and Degree:	Department: (Affiliation if other than Vidant)	Email:
Jordan Jackson, SRNA	ECU Nurse Anesthesia Program	jacksonjo12@students.ecu.edu
Travis Chabo, PhD, CRNA	ECU Nurse Anesthesia Program	chabot14@ecu.edu
Dr. McAuliffe, PhD, CRNA	ECU Nurse Anesthesia Program	mcauliffem@ecu.edu

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]
- 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] termines the activity is <u>not</u> human subject research, then any presentation, publication, etc. should <u>not</u> refer to the activity as "human subject research," "exempt research," or "expedited research."
- If you would like the [redacted] 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] and the following will be completed and returned to you for your records.

NHSR vs. HSR Determination:

☒ **Not Human Subject Research:** The [redacted] has determined that based on the description of the project/study, approval by the IRB is not necessary. Any changes or modifications to this project may be discussed with the [redacted] at that time to ensure those changes do not elevate the project to human research that would need IRB approval.

☐ **Human Subject Research:** This project/study requires review by the IRB prior to initiation. An application in the electronic IRB submission system should be submitted.

Approval Signatures:

Department (Site) Manager: [redacted] **Date:** 3/1/2021

[redacted] **Reviewer:** [redacted] **Date:** _____

UMCIRB Office Staff Reviewer: [redacted] **Date:** 3-10-21

Appendix E

Pre-Intervention Questionnaire

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

   Minimal occlusive volume
   Pilot balloon palpation
   Manometer
   Audible air leak
   Set volume
   Other: (text box)

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

   Extremely inadequate / somewhat inadequate / neither adequate nor inadequate / somewhat adequate / extremely adequate

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

   Never / sometimes / about half the time / most of the time / always

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

   Extremely inadequate / somewhat inadequate / neither adequate nor inadequate / somewhat adequate / extremely adequate

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

   0% of the time / <25% of the time / 25-50% of the time / 50-75% of the time / >75% of the time

Post-Intervention Questionnaire

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

   (text box)

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

   Extremely inadequate / somewhat inadequate / neither adequate nor inadequate / somewhat adequate / extremely adequate

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

   Never / sometimes / about half the time / most of the time / always

4. **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 / sometimes / about half the time / most of the time / always

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

   Extremely inadequate / somewhat inadequate / neither adequate nor inadequate / somewhat adequate / extremely adequate

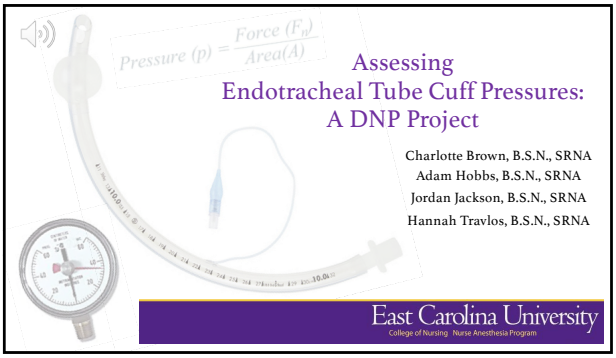
6. **In your future practice, how often do you think you will utilize an objective measurement (manometer) for obtaining appropriate ETT cuff pressure?**

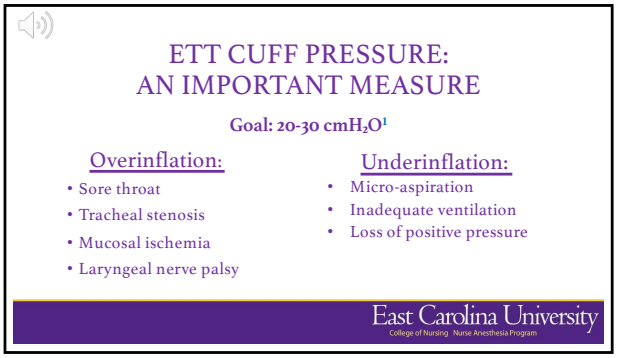
   0% of the time / <25% of the time / 25-50% of the time / 50-75% of the time / >75% of the time

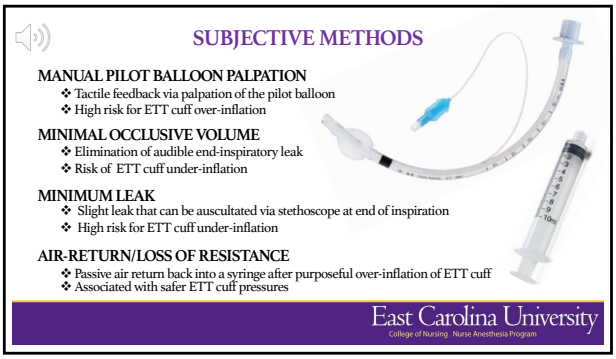
7. **Are there certain types of cases in which you think utilization of an objective manometer would be beneficial?**

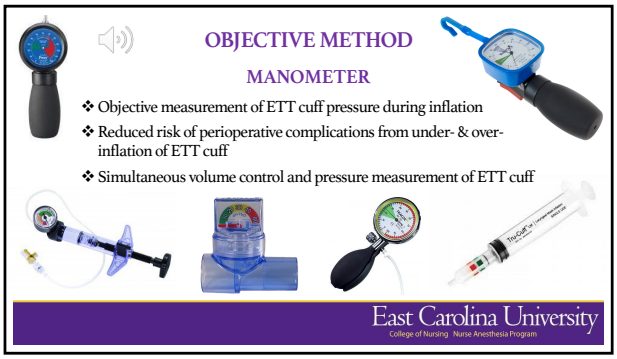
   Yes / No
   If yes, which types of cases? (text box)

Appendix F

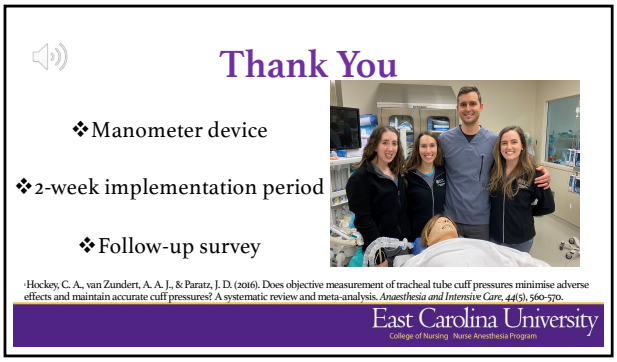

Pressure (p) = Force (F_n) / Area(A)
Assessing
Endotracheal Tube Cuff Pressures:
A DNP Project
Charlotte Brown, B.S.N., SRNA
Adam Hobbs, B.S.N., SRNA
Jordan Jackson, B.S.N., SRNA
Hannah Travlos, B.S.N., SRNA
East Carolina University
College of Nursing Nurse Anesthesia Program


ETT CUFF PRESSURE:
AN IMPORTANT MEASURE
Goal: 20-30 cmH_2O[1]
Overinflation:
• Sore throat
• Tracheal stenosis
• Mucosal ischemia
• Laryngeal nerve palsy
Underinflation:
• Micro-aspiration
• Inadequate ventilation
• Loss of positive pressure
East Carolina University
College of Nursing Nurse Anesthesia Program


SUBJECTIVE METHODS
MANUAL PILOT BALLOON PALPATION
❖ Tactile feedback via palpation of the pilot balloon
❖ High risk for ETT cuff over-inflation
MINIMAL OCCLUSIVE VOLUME
❖ Elimination of audible end-inspiratory leak
❖ Risk of ETT cuff under-inflation
MINIMUM LEAK
❖ Slight leak that can be auscultated via stethoscope at end of inspiration
❖ High risk for ETT cuff under-inflation
AIR-RETURN/LOSS OF RESISTANCE
❖ Passive air return back into a syringe after purposeful over-inflation of ETT cuff
❖ Associated with safer ETT cuff pressures
East Carolina University
College of Nursing Nurse Anesthesia Program


OBJECTIVE METHOD
MANOMETER
❖ Objective measurement of ETT cuff pressure during inflation
❖ Reduced risk of perioperative complications from under- & over-inflation of ETT cuff
❖ Simultaneous volume control and pressure measurement of ETT cuff
East Carolina University
College of Nursing Nurse Anesthesia Program


Manometer: How to Use
East Carolina University
College of Nursing Nurse Anesthesia Program


Thank You
❖Manometer device
❖2-week implementation period
❖Follow-up survey
[1]Hockey, C. A., van Zundert, A. A. J., & Paratz, J. D. (2016). Does objective measurement of tracheal tube cuff pressures minimise adverse effects and maintain accurate cuff pressures? A systematic review and meta-analysis. Anaesthesia and Intensive Care, 44(5), 560-570.
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College of Nursing Nurse Anesthesia Program

Appendix G

DNP Project Timeline

Date	Task
August 2020	Research into project background and goal of project and trajectory of project.
November 2020	Literature Review
January 2021	Initial Draft of the pre and post-intervention questionnaire s as well as drafting of educational video
February 2021	Finalization of educational video and pre and post intervention from clinical experts and project chairs.
	Application of project approval for partnering organization
	Draft email script
March 2021	Finalization and completion of email script
	Project approval granted from site manager of partnering organization
	Testing of Qualtrics pre and post intervention questionnaire s
April 2021	Recruitment of CRNA participants by project chair
May 2021	Implementation of project at partnering organization and assistance on site.
	Data collection via Qualtrics
July 2021	Data Analysis
September 2021	Project creation and finalization
November 2021	Project Presentation