

An Education Module for the Use of a 5cc Syringe for the Inflation of Endotracheal Tube

Cuffs: A Quality Improvement Project

A DNP Project Presented to the Faculty of the
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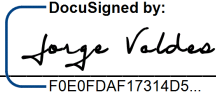
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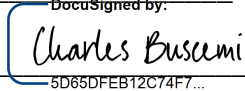
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Abstract:

This quality improvement project aimed to assess anesthesia providers' knowledge of proper endotracheal tube (ETT) cuff inflation and the consequences of inappropriate cuff pressures. Additionally, it aims to educate providers on the benefits of using a 5cc syringe to inflate ETT cuffs. Anesthesia providers receiving this education module will be solely Certified Registered Nurse Anesthetists (CRNAs). The project will involve three parts: a pre-test survey, an educational PowerPoint presentation, and a post-test survey. Pre and post-test surveys will be used to measure the outcomes of the educational intervention. Anesthesia provider education on using a 5cc syringe instead of other modalities is expected to lead to ETT cuff pressures within acceptable ranges. As a result, fewer adverse effects due to cuff overinflation are expected to follow.

Keywords: Endotracheal Tube, Cuff Pressure, Inflation, Methods, Comparison

Introduction

Problem Identification

It is estimated that over twenty million endotracheal tubes (ETTs) are used annually in the United States.¹ Many of those tubes are used for surgeries requiring general anesthesia. Research shows that in many instances, the cuff of the ETT is overinflated.² Overinflation increases cuff pressures beyond the recommended range, leading to tissue ischemia and multiple complications.^{3,4}

Background

An ETT has a cuff for two main reasons. The first is to create a seal in the trachea so that positive pressure ventilation can occur and the desired tidal volumes can be achieved.⁵ The second feature of the cuff is to prevent contents of the stomach from entering the lungs.⁶ To do these two things, the cuff must be inflated enough to create an appropriate seal. However, while doing so, many practitioners overinflate the cuff.

Different researchers have postulated the correct cuff pressures to occlude the trachea while preventing tissue ischemia. Commonly accepted pressures range from approximately 19 to 40 cmH₂O.^{5,6} To reach the desired pressure, there are three main techniques used. The gold standard is to use a manometer, as this device will give the most accurate reading of the pressure inside the cuff. The second is to perform a minimally occlusive leak test. This is done by ventilating the patient while at the same time inflating the ETT until there is no longer an audible air leak. The third method is to manually palpate the pilot balloon, which is linked to the ETT cuff. If the practitioner feels that the pilot balloon is firm enough, they can be confident that the cuff pressure is high enough to seal the trachea.

Scope of the Problem

In the operating room setting, the palpation method is most commonly used due to its relative ease and speed of use. However, even though this method is efficient, the pressures it produces are unreliable and can lead to overinflation.³ Additionally, a common practice is to use a 10cc syringe to inflate the ETT cuff. Studies have shown that when a 10cc syringe is used, ETT cuffs are grossly overinflated.^{3,4}

Consequences of the Problem

Research shows that blood supply around the trachea is completely occluded at 50cmH₂O.⁵ When that blood supply is cut off, the tissue around the cuff becomes ischemic, which leads to cell death. The consequences of overinflation include recurrent laryngeal nerve injuries, ulcerations, tracheal ruptures, and fistulas.² These adverse events lead to hospital admissions, increased hospital stays, an increase in hospital costs, and even death in some instances.¹ Additionally, research has shown a link between higher cuff pressures and complaints of sore throats post-extubation.³

Knowledge Gaps

Studies have been done to look at the link between the method used to inflate ETT cuffs and the resulting cuff pressures. Results show that practitioners cannot correctly estimate cuff pressures using the palpation method.^{3,4} Practitioner experience was considered, and even experienced providers were shown to incorrectly estimate adequate pressures. This clearly demonstrates a knowledge gap.³

Proposal Solution

Multiple sources believe that a cuff pressure of 25cmH20 is adequate for maintaining an appropriate seal while at the same time preventing tissue ischemia.^{5,6} Studies have shown that using a 5cc syringe is adequate in achieving 25cmH20 while avoiding the possibility of overinflation.³ A proposed solution and teaching opportunity would be to advocate using a 5cc syringe instead of a 10cc syringe commonly used in practice. Using a 5cc syringe instead of a 10cc syringe would create an adequate seal without going above recommended pressures. One study testing this change showed a dramatic decrease in cuff pressures, leading to a decreased report of post-operative sore throats.³

Summary of the Literature

The review of the literature reveals a strong link between higher cuff inflation pressures and laryngotracheal complaints, mainly sore throat. Of all the methods studied, the palpation method consistently resulted in overinflation of the ETT cuff. Other methods, such as using a fixed volume or using a 10cc syringe, also showed inconsistent inflation pressures and pressures above recommended values. Looking at the evidence, the two methods that were revealed consistently to keep pressures within acceptable ranges were the minimal occlusive leak test and the use of a 5cc syringe.

Methods: In-depth searches were done using CINAHL and PubMed to find articles that revealed the best practice regarding ETT cuff inflation. Only articles within the past ten years were included in this comparison.

Results: After an extensive search, seven studies were chosen for review. These studies reveal a link between inflation methods and cuff pressures.

Keywords: Endotracheal Tube, Cuff Pressure, Inflation, Methods, Comparison

Eligibility Criteria

The studies included in this literature review were based on inclusion criteria that best met the objective of understanding best practices regarding ETT cuff inflation. Only studies in English with and published within the past ten years were chosen. Out of the seven articles chosen, six of them were published within the past four years. Only adult populations were considered, and no pediatric populations were included. The studies focused on surgical patients, but there was an inclusion of a study conducted on an emergency room population. All the articles found were accessed using the Florida International University database system.

With the clinical question, keywords used to find relevant articles included: Endotracheal Tube, Cuff Pressure, Inflation, Methods, and Comparison. Similar article links on individual article pages were used to find articles with similar themes.

Information Sources

The databases used for the search included The Cumulative Index to Nursing and Allied Health Literature (CINAHL) and PubMed.

Search Strategy

Multiple variations of keywords were used to find relevant articles. An initial search for articles using the terms "endotracheal tube" and "cuff inflation" yielded 377 results on PubMed. Only articles within the past ten years with full-text access were selected, which narrowed the

results to 93 articles. The abstracts of these 93 articles were read to see if they aligned with the objectives of this literature review. Only articles that directly compared the different methods of ETT cuff inflation were considered. After comparing search results with CINAHL, 12 articles were chosen for a complete literature review. After these 12 articles were reviewed, seven were chosen to be included in this literature review.

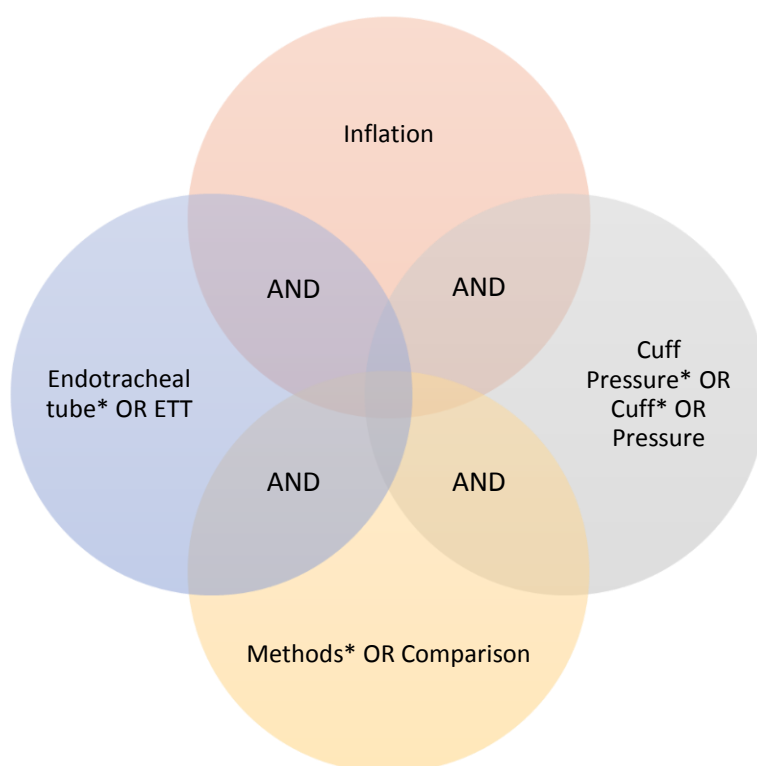


Diagram 1. Search Keywords

Study Characteristics

These studies aimed to compare different approaches to cuff inflation in their ability to achieve inflation pressures within acceptable ranges. While they all compared different approaches to cuff inflation, only some compared inflation pressure to the incidence of post-operative complaints. Of all of the studies reviewed, only adult populations were included, with a mixture of male and female patients. Six of the seven studies reviewed the cuff pressures of patients under general anesthesia, while one reviewed the cuff pressures of patients in an emergency room setting. The methods of cuff inflation studied included finger palpation, the minimal occlusive leak test, and predetermined volume.

Results

Article I

One study aimed to see how to prevent endotracheal tube cuff overinflation. The authors determined to study if education on using a 5cc syringe instead of a 10cc syringe for cuff inflation would result in fewer instances of overinflation.³ A total of 110 anesthesia providers, including anesthesiologists, CRNAs, SRNAs, and anesthesia residents were a part of this study. Thirty cuff pressures were measured on a day without any warning to any provider at a local hospital. The average cuff pressure of those 30 samples was 46.8cm H₂O. Every cuff inflated in this sample was inflated with a 10cc syringe. Inflation pressures were measured with a digital manometer. After these results, the study team educated the anesthesia staff on how using a 5cc syringe could create adequate cuff pressure while preventing overinflation. After education was given, the team returned on a random day and calculated 26 cuff pressures. The average pressure post-education was 27.1 cm H₂O, a 42% reduction in average ET tube cuff pressure.

What should be noted is that while only 10cc syringes were used in the pre-education phase, a mixture of syringe sizes was used post-education. After education, 16 cuffs were inflated with a 5cc syringe, and ten cuffs were inflated with a 10cc syringe. Some practitioners admitted that even though they used a 10cc syringe, they did not inflate the cuff with all 10ccs of volume.

Despite these variables, the average cuff pressure when the provider used a 10cc syringe was 36.8 cm H₂O, and the average cuff pressure using a 5cc syringe was 21.1 cm H₂O. Using a 5cc syringe resulted in a 55% reduction in ET tube cuff pressures from baseline, and the project demonstrated that education reduced overall ET tube cuff pressures by 42%. The most significant factor in maintaining cuff pressures within the goal range was using a 5cc syringe. Of importance to note is that no critically high ET tube cuff pressures were measured when a 5cc syringe was used.

Article II

Another study's aim was to discover the optimal syringe size for recommended endotracheal cuff pressure inflation.⁷ The authors noted that standard practice was using a 10cc syringe and wondered if using a different size would reduce the incidence of overinflation. Two hundred patients were randomized to use either a 10cc syringe (standard syringe) or a 5cc syringe (study group) for endotracheal cuff inflation. After intubation and inflation of the cuff by an anesthesiologist, the cuff pressure was measured using a manometer within ten minutes of intubation. The authors defined acceptable in-range pressures from 22- 32 cm H₂O.

The study's results showed that in-range pressures for the control group (10cc syringe) were 6.78%, and the percentage of in-range pressures for the 5cc group was 10.53%. While this is not a significant difference, 84.21% (n = 64) of the study group and 91.53% (n = 54) of the

control group had cuff pressures exceeding 30 cmH₂O. When averaged, the 5- mL group cuff pressure was 55.8 cm H₂O versus 68.8 cm H₂O in the 10- mL group. Analyzing these results, the authors concluded that even though using a 5cc syringe may not create an ideal cuff pressure compared to a 10cc syringe, it can significantly reduce the chances of overinflation. As noted earlier, any reduction in overinflation will reduce the incidence of tissue ischemia and adverse events.

Article III

While those two studies focused on syringe size, another study aimed to compare three standard methods of endotracheal tube cuff inflation (sealing pressure, precise standard pressure, and finger estimation) in regard to effective tracheal seals and the incidence of post-intubation airway complications.⁴ Seventy-five patients with an ASA physical status I or II undergoing N₂O-free general anesthesia with an expected 90 min or more duration were the population for this study.

The seventy-five patients were divided equally into the three different methods of cuff inflation (n=25). The control group (precise standard pressure) had their cuff inflated to a pressure of 25 cm H₂O and measured using a manometer. Sealing pressure, also known as a minimal occlusive leak test, was measured while applying 20 cm H₂O of positive pressure. Anesthesiologists blind to the study were used for finger estimations.

The pressures from the sealing group averaged lower than the control group. The finger palpation group, however, averaged pressures significantly higher than the control group. Analysis was done to compare laryngotracheal complaints in the Post Anesthesia Care Unit (PACU) and 24 hours after surgery with the different methods studied. The results showed an increased report of sore throats in the PACU and 24 hours later with the finger estimation group.

Grouping this information, the researchers found a strong link between higher pressures from finger estimation and the occurrence of laryngotracheal complaints. The authors concluded that finger palpation is an unreliable method of cuff inflation and that it can potentially lead to adverse outcomes.

Article IV

Similarly, a study compared endotracheal cuff pressures with different estimation techniques.⁸ Forty anesthesia providers were assessed in this study. Anesthesia providers were given the choice of their preferred mode of inflation, which included palpation (n=35), minimal leak (n=4), and predetermined volume (n=1). The population of patients tested varied from ages 18 to 65, with an ASA level of I-III. The type of providers varied, including anesthesiologists, CRNAs, and SRNAs. However, there was no statistical difference between cuff pressures and experience level or title.

The authors of this study defined an ideal cuff pressure from a range of 25-40cm H₂O. All pressures were recorded using a digital manometer, and the anesthesia provider was allowed to make any final adjustments before measurements were taken. Results from estimations revealed that 26 pressures (65%) were above 40cm H₂O, and that two pressures recorded (5%) were below 25cm H₂O. Only 12 pressures (30%) fell within the acceptable range of 25-40cm H₂O. The authors concluded that estimation techniques are inadequate and inaccurate in determining ETT cuff pressures. The authors also speculated that this trend is cyclical, as experienced providers are the ones that train newer providers, which will one day teach current standards to the next generation of providers. It was suggested that direct measurement should be used to achieve ideal pressures.

Article V

The goal of this study was to compare the pressures of two different cuff pressure techniques, fixed volume and the minimal leak test (MLT).⁹ Acceptable cuff pressures for this study were defined as 20-30 cmH₂O. For the fixed volume, 10ccs was used. One hundred ten patients in an emergency room were used for this study, all 18 years or older. A single provider administered either the fixed volume of 10ccs or used the MLT through a randomized process.

The results showed that the mean cuff pressure was 46.07cm H₂O in the fixed volume group and 33.72cm H₂O in the MLT group. Additionally, of the fixed volume group, 56.4% had normal cuff pressures, while the MLT group had 78.2% of their pressures within the normal range. These results revealed that using a fixed volume of 10ccs not only created a mean higher pressure, but a greater occurrence of pressures over the acceptable normal range. A conclusion made was that a fixed volume of 10ccs should be avoided. However, the authors speculated that using a fixed volume of 6-7ccs could be a plausible alternative.

Article VI

This study aimed to compare two different endotracheal tube cuff inflation methods and analyze the occurrence of post-operative sore throats in both groups.¹⁰ The inflation methods were defined as the Just-Seal (JS) and Stethoscope-Guided (SG) methods. The JS involved a combination of the MLT approach and palpation of the pilot balloon. The SG method used the bell attachment of a stethoscope to auscultate for the presence of any leak around the tube.

The population tested were one hundred patients with an ASA classification of 1 or 2, all undergoing elective surgeries under general anesthesia. The ages ranged from 18 to 60, both male and female. Fifty patients were put into each group. Results revealed that the mean volume injected in the JS method was 6.79mls and 4.95mls with the SG method. Corresponding

mean cuff pressures were 38.80cm H₂O in the JS group and 29.64cm H₂O in the SG group. Post extubation, the incidence of sore throat was 54% in the JS group and only 12% in the SG group. These numbers show a strong correlation between increased cuff pressures and volumes to incidences of post-operative sore throats. The authors concluded that the JS method was inadequate to obtain pressures within acceptable ranges.

Article VII

The authors of this study conducted a randomized trial to assess four different methods of ETT cuff inflation to find out which method created optimal sealing conditions, then compared those methods to post-operative complications.¹¹ The four methods studied included the palpation method, the air return method, the MinVol method, and the MLT. The air return method involved overinflating the ETT cuff, then checking for air return back into the syringe. The MinVol method involved the ETT cuff being inflated until no audible leak was detected by direct auscultation over the trachea during a prolonged inspiration at a peak airway pressure of 25 cm H₂O.

The population studied involved 139 adult surgical patients that underwent nitrous oxide-free general anesthesia. The highest ETT cuff pressures and air volume values were recorded in the palpation group, while the lowest pressures and volumes were recorded in the MLT group. Laryngotracheal complaints such as sore throat, hoarseness, and dysphagia were highest in the palpation group and lowest in the minimal occlusive volume/minimum leak group. The air return method, while not reviewed in any other study in this literature review, resulted in consistent cuff pressures. The authors concluded that the palpation method should be avoided due to its link to laryngotracheal complaints.

Author(s)	Purpose	Methodology/ Research Design	Intervention(s)/ Measures	Sampling/Setting	Primary Results	Relevant Conclusions
Holyszko (2021)	To evaluate the incidence of ET tube cuff overinflation at two hospitals' ORs and to determine whether an educational intervention advocating the use of a 5-mL syringe in place of a 10-mL syringe would reduce the incidence of cuff overinflation.	Quantitative, Quasi-Experimental Project Level II	Cuff pressures were measured on 30 patients before any education was given. After education on using a 5cc syringe instead of a 10cc syringe was given, 26 cuff pressures were measured.	56 cuff pressures were measured, 30 pre-education (Phase 1)/ 26 post-education (Phase 2). One hundred ten anesthesia providers, including anesthesiologists, CRNAs, SRNAs, and anesthesia residents were educated between measurements (Phase 2).	The mean ET tube cuff pressure decreased from 46.8cm H ₂ O in phase 1 to 27.1 cm H ₂ O in phase 3. This represents a significant 42% reduction in the average ET tube cuff pressure. The average cuff pressure, when the provider used a 10-mL syringe, was 36.8 cm H ₂ O, and the average cuff pressure with a 5-mL syringe was 21.1 cm H ₂ O. The use of a 5-mL syringe resulted in a 55% reduction in ET tube cuff pressures from baseline (phase 1).	The project demonstrated that an educational flyer reduced overall ET tube cuff pressures by 42%. The most significant factor in maintaining cuff pressures within the goal range was using a 5-mL syringe, which resulted in a 55% reduction in cuff pressures. No critically high ET tube cuff pressures were measured when a 5-mL syringe was used.
Al-Metwalli (2011)	To compare the three common methods of endotracheal tube cuff inflation	Prospective, Controlled, Randomized, Blinded Study Level I	There was a control group (n=25), where the cuff was inflated to a pressure of 25 cm H ₂ O. There was a sealing group (n=25), where the cuff	Seventy-five adult patients were scheduled for N ₂ O-free general anesthesia with an expected duration	The cuff pressure was significantly low in the sealing group compared to the control group, which was	Estimation of the cuff pressure by finger palpation is an unreliable technique, which could result in a high incidence of laryngotracheal

	(sealing pressure, precise standard pressure, or finger estimation) regarding the effective tracheal seal and the incidence of post-intubation airway complications.		was inflated to prevent air leaks at an airway pressure of 20 cm H ₂ O, and a finger group (n=25), the cuff was inflated using finger estimation.	of 90 min or more were studied.	significantly high in the finger group compared to both the control and the sealing group The incidence of sore throat was similar for the control and sealing groups in the PACU and at 24 hours, whereas for the finger group, the incidence of sore throat was significantly higher than the other two groups in the PACU and at 24hrs.	complaints. There was a link between higher cuff pressures using the finger palpation technique and the incidence of sore throat.
Williams (2019)	To determine optimal syringe size for recommended endotracheal cuff pressure.	RCT Level 1	Following the insertion of the endotracheal tube, the ETTC was inflated per the attending anesthesiologist. Within 10 minutes of intubation, ETCP was measured with a hospital-provided manometer.	Two hundred patients were randomized using either a 10- mL syringe (standard syringe) or a 5- mL syringe (study group) for endotracheal cuff inflation	The percentage of in-range cuff pressures for the 5- mL group was 10.53% and 6.78% for the 10- mL group. 84.21% (n = 64) of the study group and 91.53% (n = 54) of the control group had cuff pressures exceeding 30 cmH ₂ O. Although the study did not demonstrate that syringe size was predictive of ideal cuff pressure ranges, the average cuff pressure for	The study did not show that syringe size was predictive of ideal cuff ranges, the data did demonstrate that using a 5- mL syringe resulted in a lower degree of elevated pressure as compared to a 10- mL syringe. Use of a 5- mL syringe should be considered when inflating the endotracheal cuff to possibly

					the 5- mL group was 55.8 cm H ₂ O versus 68.8 cm H ₂ O in the 10- mL group.	reduce patient harm secondary to elevated cuff pressures.
Stewart (2021)	To compare endotracheal cuff pressures with different estimation techniques.	Quasi-Experimental Level II	40 different anesthesia providers inflated their ETT cuffs to their desired level using different estimation techniques before data was collected using a manometer	40 patients aged 18 to 65 years of age with an ASA level of I-III	Pressure > 40cm H ₂ O: 26 (65%) Pressure 25-40cm H ₂ O: 12 (30%) Pressure < 25cm H ₂ O: 2 (5%)	Estimation techniques resulted in 28 pressures (70%) being too high or too low, and only 12 (30%) were within an ideal range. Estimation techniques used by anesthesia providers are inaccurate and, therefore, inadequate.
Sanaie (2019)	To compare the tracheal cuff pressure measurement by two methods: fixed volume and minimal leak test	Descriptive, Randomized Level II	ETT cuff was filled with 10cc of air in the fixed volume technique, and in the MLT technique, after intubation, patients were positioned supine on a 30° inclined bed.	One hundred ten patients in the emergency room at least 18 years of age.	Mean cuff pressure was 46.07 cmH ₂ O in the fixed volume group and 33.72 cmH ₂ O in the MLT group Fixed volume group: 56.4% had normal cuff pressures, MLT: 78.2% had normal cuff pressures	Both techniques cause above-normal intracuff pressure; however, MLT produces more acceptable pressure than fixed volume. The volume of 10cc produces high pressures; therefore, fixed values may yield more appropriate results in lower volumes.

Borhazowal (2017)	<p>To compare the Just-Seal (JS) and Stethoscope-Guided (SG) method of ETT cuff inflation.</p> <p>To assess the occurrence of post-operative sore throat after extubation in both groups.</p>	<p>Prospective observational study</p> <p>Level II</p>	<p>100 ETT cuffs were inflated by one of two methods: the JS or the SG method. Volumes, pressures, and incidence of post-operative sore throat were compared.</p>	<p>One hundred patients with ASA physical status 1 and 2 of both gender and aged between 18 – 60 years posted for elective surgeries under general anesthesia, with 50 each in both groups</p>	<p>The mean volume injected in JS was 6.79 ml, and the SG was 4.95 ml.</p> <p>Mean cuff pressure achieved was 38.80 cm H₂O in the JS and 29.64 cm H₂O in SG</p> <p>The incidence of post-extubation sore throat was 54% (27 in 50) in the JS group and only 12% (6 in 50) in the SG.</p>	<p>The SG method of ETT cuff inflation is found to be superior to the JS in terms of achieving cuff pressures within the recommended range and the consequent lesser occurrence of complications</p>
Tsaousi (2018)	<p>To assess four methods of endotracheal tube cuff inflation based on the optimal level of intracuff pressure and the presence of intubation-related complications.</p>	<p>RCT</p> <p>Level 1</p>	<p>Patients were assigned to one of four groups according to the method used for ETT cuff inflation. The cuff pressure and air volume applied in each method, and laryngotracheal complications were recorded.</p>	<p>A total of 139 adult surgical patients scheduled to undergo nitrous oxide-free general anesthesia</p>	<p>The highest and lowest ETT cuff pressure and air volume values were recorded in the palpation and minimum leak technique group, respectively.</p> <p>Laryngotracheal complaints were highest in palpation and lowest in minimal occlusive volume/minimum leak techniques.</p>	<p>The findings of this study indicate that palpation estimation performs rather poorly regarding optimal ETT cuff pressure inflation, entailing an advanced risk of cuff overinflation.</p>

Discussion

The review of the literature reveals a strong link between higher cuff inflation pressures and laryngotracheal complaints, mainly sore throat. Of all the methods studied, the palpation method consistently resulted in overinflation of the ETT cuff. Other methods, such as using a fixed volume or using a 10cc syringe, also showed inconsistent inflation pressures and pressures above recommended values. Looking at the evidence, the two methods that were revealed to keep pressures within acceptable ranges consistently were the minimal occlusive leak test and the use of a 5cc syringe.

Conclusion

There are many techniques available regarding endotracheal tube cuff inflation. The gold standard is with the use of a manometer, which can precisely measure the amount of pressure applied to the trachea. However, in the operating room setting, manometers are not often used. This could be due to the cost of device use or an accepted thought process that estimated pressures are suitable for inflation. Unfortunately, the literature reveals that a narrow pressure range is needed to both occlude the trachea and prevent ischemia and morbidity.

It is common practice for anesthesia providers to attach a 10cc syringe to an ETT cuff for inflation. The amount of air injected is either by a predetermined amount or by palpation of the pilot balloon. The problem is that even though palpation of the pilot balloon is the most simplistic and rapid technique, it frequently creates gross overinflation of ETT cuffs. Similarly, when a 10cc syringe is attached to a cuff, it is often that all 10ccs are injected.

A shift to using a 5cc syringe when inflating ETT cuffs could drastically change the number of post-operative complications due to cuff overinflation. The 5cc syringe would do two things. First, it would prevent overinflation from the anesthesia provider, who is accustomed to

inflating the cuff with all available air from a 10cc syringe. Likewise, it would prevent those that use the palpation method from incorrectly overestimating necessary volumes.

After a review of the literature, it has been deemed that while not the gold standard, a shift to using a 5cc syringe could readily be accepted by anesthesia providers and thus create safer and more optimal care.

PICO Question Purpose

Population (P): Patients receiving general anesthesia with an endotracheal tube

Intervention (I): Using a 5cc syringe for endotracheal cuff inflation

Comparison (C): Use of a 10cc syringe for endotracheal cuff inflation

Outcomes (O): Decreased incidence of adverse effects due to endotracheal tube overinflation

Primary DNP Project Goal

The goal of this project is to educate anesthesia practitioners about their cuff inflation practices and the potential risks associated with those practices. Once a baseline level of knowledge has been established, there would be education on the latest evidenced-based guidelines for cuff inflation when a manometer is not available. Multiple sources believe that a cuff pressure of 25cmH₂O is adequate for maintaining an appropriate seal while at the same time preventing tissue ischemia.^{5,6} Studies have shown that using a 5cc syringe is adequate in achieving 25cmH₂O while avoiding the possibility of overinflation.⁴ The specific project goal would be focused on the education of using a 5cc syringe instead of a 10cc syringe. Using a 5cc syringe instead of a 10cc syringe would create an adequate seal without going above

recommended pressures. Doing so would decrease instances of overinflation, as well as decrease instances of post-operative sore throat and other adverse events.⁴

Goals and Outcomes

Goal objectives move a project towards an end goal. They must be specific, measurable, achievable, realistic, and timely (SMART). The SMART acronym was used to organize goal objectives.

Specific

Anesthesia providers will have an evidence-based guideline for inflating adult endotracheal tubes. This guideline will use a 5cc syringe when inflating the cuff rather than a 10cc syringe.

Measurable

A gained understanding of the evidence-based guideline will be measured by giving anesthesia providers a questionnaire before and after an education session. Topics of the education session include acceptable cuff inflation pressures, possible techniques, consequences of inadequate pressures, and evidence-based techniques. Results of the questionnaires before and after the education will then be compared to confirm that proper education has taken place.

Achievable

The switch from using a 5cc syringe instead of a 10cc syringe would be simple and achievable. No new supplies would have to be ordered.

Realistic

The change in syringe size would not hinder current practice or require additional implementation time. It would be an easy change that any anesthesia provider could implement.

Timely

The time for the objective to be met would only be the time it would take to educate the entire anesthesia team. In a six-month time frame, the entire anesthesia staff could go through the education with its pre and post-education questionnaire and implement evidence-based guidelines into practice.

Definition of Terms**Endotracheal Tube**

A standard definition of an endotracheal tube is a flexible plastic tube that is inserted through the mouth into the trachea. Once accomplished, it is commonly connected to a ventilator, which delivers oxygen and anesthesia gases to the lungs. The process of inserting the tube is called endotracheal intubation.

Endotracheal Tube Cuff

The cuff to an endotracheal tube is a balloon that sits close to the tip of the tube. Once the endotracheal tube is inserted into a patient's trachea past the glottic opening, the balloon is inflated.

Methodology**Setting and Participants**

The goals of this project will be directed toward the anesthesia staff at Memorial Regional Hospital. Currently, the staff at Memorial Regional Hospital includes a balance of anesthesiologists, Certified Registered Nurse Anesthetists (CRNAs), and Anesthesiology Assistants (AAs). The hospital is a level 1 trauma center that contains twenty operating rooms. Additionally, the hospital contains multiple gastrointestinal suites, interventional radiology

rooms, and electrophysiology rooms. On a given day, approximately thirty-five anesthesia providers could be on duty at a given time, not including obstetrical anesthesia staff.

Description of Approach and Project Procedures

This DNP project will start by emailing the anesthesia staff at Memorial Regional Hospital. The email will ask the staff to engage in a study. The study will begin by asking the anesthesia provider background demographics, which will include what type of anesthesia provider they are, as well as years of experience in the anesthesia field. Once completed, the study will proceed with a pre-test to attain a baseline understanding of the practitioner's knowledge of endotracheal tubes and appropriate pressures. Afterward, participants will go through an educational PowerPoint on endotracheal tube cuff pressures and best practice recommendations. Once completed, the participants will be asked to take the same pre-test.

Protection of Human Subjects

Each participant asked to participate in the survey will be asked to do so via email. This will allow each respondent to remain anonymous. Participants will use an online survey platform that is HIPAA compliant. At any time, the participant can withdraw their consent. Participation in this educational model includes benefits such as an increased knowledge base of the function of ET cuffs and how to use them best. Due to the potentially low number of surveys that will be filled out, some participants may be identifiable through demographic information. To maintain privacy, all data will be password protected.

Data Collection

The style of questions that will be asked of the participants in this survey will be in the form of multiple-choice questions. An understanding of knowledge will be based on the percentage of correct answers. In addition, practitioners will be asked how they conduct

endotracheal tube cuff inflation in the pre-test. In the post-test, participants will be asked if the information provided will change how they inflate their cuffs in the future.

Data Management and Analysis Plan

The data to be received will be stored in an electronic database. Only the lead researcher will have access to the database through password encryption. No direct identifiers will be asked of the participants, and all survey results will be aggregated to protect anonymity. The scores of both tests will be compared, and the effectiveness of the educational module will be analyzed.

Discussion of the Results and Implications

Research is constantly improving healthcare delivery, and it is through research that healthcare practitioners can improve quality and safety. Current data shows that implementing a smaller syringe size of 5cc instead of 10ccs for endotracheal tube cuff inflation could positively impact the patient populations in the surgical setting. This educational module could prevent many instances of cuff overinflation, thereby increasing patient outcomes. This training can increase awareness of current practice standards and provide education on how to enhance current models.

Appendix

Appendix A. IRB Approval



Office of Research Integrity
Research Compliance, MARC 414

A handwritten signature in black ink, appearing to be "EJ", written over a light blue horizontal line.

MEMORANDUM

To: Dr. Vicente Gonzalez
CC: Robert Howell
From: Elizabeth Juhasz, Ph.D., IRB Coordinator
Date: April 28, 2022
Protocol Title: "An Education Module for the Use of a 5cc Syringe for the inflation of Endotracheal Tube Cuffs: A Quality Improvement Project"

The Florida International University Office of Research Integrity has reviewed your research study for the use of human subjects and deemed it Exempt via the **Exempt Review** process.

IRB Protocol Exemption #: IRB-22-0179 **IRB Exemption Date:** 04/28/22
TOPAZ Reference #: 111570

As a requirement of IRB Exemption you are required to:

1. Submit an IRB Exempt Amendment Form for all proposed additions or changes in the procedures involving human subjects. All additions and changes must be reviewed and approved prior to implementation.
1. Promptly submit an IRB Exempt Event Report Form for every serious or unusual or unanticipated adverse event, problems with the rights or welfare of the human subjects, and/or deviations from the approved protocol.
1. Submit an IRB Exempt Project Completion Report Form when the study is finished or discontinued.

Special Conditions: N/A

For further information, you may visit the IRB website at <http://research.fiu.edu/irb>.

EJ

Appendix B. Letter of Support

February 1, 2022

Vicente Gonzalez, DNP, CRNA, APRN
Clinical Assistant Professor,
Department of Nurse Anesthesiology
Florida International University

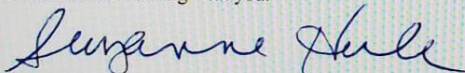
Dr. Gonzalez,

Thank you for inviting Memorial Regional to participate in Doctor of Nursing Practice (DNP) project conducted by Robert Howell entitled "Use of a 5cc syringe for the inflation of endotracheal tube cuffs: An Educational Module." in the Nicole Wertheim College of Nursing and Health Sciences, Department of Nurse Anesthetist Practice at Florida International University. I have warranted his permission to conduct the project using our providers.

Evidence-based practice's primary aim is to yield the best outcomes for patients by selecting interventions supported by the evidence. This project intends to evaluate if a structured education targeting providers will increase knowledge on the potential benefits of using a 5cc syringe to inflate endotracheal tube cuffs.

We understand that participation in the study is voluntary and carries no overt risk. All Anesthesiology providers are free to participate or withdraw from the study at any time. The educational intervention will be conveyed by a 15-minute virtual PowerPoint presentation, with a pretest and posttest questionnaire delivered by a URL link electronically via Qualtrics, an online survey product. Responses to pretest and posttest surveys are not linked to any participant. The collected information is reported as an aggregate, and there is no monetary compensation for participation. All collected material will be kept confidential, stored in a password-encrypted digital cloud, and only be accessible to the investigators of this study: Robert Howell and Dr. Gonzalez. We expect that Robert Howell will not interfere with normal hospital performance, behave in a professional manner and follow standards of care.

Prior to the implementation of this Educational project, the Florida International University Institutional Review Board will evaluate and approve the procedures to conduct this project. Once the Institutional Review Board's approval is achieved, this scholarly project's execution will occur over two weeks. We support the participation of our Anesthesiology providers in this project and look forward to working with you.



Suzanne Hale, MSN, CRNA, ARNP
Advanced Practice Provider Director, Broward and Dade
Chief, Memorial Regional Hospital
Envision Physician Services
954-265-2044

Appendix C. Invitation to Participants



Nicole Wertheim College of Nursing & Health Sciences

An Education Module for the Use of a 5cc Syringe for the Inflation of Endotracheal Tube Cuffs: A Quality Improvement Project

Dear Memorial Regional Hospital Anesthesia Provider:

My name is Robert Howell, and I am a student from the Anesthesiology Nursing Program Department of Nurse Anesthetist Practice at Florida International University. I am writing to invite you to participate in my quality improvement project. The goal of this project is to improve health care provider knowledge on the use of a 5cc Syringe for the inflation of endotracheal tube cuffs. You are eligible to take part in this project because you are a member of the Anesthesia Department for Memorial Regional Hospital

If you decide to participate in this project, you will be asked to complete and sign a consent form for participation. Next, you will complete a pre-test questionnaire, which is expected to take approximately 5 minutes. You will then be asked to view an educational presentation online. After watching the video, you will be asked to complete the post-test questionnaire, which is expected to take approximately 5 minutes. *No compensation will be provided.*

Remember, this is completely voluntary. You can choose to be in the study or not. If you'd like to participate or have any questions about the study, please email or contact me at rhowe011@fiu.edu or 954-864-0711.

Thank you very much.

Sincerely,

Robert Howell SRNA, BSN, CCRN

Appendix D. Informed Consent

Welcome to the QI Project!

An Education Module for the Use of a 5cc Syringe for the Inflation of Endotracheal Tube Cuffs

INTRODUCTION

The primary aim of this Quality Improvement project is to improve the knowledge of CRNAs pertaining to the utilization of 5cc syringes for the inflation of endotracheal tube cuffs. Please answer the questions below to the best of your ability. The questions include demographic information and knowledge of the inflation of endotracheal tube cuffs. Questions are in multiple choice or True/False format and are meant to measure the CRNAs knowledge and utilization of different inflation techniques. Please be assured that your responses will be kept completely confidential.

This survey comprises of a pre-test questionnaire, which is expected to take approximately 5 minutes. Afterwards, you will then be asked to view a brief educational video online. Following the video, you will be asked to complete a post-test questionnaire, which is expected to take approximately 5 minutes. No compensation will be provided for your participation, and participation is voluntary.

By clicking the button below, you acknowledge that your participation in this study is voluntary, that you are at least 18 years of age, and that you are aware that you may choose to terminate your participation in this study at any time and for any reason.

Please note that this survey will be best displayed on a laptop or desktop computer. Some features may be less compatible for the use on a mobile device.

Appendix E. Educational Module PowerPoint Presentation

An Educational Module for the Use of a 5cc Syringe for the Inflation of Endotracheal Tube Cuffs: A Quality Improvement Project

Michelle Werhane, College of Nursing & Health Sciences, Florida International University
Robert Howard

FIU Florida International University
College of Nursing & Health Sciences

1

Background

- It is estimated that over twenty million endotracheal tubes (ETTs) are used in the United States every year.
- Most ETTs are used for surgeries requiring general anesthesia.
- ETTs have a balloon called a "cuff", which is inflated after insertion.
- Goal Cuff Pressure: 19 to 40 cmH₂O

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2

Reasons for Cuff Inflation

- To create a seal in the trachea so that positive pressure ventilation can occur, and the desired tidal volumes achieved.
- Prevent contents of the stomach from entering the lungs.

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3

Problem Identification

- ETT cuffs in the OR are often overinflated.
- Overinflation: Increased cuff pressures beyond the recommended range lead to tissue ischemia.

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4

Complications of Overinflation

- Sore Throats
- Laryngeal Nerve Injuries
- Ulcerations
- Tracheal Ruptures
- Fistulas

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College of Nursing & Health Sciences

5

Complications Lead To:

- Hospital admissions
- Increased hospital stays
- Increase in hospital costs
- Death

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College of Nursing & Health Sciences

6

Literature Review of Different Methods of ETT Cuff Inflation

- Manometer
- Minimally Occlusive Leak Test
- Palpation of the pilot balloon
- Fixed Volume (10cc Syringe)
- Fixed Volume (5cc Syringe)

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7

Literature Review Findings

- Multiple sources believe that a cuff pressure of 25cmH₂O is adequate in maintaining an appropriate seal while at the same time preventing tissue ischemia.
- The use of a 5cc syringe was proven to achieve 25cmH₂O while avoiding the possibility of overinflation.

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8

Quality Improvement

- Eliminating the use of a 10cc syringe and replacing it with a 5cc syringe
- Just remember: "Think 5(cc) for less than 25(cmH₂O)"

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9

Reference List

- Overinflation of endotracheal tube cuffs: a review of the evidence. *J Perianth Care*. 2012;27(3):199-201. doi:10.1016/j.pn.2012.05.004
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- Shahzad A, Lee L, Frazier S, Zemanick S, Thomas CD. How to Prevent Endotracheal Tube Cuff Overinflation: The 20" 4.0x4.2. 2012;39(2):147-154.
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- Overinflation of endotracheal tube cuffs: a review of the evidence. *J Perianth Care*. 2012;27(3):199-201. doi:10.1016/j.pn.2012.05.004
- Stulen F, Corbridge B, New SO, Cheng R. Endotracheal tube cuff pressure monitoring: a review of the evidence. *J Perianth Care*. 2011;26(1):79-88. doi:10.1016/j.pn.2010.12.010
- Shahzad A, Lee L, Frazier S, Zemanick S, Thomas CD. How to Prevent Endotracheal Tube Cuff Overinflation: The 20" 4.0x4.2. 2012;39(2):147-154.
- Al-Jabir F, Al-Ghannam A, Al-Jabir F, Al-Jabir F, Al-Jabir F. Is using cuff pressure, easy, reliable and safe technique for endotracheal tube cuff inflation? A comparative study. *J Anaesth*. 2011;25(1):10-15. doi:10.4236/ja.2011.25101

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10

Appendix F. Results

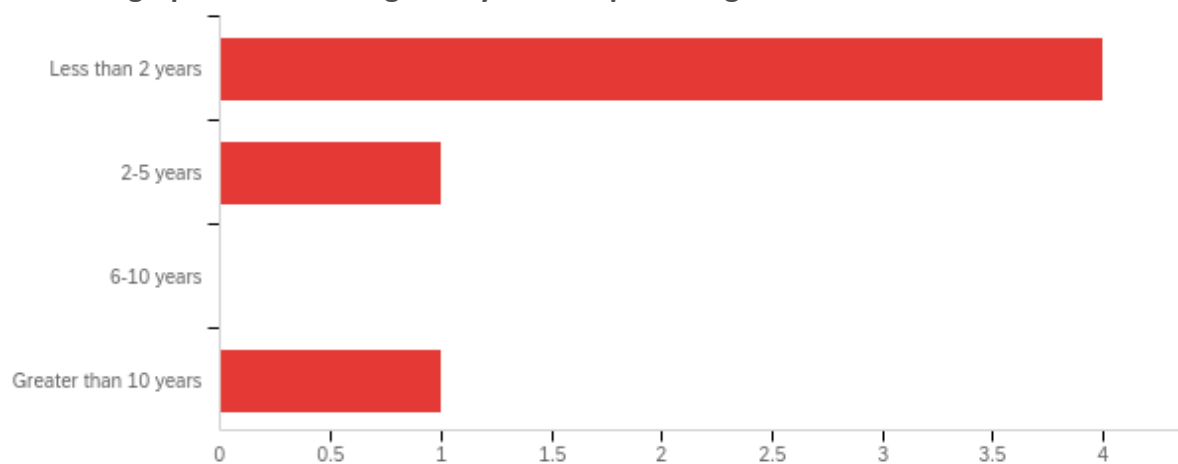
Qualtrics Results

The CRNA staff at Memorial Regional Hospital were asked to participate in the educational module. The module comprised of a pre-test questionnaire, a brief educational video online, and followed by a post-test questionnaire. Participants were told that no compensation would be provided for their participation, participation was voluntary, and survey results were anonymous.

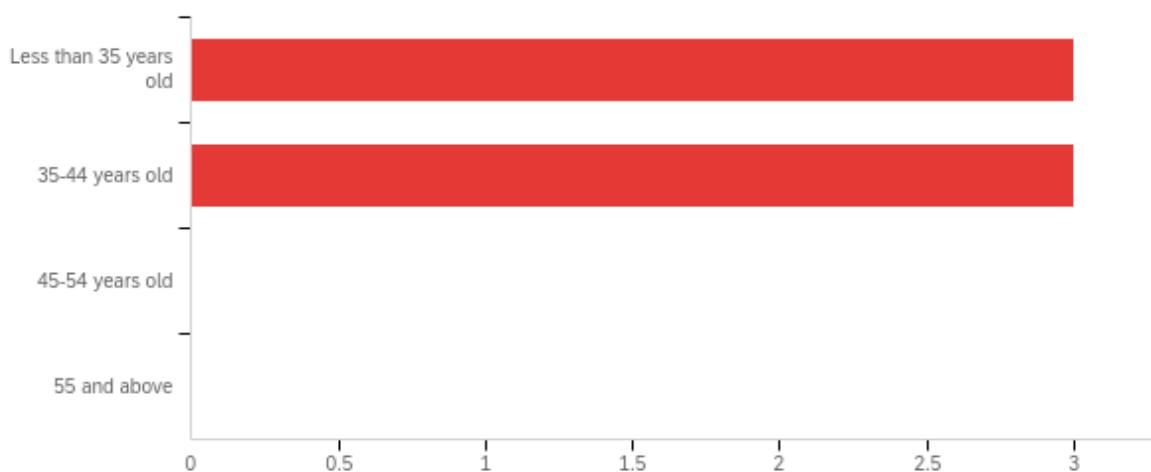
There was a total of six individuals who participated in the survey. All six participants fully completed the educational module, comprising two demographic questions, ten pre-test questions, and ten post-test questions. The pre-test questions and post-test questions were identical. Below is the breakdown of the results.

Demographic Results:

Demographic 1 - How long have you been practicing anesthesia?



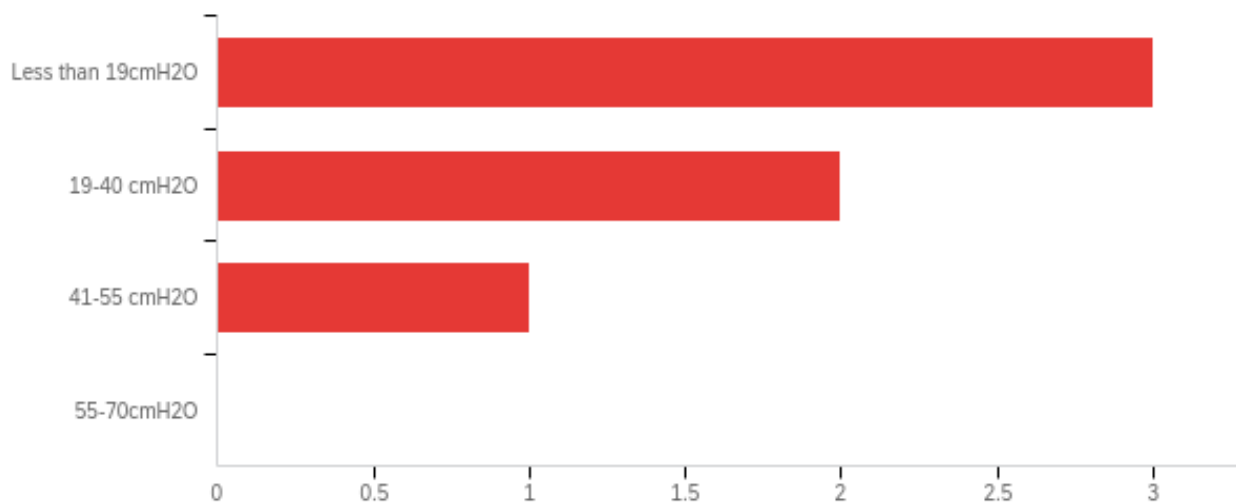
Demographic 2 - What age category do you fall into?



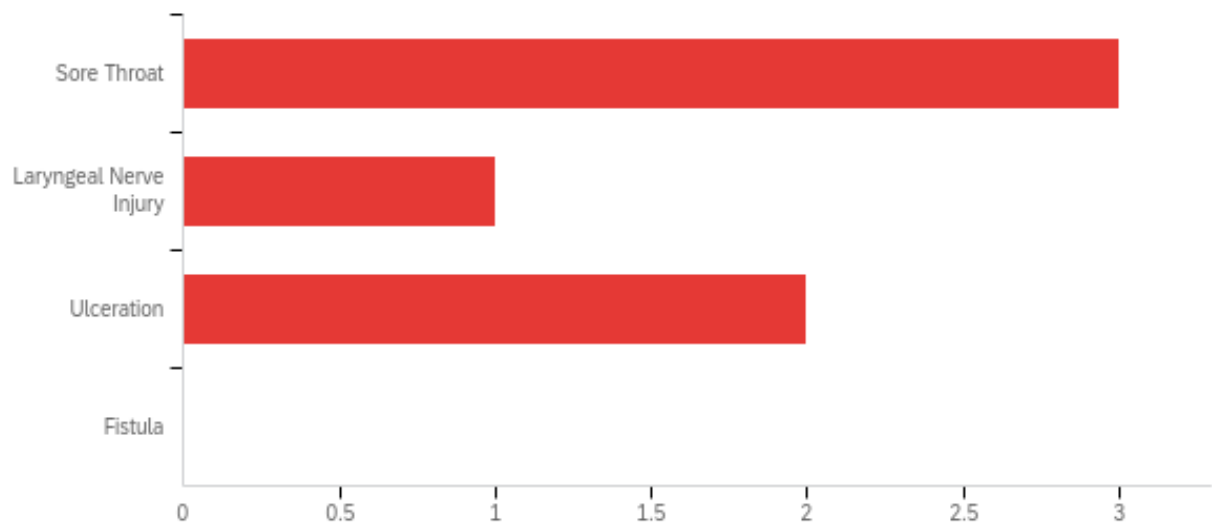
Of the participants that volunteered to participate in the survey, four had been practicing anesthesia for less than two years, one in-between two and five years, and one for more than ten years. The age of the participants fell into one of two categories. Three participants reported being less than thirty-five years old, while the other three reported belonging to the thirty-five to forty-four age group.

Pretest Question Results

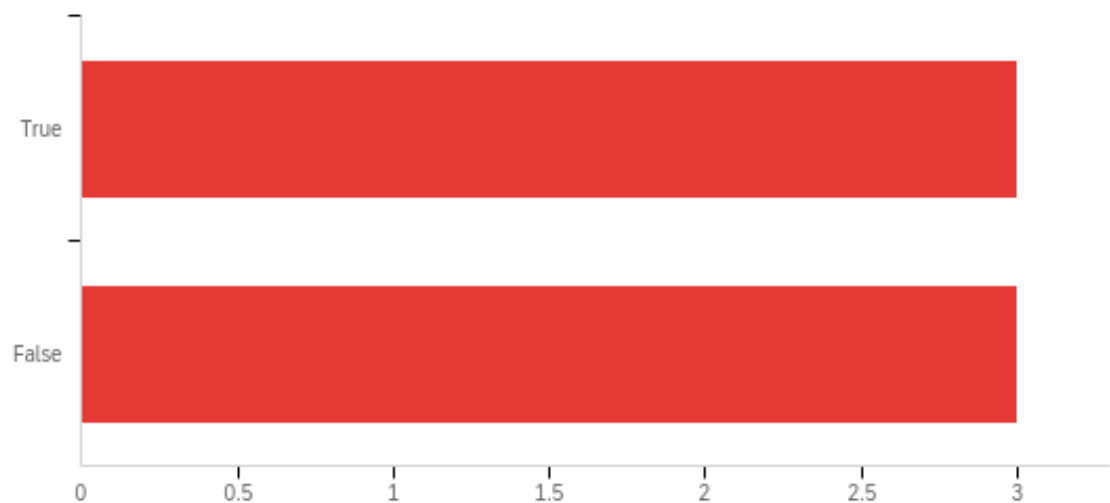
Pre - Q1/10 What is the goal cuff pressure of an endotracheal tube?



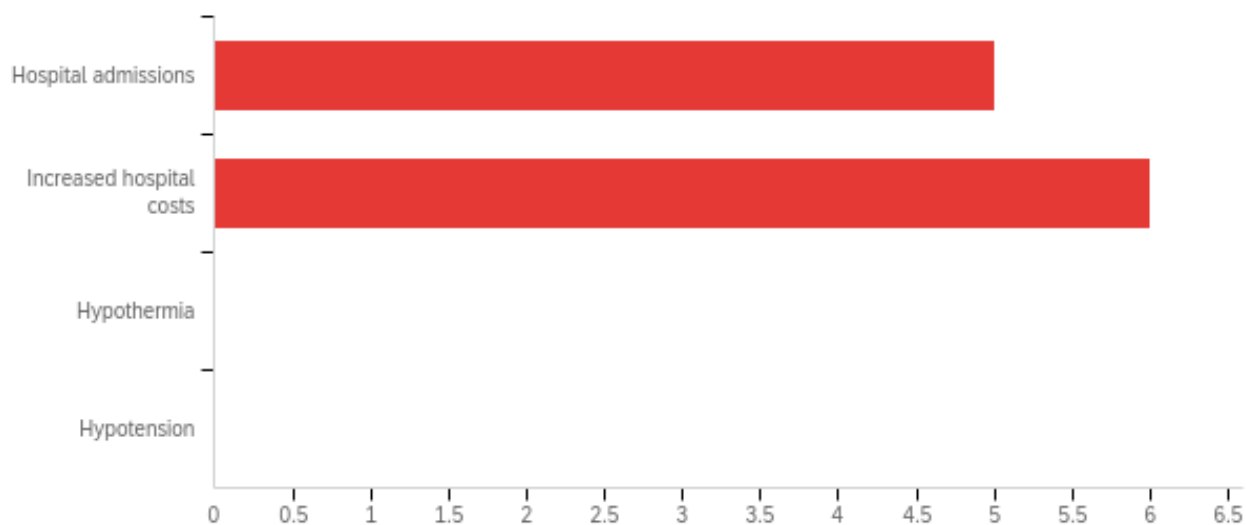
Pre - Q 2/10 What is the most common complication of an overinflated endotracheal tube cuff?



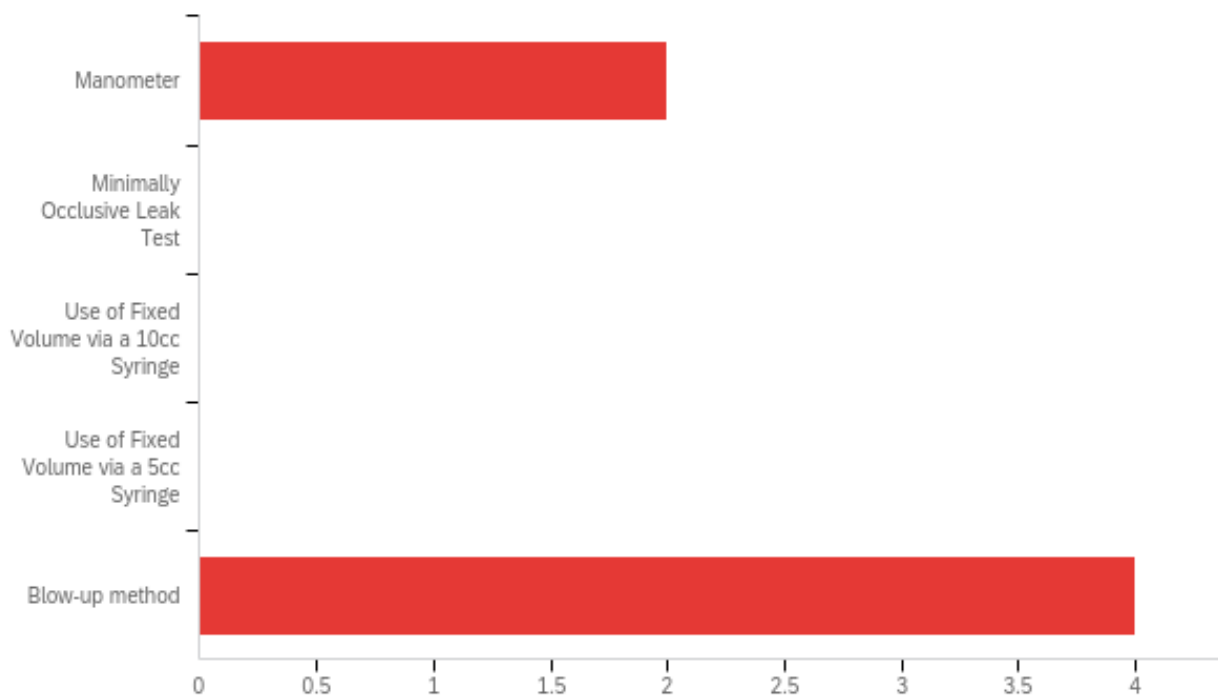
Pre - Q 3/10 Death has been reported due to the complications of over-inflated cuffs.



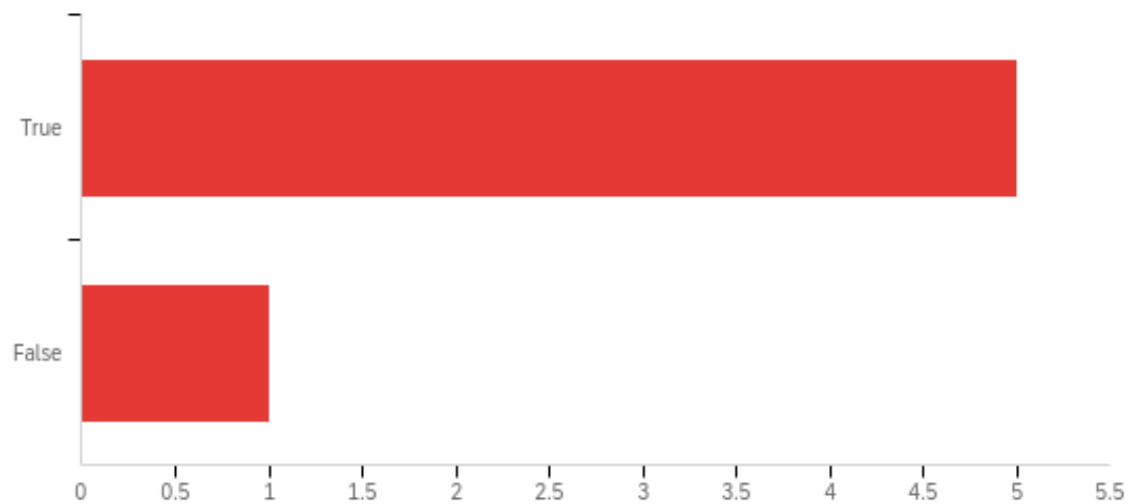
Pre - Q 4/10 Complications of over-inflated endotracheal tube cuffs can lead to (select 2):



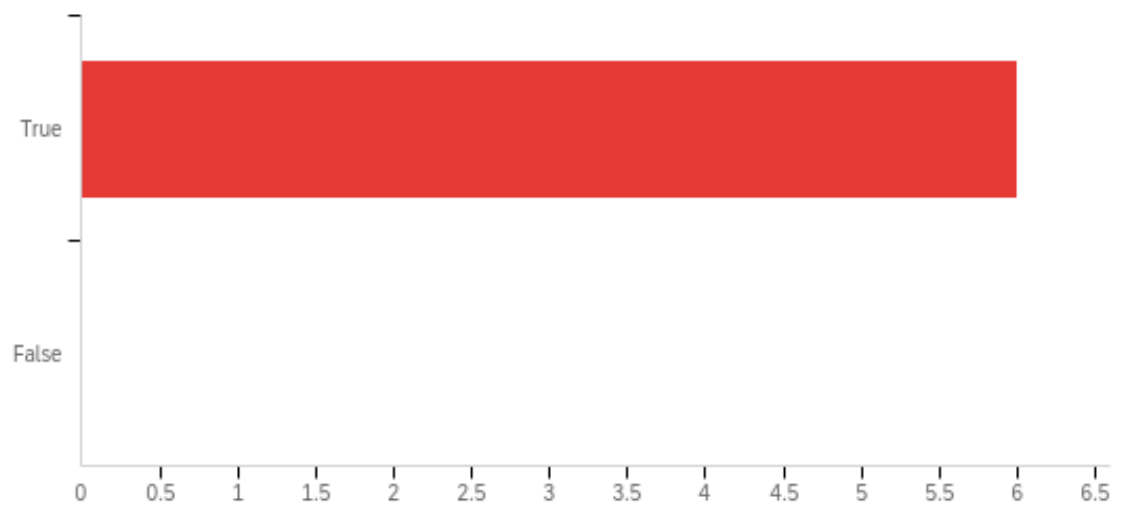
Pre - Q 5/10 Which is not a commonly used method to achieve desired endotracheal tube cuff pressures?



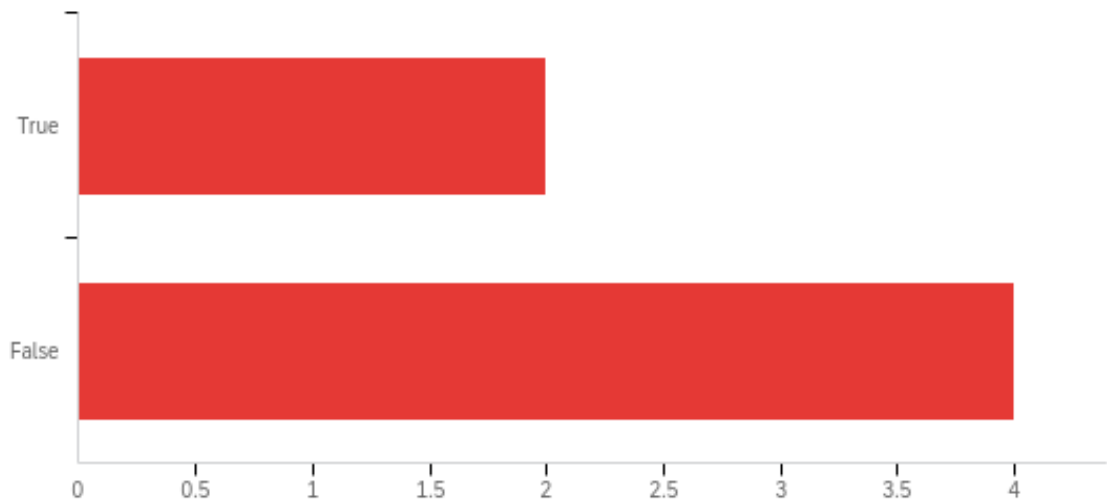
Pre - Q 6/10 Palpation of the pilot balloon is an effective way to measure endotracheal tube cuff pressure.



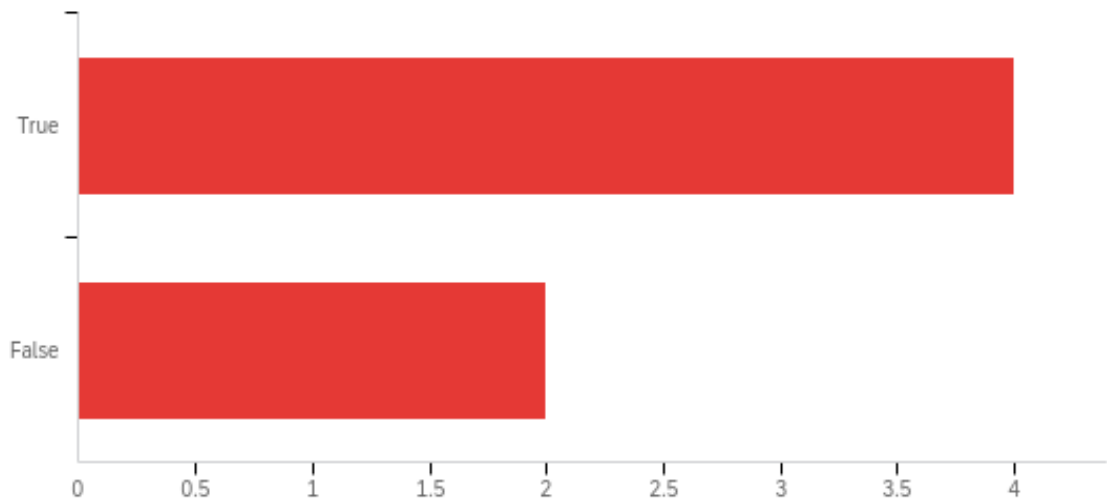
Pre - Q 7/10 Using a manometer is the “gold standard” to measure endotracheal tube cuff pressures.



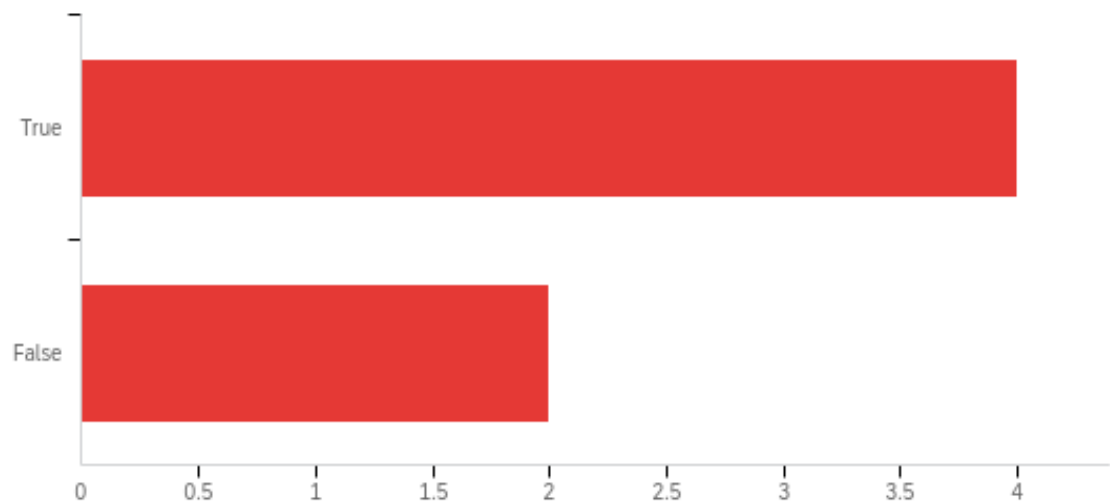
Pre - Q 8/10 The cuff pressure of 45cmH2O is adequate in maintaining an appropriate seal around the trachea while at the same time preventing tissue ischemia.



Pre - Q 9/10 The use of a 10cc syringe has been proven to achieve 25cmH20 while avoiding the possibility of over inflation.

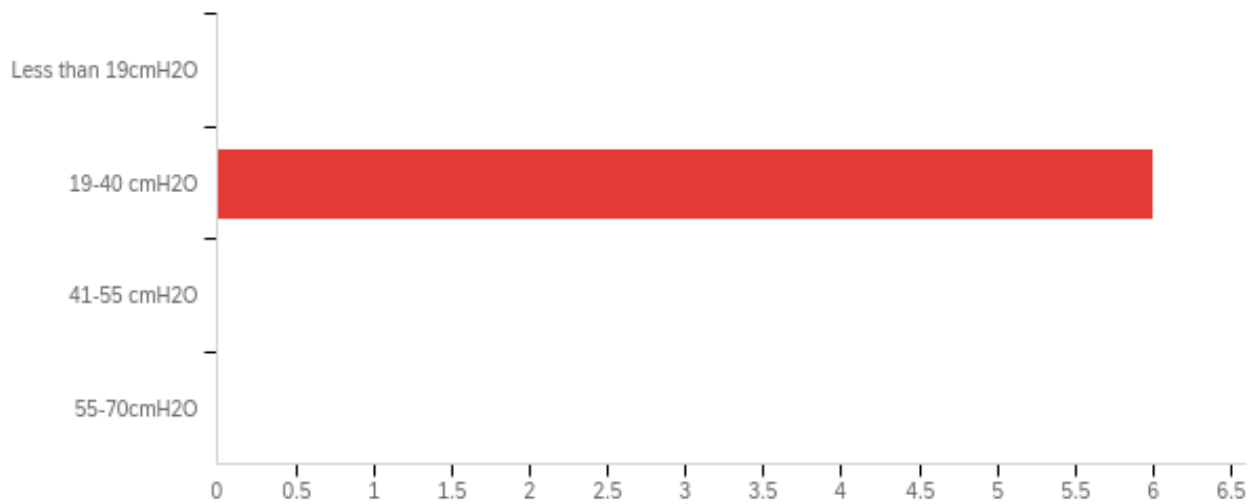


Pre - Q 10/10 The use of a 5cc syringe has been proven to achieve 25cmH20 while avoiding the possibility of over inflation.

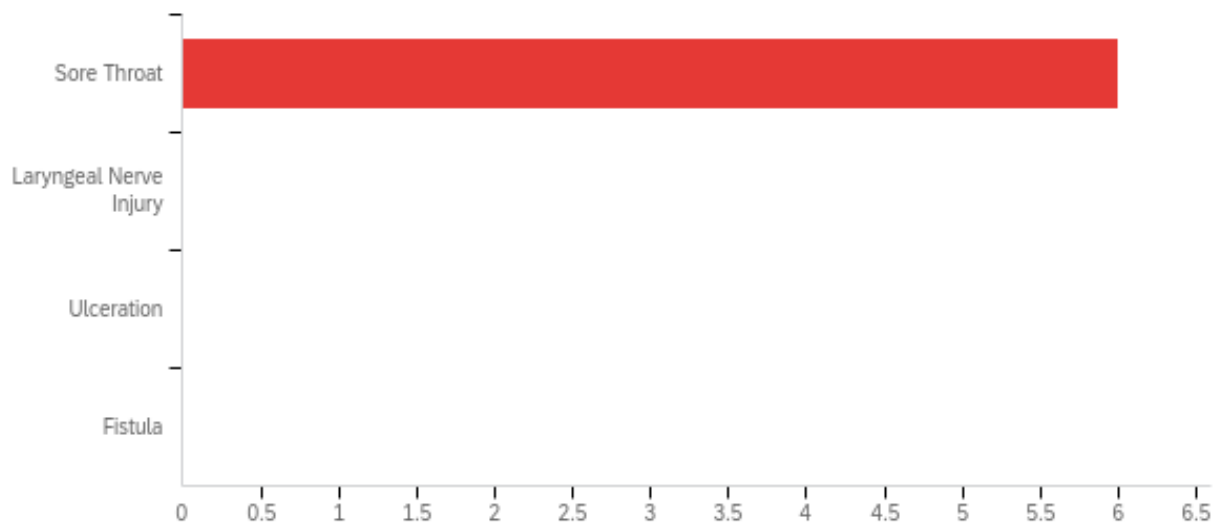


Post-Test Results:

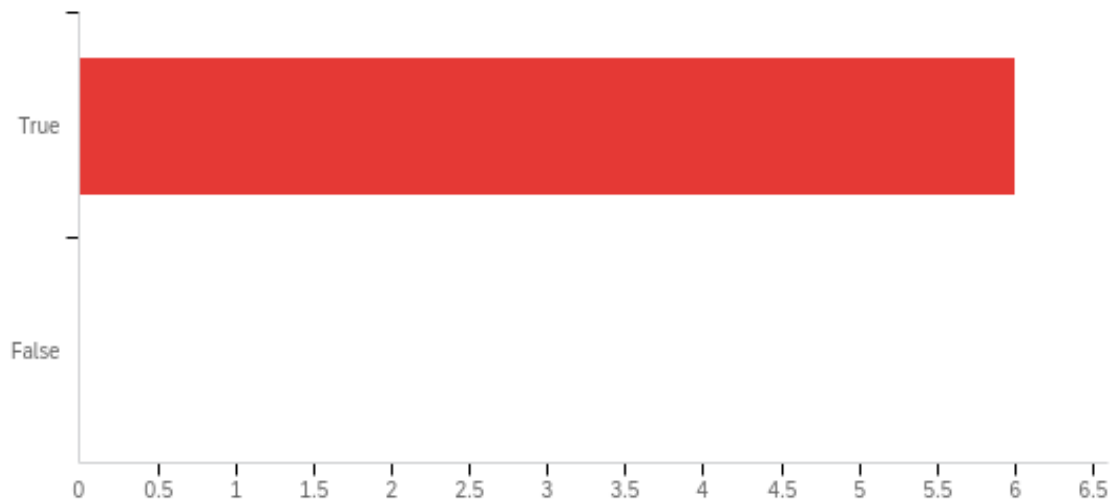
Post - Q1/10 What is the goal cuff pressure of an endotracheal tube?



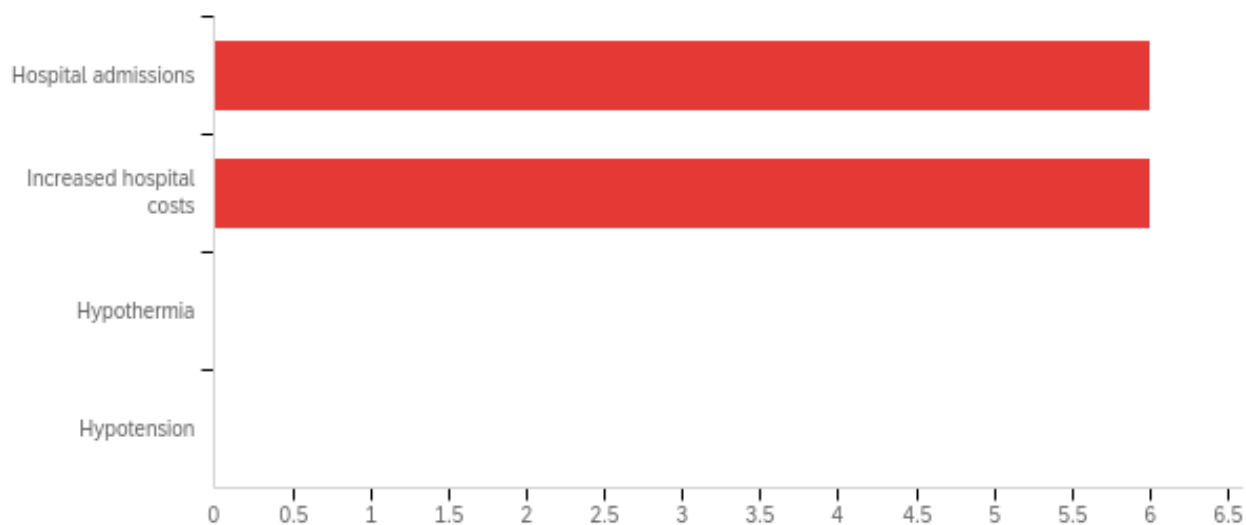
Post - Q 2/10 What is the most common complication of an overinflated endotracheal tube cuff?



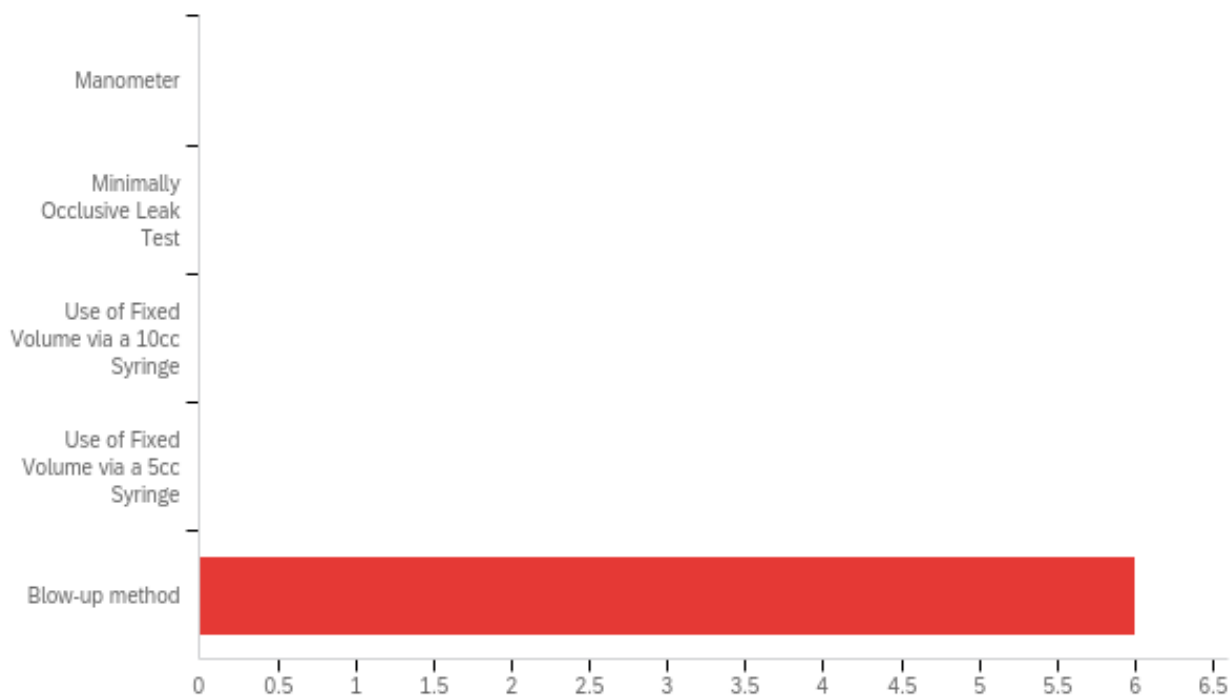
Post - Q 3/10 Death has been reported due to the complications of over-inflated cuffs.



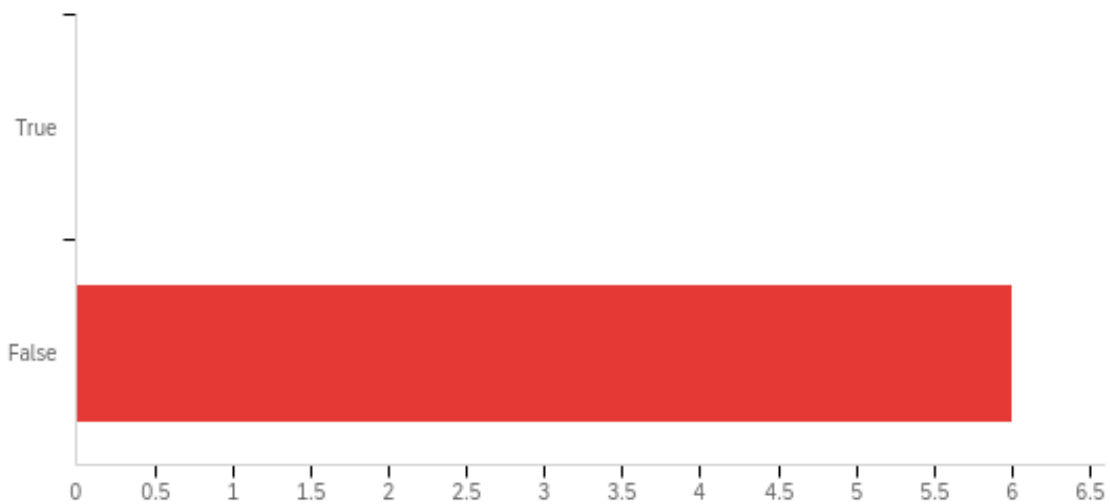
Post - Q 4/10 Complications of over-inflated endotracheal tube cuffs can lead to (select 2):



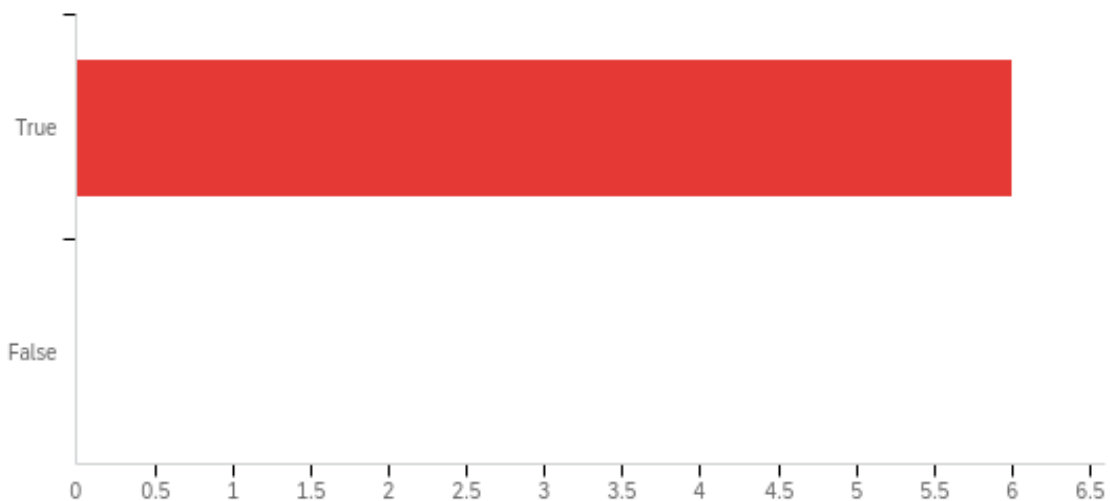
Post - Q 5/10 Which is not a commonly used method to achieve desired endotracheal tube cuff pressures?



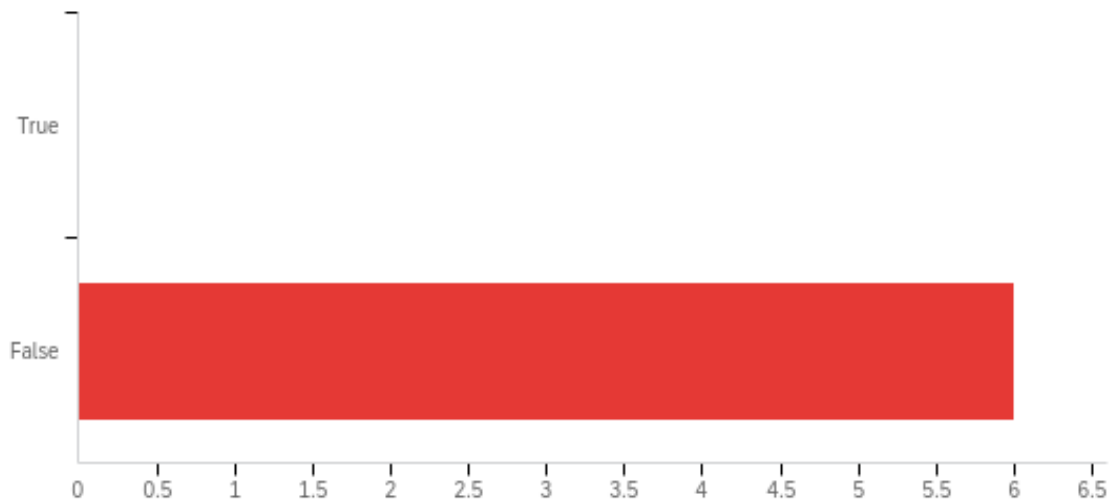
Post- Q 6/10 Palpation of the pilot balloon is an effective way to measure endotracheal tube cuff pressure.



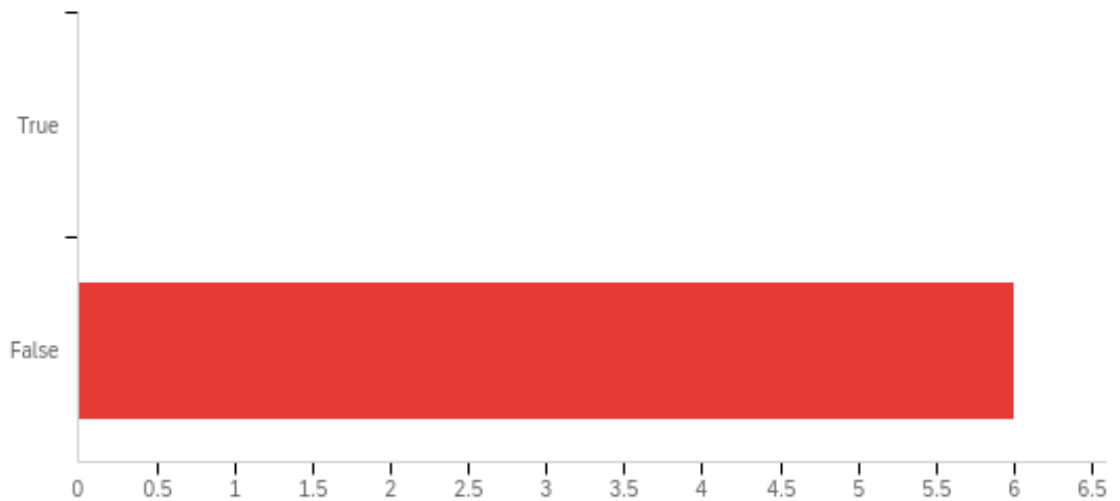
Post - Q 7/10 Using a manometer is the “gold standard” to measure endotracheal tube cuff pressures.



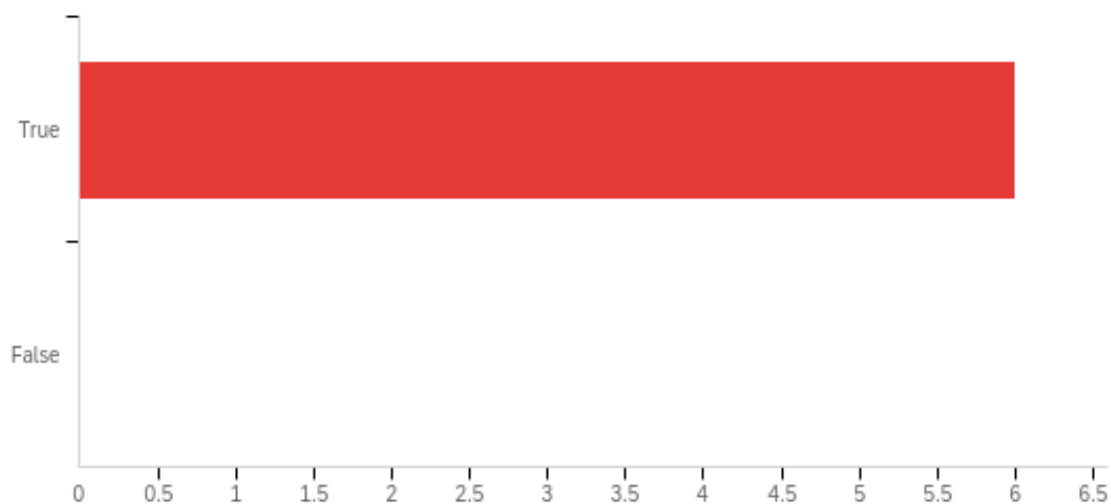
Post - Q 8/10 The cuff pressure of 45cmH2O is adequate in maintaining an appropriate seal around the trachea while at the same time preventing tissue ischemia.



Post - Q 9/10 The use of a 10cc syringe has been proven to achieve 25cmH20 while avoiding the possibility of over inflation.



Post - Q 10/10 The use of a 5cc syringe has been proven to achieve 25cmH20 while avoiding the possibility of over inflation.



Appendix G. Summary

Listed below are the results of the pre-test and post-test questionnaire.

Percent Correct

	Pre	Post
Q1	50%	100%
Q2	50%	100%
Q3	50%	100%
Q4	100%	100%
Q5	66%	100%
Q6	66%	100%
Q7	100%	100%
Q8	66%	100%
Q9	33%	100%
Q10	66%	100%

The results of the percentage of correct answers after the educational module show a dramatic increase. Every participant scored a 100% in their post-test survey.

Interpretation

Interpretation of the data would suggest that effective learning took place for the participants of the educational module.

Limitations

Due to the smaller sample size, it is unclear if effective learning will occur on a large scale. Further educational modules would need to be implemented.

Conclusions

There are many different methods used for the inflation of endotracheal tube cuffs. This quality improvement project shows evidence of effective learning for the participants of the educational module. If the participants choose to implement the information learned from this project, then the data suggests that safer and higher quality anesthesia practice will occur. The educational module can be used to educate other anesthesia practice groups. It can also be presented to any healthcare worker that uses endotracheal tubes in their line of work.

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