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Cricoid Pressure: Closing the Knowledge-Practice Gap

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Abstract

Background and Review of Literature: Cricoid pressure is a technique of applying digital pressure along the outside of the upper airway to reduce the risk of aspiration of stomach contents during anesthesia induction. Improper placement can cause harm or make endotracheal intubation difficult. No accepted alternative practice exists, but it is performed incorrectly in most attempts. Incorrect placement and amount of force are typical causes of failure to occlude the esophagus and protect the airway There is no standardized training for cricoid pressure.

Purpose: This project was developed to determine whether incorporating simulated training, an educational session, and practice applying pressure with force measurement would be able to improve knowledge of and ability to correctly place cricoid pressure. This could determine if such an intervention is a viable option for future standardization of education on the topic.

Methods: A quality improvement design was used to test an education/simulation experience using the results of a 12 question pretest-posttest questionnaire and measurement of force placed on an airway manikin during three separate attempts with and without measured force feedback.

Implementation Plan/Procedure: A convenience sample of 33 Marian University first-year nurse anesthesia students completed the educational/simulated training experience and practice attempts, and 26 of the students finished the posttest survey to compare against the pretest data.

Implications/Conclusion: Average total questionnaire scores improved from 47.9% to 69.1% ($p < 0.001$) and cricoid pressure deviation from the target range decreased from 4.53 to 1.42 pounds ($p < 0.001$). There is still some room to improve, but the combined interventions created positive change in both data sets and could be a good starting point for standardizing education to reduce cricoid pressure variability in the clinical practice setting.

Keywords: cricoid pressure, Sellick(‘s) maneuver, practice, education, and training

Cricoid Pressure: Closing the Knowledge-Practice Gap

Since its description and use in the 1960s, performance of cricoid pressure to reduce the risk of pulmonary aspiration of gastric contents has been considered a standard practice and safety measure for patients undergoing rapid sequence induction and intubation (Landsman, 2004). In more recent years, the effectiveness of this intervention when applied to real patients has been called into question (Zdravkovic et al., 2021). Despite many years of practice, evidence with actual patients is lacking, conflicting, or able to be attributed to confounding variables (Zdravkovic et al., 2021). A major variable that has been described throughout the research on this topic is discrepancies in where and how forcefully pressure is placed on the cricoid cartilage (Andruszkiewicz et al., 2017). One way to begin rectifying this is to ensure a more standardized teaching of cricoid pressure technique in the academic setting (Zdravkovic et al., 2021). Whether or not cricoid pressure is truly effective, in order to ensure its use on patients is safe, proper placement must be ensured, and this can be taught successfully with simulated training (Andruszkiewicz et al., 2017). For this reason, a project designed to standardize student nurse anesthetist training for cricoid pressure placement would be useful to determine the consistent success of placement thereafter as a means to close the gap between the technique known to be effective in simulation and its implementation in the real-world surgical setting.

Background

Anatomically, the cricoid cartilage is the only cartilaginous structure in the upper airway that is completely circumferential, surrounding the entire trachea (Landsman, 2004). The concept of placing pressure on this cartilage is in theory a method of occluding the esophagus, as this is just posterior to the trachea and the cricoid ring (Zdravkovic et al., 2021). Aspiration of gastric contents is a risk of all general anesthetics, although this risk is further increased by many specific conditions, including pregnancy, diabetes, uncontrolled gastroesophageal reflux disease, or by not fasting prior to surgery, as is the case with many emergent procedures (Bohman et al., 2018). Despite efforts to prevent aspiration, it is a fairly common occurrence in surgical patients, with as many as 19 percent of patients that are treated prophylactically still developing aspiration of gastric contents to some degree, regardless of patient demographic factors (Bohman et al., 2018).

Aspiration occurring so frequently is a major concern, given that even in an amount too small to see, it is associated with pneumonia, acute respiratory distress syndrome, and acute respiratory failure (Bohman et al., 2018). Rapid sequence induction (RSI) is the terminology used for securing the airway in patients at high risk for aspiration, grouping together all the standardized prophylactic measures into one procedure, as an alternative to a typical anesthetic induction (Zdravkovic et al., 2021). Cricoid pressure has been instituted as a routine component of RSI, as there currently is no other method of manually attempting to limit the esophageal opening during intubation (Landsman, 2004). Cricoid pressure's original use in preventing aspiration in victims of drowning was transferred to anesthetic use and dubbed Sellick's maneuver, named for the man who first described its use for rapid sequence intubation (Landsman, 2004). Studies performed on cadavers have suggested cricoid pressure only provides a benefit against aspiration with force as strong as 30 to 40 Newtons (Landsman, 2004).

A major concern with cricoid pressure placement is that 30 to 40 Newtons is a specific value that may not necessarily translate to a measurable amount of force with which a provider attempting the maneuver would be familiar. How much digital pressure does one apply to achieve 30 Newtons? Another major concern is an inconsistency among providers and the ability to identify the cricoid cartilage itself; more than 50 percent of health care workers responsible for airway securement are unable to successfully locate the cricoid in real patient scenarios (Qasem et al., 2019). The problem with this is that with inappropriate force or location, cricoid pressure is certainly not effective at reducing aspiration, and can also cause difficulty achieving optimal view during laryngoscopy for intubation, with 24 percent of cases having reduced visualization (Zdravkovic et al., 2021). Poor view during airway securement is not the only concern, as cricoid pressure is also contraindicated in patients who are actively vomiting, due to the increased pressure in the esophagus and its potential to lead to rupture (Landsman, 2004).

This suggests that cricoid pressure being performed incorrectly is actually putting patients at risk for other serious complications on top of failing to reduce the risk for aspiration. Part of the reason the body of research does not explicitly support or reject cricoid pressure is also part of why it is performed incorrectly so often – there is no consistent, standardized training for cricoid pressure (Herman et al., 1996). The most training many providers receive during their education is a brief explanation of the technique (Herman et al., 1996). Guided simulation and practice performing cricoid pressure is a strategy that has been shown to provide more consistent, proper technique, but has not been successfully implemented in a widespread manner (Zdravkovic et al., 2021).

Problem Statement

Cricoid pressure is still a widely practiced intervention in anesthesia, and there is not an accepted alternative at present. Given the dangers and the ineffectiveness of cricoid pressure with improper technique, ensuring adequate education and training prior to clinical use is important to protect patients. Simulated training has proven a successful venture for improving technique, and it could be a method to begin standardizing training for future anesthesia providers. Thus, the following question has been posed: For student registered nurse anesthetists (SRNAs) during RSI checkoffs, does having measurement of force in their simulated training alongside an educational session yield more consistent knowledge and accurate application of cricoid pressure placement and force?

Needs Assessment & Gap Analysis

At a private liberal arts university in the Midwest, an accredited doctoral nurse anesthesia program incorporates simulated training into its students' education, including specific simulated training for RSI. This training includes a basic understanding of when and where to use cricoid pressure and how much force to apply but does not afford a measurable method of teaching what 30 to 40 Newtons of pressure feels like, or where to locate the cricoid cartilage. This is the same area in which, nation-wide, providers have generally not received a standardized training. Current research on cricoid pressure suggests that the first step to fixing this gap between knowledge and practice is to ensure education and training to provide a more consistent approach to cricoid pressure that reduces variability of outcomes (Zdravkovic et al., 2021).

In working with this university in its simulated RSI training, this provided an opportunity to develop and refine methods that effectively teach cricoid pressure technique which are easily applied to other educational facilities. The ultimate goal of this was to test methods that facilitate the standardization of education and training for cricoid pressure as it is presently understood. In doing so, this supports further studies that can more conclusively determine if its benefits outweigh its risks. At a minimum, this taught a select group of future anesthesia providers how to properly perform the technique and promote patient safety.

Review of Literature

To fully understand the facets of cricoid pressure, and to maintain the relevance of a project designed to improve its use and work towards a needed standardization of practice, current literature and objective research data must be examined and incorporated into the project. This should be reviewed in its entirety to best facilitate a successful, meaningful, and conclusive result for the project, and needs to be accomplished prior to its initiation. A comprehensive review of literature is a universally accepted method of achieving this goal.

Research Methods

To begin the undertaking of this project, a comprehensive review of literature was conducted. A PRISMA diagram detailing the search and selection of research data can be found in Appendix A. This examination of research began in early September 2022 and concluded at the end of November thereafter. Keywords used include *cricoid pressure*, *Sellick('s) maneuver*, *practice*, *education*, and *training*. BOOLEAN phrases were created to form combinations that led to a thorough search for relevant research, including "*cricoid pressure*" OR "*Sellick maneuver*" AND *practice* OR *education* OR *training*. The primary focus of this research was to find any and all studies pertaining specifically to cricoid pressure's usefulness or hazards of inappropriate technique, the success or failure of methods to teach and improve localization of the cricoid cartilage, and approaches to teaching practitioners how much pressure to place.

PubMed and Medline-Ovid databases were searched extensively, alongside hand-searching, and a total of 200 articles were identified, 95 of which were eliminated as duplicates. The remaining 105 were surveyed and limited to 25 based on type of article, topic of research, and publication within five years. Two reports were unavailable for access in entirety and were therefore excluded. Of the 23 full articles viewed, two were highly specific and deemed unrelated to the topic at hand, two were conducted in finite locations that limited their universal application, and three were determined to be too narrative, or merely adjunct in nature, with little original objective data to report. The other 16 articles were all included in the review.

Results

This comprehensive review of literature revealed multiple avenues of study with a few notable commonalities. Several studies suggest cricoid pressure is ineffective at completely occluding the esophagus or reducing the risk of aspiration (Birenbaum et al., 2019; Bohman et al., 2018; Trethewy et al., 2017; White et al., 2020). Others indicate its utility as a protective measure, even with less force of pressure than previously accepted (Lim et al., 2021; Pellrud et al., 2018; Zeidan et al., 2017). Virtually all the studies concur that present understanding and practice of cricoid pressure is varying, and more often than not, either inaccurate, insufficient, or both (Andruszkiewicz et al., 2017; Bohman et al., 2018; Hee et al,, 2020; Lee et al., 2018; Noll et al., 2019; Qasem et al., 2019; Williams & Umranikar, 2017; You-Ten et al., 2018). With such a widely acknowledged gap in current practice, a good variety of research has been conducted to determine whether it should be used at all and how to teach or improve its use in practice, since it is still being utilized. These studies are listed in a literature review matrix (Appendix B) and can be analyzed collectively to reveal certain recurring themes.

Frequency & Dangers of Improper Cricoid Pressure Placement

Birenbaum et al. (2019) determined that cricoid pressure was not truly protective at preventing aspiration (p=.14). This study also noted that cricoid pressure was associated with an increased difficulty with intubation determined by increased time to intubate (p<.001) and increased Cormack and Lehane grading score for view of the larynx (p<.001). White et al. (2020)

compiled several studies for a separate review, and also determined that cricoid pressure increased the time required to achieve intubation (*p*<.001).

On the other hand, cricoid pressure is performed improperly often, removing its benefits as a practice, and this can often be attributed to a lack of understanding (Andruszkiewicz et al., 2017; Hee et al,, 2020; Lee et al., 2018; Qasem et al., 2019; Williams & Umranikar, 2017; You-Ten et al., 2018). Several studies determined that the accuracy of locating the cricoid anatomy was inadequate, 49% for Andruszkiewicz et al. (2017), 59% for Lee et al. (2018), 42% for Qasem et al. (2019), and 30% for You-Ten et al. (2018). Williams & Umranikar (2017) determined that on average, clinicians are about 10mm off from ideal placement on the cricoid cartilage. Studies also determined that force of pressure was inappropriate as much as 83.5% (Andruszkiewicz et al., 2017) and 73.5% (Hee et al., 2020). Other reports of ineffective use of cricoid pressure include Noll et al. (2019), stating that 96% of cricoid pressure attempts were unsuccessful at achieving proper technique, and Bohman et al., (2018) who described that unregulated, unstructured cricoid pressure attempts failed to prevent 19% of patients from developing some degree of aspiration (*p*=.529).

Correctly Locating the Cricoid Cartilage

Several studies have used ultrasonography to confirm or test against cricoid cartilage or esophageal localization by practitioners (Lee et al., 2018; Lim et al., 2021; Qasem et al., 2019; Williams & Umranikar, 2017; You-Ten et al., 2018). Of these, Lee et al. (2018), Qasem et al. (2019), Williams & Umranikar (2017), and You-Ten et al. (2018) had participants use the common practice for locating the cricoid cartilage, via the identification of surface landmarks along the upper airway. Lee et al. (2018) and Williams & Umranikar (2017) describe a distance more than 5mm away from the cricoid cartilage in 41% of attempts, averaging 10mm away, and were unable to attribute this to patient demographics including body mass index (p=.539; p=.285), neck circumference (p=.243), age (p=.843), and sex (p=.138). Qasem et al (2019) found that the ability to locate the cricoid cartilage across professions was 42%, with respiratory therapists being significantly faster at identification compared to anesthesia consultants (p<.001), residents (p=.002), and nurses (p=.071).

You-Ten et al. (2018) examined participant accuracy after practice with or without an ultrasound, finding the ultrasound group to have 65% accuracy compared to 30% for the control group (p=.025). The ultrasound group had a mean distance from the target that was nearly half the distance of the control, 3.6mm compared to 6.8mm (p=.001) (You-Ten et al., 2018). Lim et al. (2021) used ultrasound guidance to find the esophagus in patients, note its position relative to midline, and observe for esophageal occlusion with cricoid pressure placement. This revealed that 100% of patients with midline esophagus achieved occlusion with cricoid pressure, while only 27% of patients with alternative esophageal alignment were successfully occluded, with no difference in results relative to paralaryngeal pressure placement (p=1.0) (Lim et al., 2021).

Determining the Appropriate Amount of Force

The universally accepted amount of force to be applied is 30-40 Newtons, but this value is not clearly distinguishable during application, and it may not even be attainable while manipulating the airway (Trethewy et al., 2017). Andruszkiewicz et al. (2017) reported not only that anesthesia personnel could only achieve correct pressure 16.5% of attempts, but that only 18% had a baseline understanding of how much pressure would be appropriate (p<.001). Hee et al. (2020) and Trethewy et al. (2017) both provided real-time feedback of force measurement to some subjects during cricoid pressure placement to assess if this would improve accuracy of force, finding differing results. Hee et al. (2020) found that force of pressure was only appropriate 26.5-33.3% of attempts without feedback, but that with feedback the results improved to 81.1-88.3% ($p<.001$). Trethewy et al. (2017) found that there was no significant difference in pressures during cricoid pressure before ($p=.416$) and during intubation ($p=.742$), but that to achieve 30N, pressures were sufficient before and insufficient during endotracheal tube placement.

Comparing these findings to that of Pellrud et al. (2018) and Zeidan et al. (2017) could support an argument for the effectiveness of cricoid pressure with less than 30N in some patients. Both of these studies measured pressure with electronic devices and live subjects, and both determined that the pressure required to occlude the esophagus was on average at or below 30N (Pellrud et al., 2018; Zeidan et al., 2017). Zeidan et al. (2017) determined that male patients on average require 30.8N to occlude, whereas female patients on average require 18.7N ($p<.001$). Pellrud et al. (2018) found that upper esophageal sphincter pressures with cricoid pressure placed at about 30N increased from between 44-46mmHg to 167-173mmHg, which was determined to be much more than necessary for esophageal occlusion.

Educational Tactics to Improve Technique

Pulling together varying methods on how to teach this airway management skill effectively, many of these studies also compare simulated training and practice against didactic learning and educational sessions (Beckford et al., 2018; Fischer et al, 2018; Noll et al, 2019; You-Ten et al., 2018). Fischer et al. (2018) and You-Ten et al. (2018), while not directly looking at education on cricoid pressure, both demonstrate the effectiveness of simulated training. You-Ten et al. (2018) showed that practice with an ultrasound in simulation improved cricothyroid membrane identification in real patients from 30% to 65% ($p=.025$) and closed the distance to the cricothyroid target ($p<.001$). Fischer et al. (2018) showed enhanced performance with coronary angiography and higher test-scoring in general and across categories in a group of medical students who used simulated training compared to those with didactic teaching ($p<.001$). These students also reported a higher satisfaction with the training provided when compared to those without simulation experience ($p<.001$) (Fischer et al., 2018).

Noll et al. (2019) and Beckford et al. (2018) reveal that simulated training can specifically improve cricoid pressure technique and performance, especially with repetition. Noll et al. (2019) found that while cricoid pressure force was consistently inadequate, practice with a measurement of force followed by subsequent attempts at pressure yielded a 16% increase in success overall ($p<.001$), and that throughout all 30 cycles performed, each successive attempt was improved ($p<.001$). Beckford et al. (2018) looked at multiple studies on the education and training of cricoid pressure and concluded that the technical application of pressure is able to be successfully improved through repeated education, and in particular, simulated training efforts ($p<.001$).

Discussion

Cricoid pressure has been a long-standing practice yet is still quite controversial a matter. Looking at the collective data and inferences made from the results of these studies, it is apparent that there is still a strong mix of information concerning this topic. Lim et al. (2021) highlights the effectiveness of cricoid pressure at occluding the esophagus as long as it is anatomically midline, while Birenbaum et al. (2019), Bohman et al. (2018), Trethewy et al. (2017), and White et al. (2019) all suggest that cricoid pressure is ineffective as a technique and point out both the dangers of its incorrect use and even some of the reasons why it is being misused. Looking at Trethewy et al. (2017) and the conclusion that force may be involuntarily less than the therapeutic 30N during actual endotracheal tube placement, Pellrud et al. (2018) and Zeidan et al. (2017) suggest that less than 30N may still have protective benefits. Overall, the literature supports the use of simulated training and in particular, practice and repetition with localization and force of application on the cricoid cartilage (Beckford et al., 2018, Fischer et al, 2018; Noll et al., 2019; You-Ten et al., 2019). There is a substantial gap in baseline understanding of placement and force to bridge that has also been identified in the review (Andruszkiewics et al., 2017; Bohman et al., 2018; Hee et al., 2020, Lee et al., 2018; Noll et al., 2019; Qasem et al, 2019; Williams & Umranikar, 2017; You-Ten et al., 2018).

To fully address all the concerns mentioned throughout the articles, ultrasound guidance and measurement of force during simulated training of cricoid pressure appears to be a superior method for preparing providers to apply cricoid pressure effectively in the clinical setting, thereby reducing some of the risks associated with improper performance and maximizing the likelihood of protecting the airway from gastric aspiration. The studies that tested localization used some means of comparing a target point to a participant-placed point, using invisible ink, skin markers, and/or stickers (Lee et al., 2018; Qasem et al., 2019; Williams & Umranikar, 2017; You-Ten et al., 2018). The studies that measured force of pressure did so by using a weighted scale, manometer, and/or some other novel electronic force measurement/feedback device (Andruszkiewicz et al., 2017; Hee et al., 2020; Noll et al., 2019; Pellrud et al., 2018; Thethewy et al., 2017; Ziedan et al., 2017). Providing these with feedback during guided practice and simulated training may be the key to standardizing this practice.

Recommendations for future studies would be to develop data on long-term success at cricoid pressure after a training session, or recurrent training sessions at specified intervals. Another novel concept would be to test cricoid pressure placement against the incidence of aspiration with pressures outside the range of 30-40N or at a lower range. One additional area of study that would help clear some of the fog surrounding cricoid pressure's effectiveness would be to test patients for midline esophageal placement and determine aspiration incidence after cricoid pressure specifically in this population. Additionally, the major concern of inappropriate cricoid pressure placement and lack of proper technique should still be addressed in studies determining a way to effectively standardize correct usage. Recommendations for current practice are to continue educating practitioners on cricoid pressure use and training them on appropriate placement and force. The use of cricoid pressure in clinical practice for RSI is still encouraged, but, as its effectiveness is still uncertain, relieving the pressure as appropriate for conditions that increase esophageal pressure or difficult laryngoscopy. Using ultrasound to properly locate the cricoid cartilage is an option for providers to increase the likelihood of successful pressure, although this is not recommended for urgent situations in which airway securement is the higher priority.

Limitations of this review include the confines of the data relative to the broadness of the topic and multiple facets of the issue at hand. There is a notable lack of research determining or specifying varying finger placements and vector of force application to acknowledge other confounding variables in the study of cricoid pressure effectiveness. Studies in the review that themselves have limitations, including sample size or generalizability, may have still been included, as the selection process involved some unavoidable subjectivity relative to exclusionary criteria. Despite these limitations, this literature review is comprehensive in nature, involving all available modern, objective studies of this topic, and helps to identify where questions of effectiveness arise, and how to best address these moving forward. The data analysis supports the need for further provider education on cricoid pressure, regardless of conclusive protective benefits.

Conceptual Framework

The Revised Iowa Model of Evidence-Based Practice to Promote Excellence in Healthcare was chosen to provide a framework for the successful creation and implementation of this project (Appendix C). The Iowa Model has been used to ensure a project reaches its completion while maintaining its thorough evidence and transition into actual clinical practice (Iowa Model Collaborative, 2017). The application of this model to a project for cricoid pressure technique was accomplished looking in a step-by-step manner at the model and relating each segment to the topic at hand.

This model indicates the need to identify an issue or opportunity to improve, which in this instance was the improper use and/or application of cricoid pressure in real patient scenarios that results in not only difficult view for intubations and subsequent longer apneic times for surgical patients, but also definitive failure to produce protection of the airway from potential aspiration of gastric contents (Iowa Model Collaborative, 2017). The question and purpose of this project as determined by the next step in the Iowa Model, was addressed by the PICOT question: For SRNAs during RSI checkoffs, does having measurement of force and point localization methods included in their education and simulated training yield more consistent and accurate application of cricoid pressure placement and force? This question is a priority due to the negative consequences of incorrect cricoid pressure placement and the present scrutiny of cricoid pressure as an effective protective measure in anesthesia practice.

After forming a team to develop and implement the project, including the simulation director and educator for practical management of RSI, the next step was forming a body of evidence and examining the present research available on cricoid pressure, determining if the evidence was substantial enough for the project as designed, or if the project needed redirection

(Iowa Model Collaborative, 2017). The evidence did not confirm the success of cricoid pressure at preventing gastric aspiration in surgical patients, but it did confirm the frequent improper application of cricoid pressure, continued widespread use of cricoid pressure in practice, and the lack of standardized teaching for cricoid pressure placement (Zdravkovic et al., 2021). This confirmed the education of students in the proper technique of cricoid pressure was an appropriate trajectory for this project.

Planning and implementing the practice change via the designated intervention encompassed the next several steps of the Iowa Model, followed by collecting measured data from the implementation phase and determining the effectiveness of the intervention (Iowa Model Collaborative, 2017). This decided whether the project should be disseminated or if further revisions were required prior to attempting to standardize the process. These steps all ensued after the hybrid educational and simulated training session was designed, modified, and delivered to SRNAs, allowing for data collection and analysis to follow. According to the Iowa Model, after the results of this suggested that the intervention was successful, the remaining steps were designed to incorporate the intervention into practice, continue to monitor its results, and eventually circulate the intervention so as to spread its use and adoption as standard practice (Iowa Model Collaborative, 2017).

Project Aims/Objectives

The current understanding of cricoid pressure among anesthesia providers is subpar, however simulated efforts to correct this have proven successful, particularly so in the event these training efforts include measurement of force and localization for cricoid pressure technique (Andruszkiewicz et al., 2017; Hee et al., 2020; Noll et al., 2019). The primary aim of this project was to determine whether the simulated training session and education provided in conjunction with practicing the proper amount of force improved the students' understanding of proper cricoid pressure use and skill applying the technique.

Objectives of this project to help attain this goal included:

- Design a single hybrid educational and simulated training session for the established application technique and clinical use of cricoid pressure during RSI
- Obtain a weighing scale and test its measurement of force applied to a manikin placed atop
- Determine the conversion of pounds of force to Newtons of pressure and calculate appropriate force of cricoid pressure in pounds for real-time feedback to be given to the students during the simulated training.
- Create an appropriate, validated pretest/posttest questionnaire to determine students' level of understanding of cricoid pressure use and technique prior to the session and immediately thereafter
- Collect and analyze the pretest/posttest scores to determine the effectiveness of the education and training session in whole

SWOT Analysis

Identifying the strengths and weaknesses of the project beforehand can help to avoid pitfalls and augment the positive aspects, improving the overall execution of the project. The strengths of this project stem from its reproducibility and its relevance among the present climate of anesthesia. The project is applicable to students, providing very few risks to anyone involved, and no risks to patients. It identifies a current issue that anesthesia providers face and works towards addressing this. It is a cost-effective, timely project, with very limited resources and expertise required. Some of the project's weaknesses revolve around its size and follow-up, and its anesthesia program specificity. The sample size is a single cohort of anesthesia students, limiting the data and its generalizability. This project hinges on the participation of the students in the chosen cohort, of which, some or many may decline, leading to a very limited pool of data. The opportunity for long-term follow-up with the participants of the project is limited due to the project timeline, limiting the available results of the intervention.

Some of the opportunities afforded by this project are to observe the impact of simulated training, educational interventions, and specific measured parameters on cricoid pressure technique and general understanding thereof. Additionally, regardless of the results, the project provides the opportunity to speak on the subject to aspiring anesthesia providers, increasing the chances of successful application of cricoid pressure and/or awareness of the controversy surrounding its use. Another opportunity of this project is to enhance the students' education regarding RSI, as the intervention is designed to be an adjunct to the RSI class simulation.

Threats to the project are mostly directly related to the convenience sampling from the single anesthesia program. As mentioned, the sample size will already be low, and there is a potential for further decreases as participation is not mandatory. A small sample also increases the likelihood of skewed results from any outliers that misrepresent the population of interest. Another threat to the project is the limited opportunity to offer training sessions as direct adjuncts to RSI simulation, meaning the class is only scheduled for two separate days, and availability to provide a flexible schedule for students to participate is determined by multiple factors unable to be influenced by the project lead. These strengths, weaknesses, opportunities, and threats all balance and create elements of the project that its developers must remain aware of in order to achieve the most successful results. These SWOT analysis characteristics can also be found outlined in Appendix D.

Project Design/Methods

The primary purpose of this project was to assess anesthesia students' understanding of cricoid pressure and its use, the utility of force measurement feedback during cricoid pressure training, and the effectiveness of mixed education and simulation at improving cricoid pressure knowledge and technique, while promoting the correct use thereof through educational intervention. Thus, the design was to utilize a pretest-posttest format, provide a hybrid educational/simulated training experience that incorporated a measurement of cricoid pressure force. The pretest-posttest primarily focused on quantitative data to be used as measures of knowledge of cricoid pressure both before and after the educational session. Cricoid pressure technique was evaluated through comparative measurement of force relative to the presence of real-time feedback in practice.

Population/Setting

This was done using a convenience sample of students in an accredited nurse anesthesia program from a private liberal arts university in the Midwest. These were doctoral students in their first year of matriculation, without clinical anesthesia experience, who were currently reviewing RSI in a simulation-based course. All of these students who completed the training and testing were considered the participants in this project. The class and training session were conducted at the university in a designated anesthesia simulation center.

Measurement Tools

A pretest questionnaire was created using the Qualtrics program (Appendix E) and included questions that had been tested for face and content validity by multiple anesthesia providers versed in RSI and cricoid pressure. This was distributed to the participants via email and recorded their answers. The survey included multiple choice, fill-in-the blank, and hotspot questions related to cricoid pressure use, technique, and localization. A common household bathroom scale with a digital numeric display was obtained and used to measure the amount of force in pounds of pressure placed on a manikin of an upper airway. For the purposes of this project, cricoid pressure values within a range of 6.75 to 9 pounds were considered appropriate equivalents to 30 to 40 Newtons.

Data Collection

The pretest link was sent out to participants within one week prior to the RSI review. The questionnaire link was distributed via email to prospective participants, who were instructed to fill out the survey prior to RSI simulation. Immediately following simulated RSI training, an additional five-to-ten-minute educational session specific to cricoid pressure was provided, and participants were asked to perform cricoid pressure on a manikin once without force feedback, once with, and once more without. A visual reminder of the conversion of Newtons to pounds for each value 10, 20, 30, and 40N was made available to participants during cricoid pressure placement. The measured force of actual pressure placement in pounds per the digital readout from the scale was recorded on paper by the project team during the training session and has been logged separately from the survey data. Participants were asked to fill out the posttest questionnaire moments after finishing cricoid pressure performance.

Ethical Considerations

Institutional Review Board (IRB) approval was obtained prior to initiating this DNP project. All participants were reminded of their right to refuse to participate in any and all components of the project. At no point was any personally identifiable information recorded about any of the participants. There was little risk of physical or emotional injury to participants, and danger was no greater than for routine simulated practice with RSI. They were not given any bonus, payment, or other coercion to participate. Participants were given all pertinent information prior to agreeing to be part of the project and submitted an implied consent prior to data collection. Participant data has all been stored on a secure laptop, accessible only to the project lead, and personal information was not utilized as part of the data collection. To keep the participant pretest-posttest data associated for statistical analysis, each participant was asked to create a personal code for both tests that consisted only of partial student identification numbers, of which the project lead did not have school server access and could not associate with any individuals. To keep the participant force measurement data impersonal but associated for analysis, random numbers were used to represent individuals, with a value of force obtained for all three attempts logged for each corresponding number. The project team will continue to hold the data on its secure password-protected computer log as its location for a maximum of two years before secure disposal.

Project Evaluation

Survey data collected via Qualtrics and cricoid pressure force data collected by hand have both been entered separately into Microsoft Excel for statistical analysis and were tested for significance between questionnaire answers before and after the training session, as well as force of pressure before, during, and after feedback. This was accomplished via paired T-testing for test scores before and after the educational session using a resulting *p*-value of 0.05 or less to indicate statistical significance. The scoring of individual questions has been analyzed in the same fashion to determine areas of strength and weakness of the educational session. The two values collected with the digital readout covered and one value with the digital readout visible were recorded for each individual project participant and these values have been tested for significance in the same manner as the survey data. All of the statistical analyses have been evaluated by the project team to determine the overall effectiveness of the hybrid educational/training session and improvement of cricoid pressure knowledge and technique.

Based on the calculations from paired t-testing of questionnaire results and separate t-testing of force measurement before and after feedback, the data comparison is quantifiable. Having descriptive and inferential statistical values to evaluate the success in all avenues of the project, the project team was able to develop conclusions about the success or failure of the interventions provided. Looking at mean and median values, averages were calculated to represent the participant population as a whole. Making inferences using $p<0.05$ to determine significance, changes in score or accuracy were assessed for any correlation with the instruction provided.

Positive correlation for the survey, reflected by an improvement in scores on the questionnaire, would have indicated the educational intervention improved knowledge and understanding of cricoid pressure. Positive correlation of force measurement, determined not by increased value of force, but by increased accuracy of force relative to 30-40N of pressure, would have indicated that the force feedback improved cricoid pressure technique. If both of these interventions have proven to be successful at yielding both of these positive changes, the project team would have been able to conclude the hybrid educational/simulated training is an effective means of teaching cricoid pressure to anesthesia students. If the intervention was unsuccessful, this still developed the anesthesia provider community's understanding of cricoid pressure education and can help to direct future endeavors at improving practice in this arena. If the intervention was successful, this method of training may provide an affordable, safe, and efficient approach that could help to standardize education on this matter and translate this into improvement in patient outcomes in the clinical setting.

Data Analysis/Results

The primary data for this project came from two separate sources: the questionnaire answers and the force measurements. The pretest questionnaire was sent to 33 and completed by 32 first-year nurse anesthesia students at Marian University in Indianapolis, with six students declining to complete the posttest within the allotted testing window. This reduced the sample size to 26 for the purposes of comparative analysis. Of the same sample of students polled, all 33 participated in the simulated training, educational session, and practice with force measurement, providing the second set of data. Questionnaire answers and measurements of force in pounds of pressure were compiled and tested for significant changes before and after intervention via T-testing. Table 1 below outlines the statistical data collected from the questionnaire, and Table 2 outlines the statistical data collected from the measurement of force applied to the airway manikin. All analyses were conducted by testing for significance determined by a p-value < 0.05.

Table 1

Pretest-Posttest Questionnaire Results (n=26)

Question Number by Topic	Number of correct responses: Pretest *n*	Pretest %	Posttest *n*	Posttest %	*p*-value:
	Locating the cricoid cartilage				
Question 2	13	50	8	30.8	0.134
Question 3	11	42.3	20	76.9	0.004
	Amount of force applied				
Question 4	12	46.2	24	92.3	< 0.001
Question 10	14	53.8	22	84.6	0.03
	When to use or avoid cricoid pressure				
Question 5	2	7.7	10	38.5	0.003
Question 6	7	26.9	12	46.2	0.096
Question 8	7	26.9	7	26.9	1
Question 11	15	61.5	18	73.1	0.265
	Cricoid pressure technique				
Question 7	7	26.9	21	80.8	< 0.001
Question 9	24	92.3	26	100	0.161
	General information about cricoid pressure				
Question 12	22	84.6	26	100	0.043
	Average level of comfort with cricoid pressure				
Question 1	"Somewhat doubtful" to "Neutral or Unsure"		"Somewhat confident" to "Very confident"		< 0.001
	Average Total Score				
	47.9%		69.1%		< 0.001

Posttest total scores improved upon pretest values from an average of 47.9% to 69.1%, with a p-value of < 0.001. Significant improvement was determined in more than half the questions asked, and at least one question in every topic area. Scores decreased on the posttest for question 2 regarding the location in which to place cricoid pressure on a picture of a human neck. All other question score averages either improved or stayed the same. Questions 2, 6, 8, 9, and 11 were not significantly improved on the posttest, though every participant answered question 9 correctly. Overall confidence in one's own ability to perform cricoid pressure improved, with every participant stating either "somewhat confident" or "very confident" on the posttest questionnaire.

Table 2

Force Measurement Manikin Data (n=33)

Measured Amount of Force	Attempt number		
	Pressure #1 (Blind)	Pressure #2 (Feedback)	Pressure #3 (Blind)
Average pressure applied (lbs)	10.88	9.25	7.11
Average deviation from target range (6.75-9 lbs)	4.53	2.3	1.42
Changes in Force Across Attempts	Attempt number comparison		
	Pressure #1 (Blind) to Pressure #2 (Feedback)	Pressure #1 (Blind) to Pressure #3 (Blind)	Pressure #2 (Feedback) to Pressure #3 (Blind)
Change in pressure	$p = 0.14$	$p = 0.002$	$p = 0.019$
Change in deviation from target range (6.75-9 lbs)	$p = 0.012$	$p < 0.001$	$p = 0.28$

The average force from the first to the third attempt in succession was 10.88, 9.25, and 7.11 pounds of pressure. The average deviation from the goal range of 6.75 to 9 pounds of pressure from the first to the third attempt in succession was 4.53, 2.3, and 1.42 pounds of pressure. The difference in pressure from attempt 1 and attempt 2 to attempt 3 was significant ($p = 0.002$ and $p = 0.019$), but the difference between attempt 1 and attempt 2 was not significant ($p = 0.14$). The change in deviation from the goal range was significant from attempt 1 to attempt 2 and attempt 3 (p – 0.012 and $p < 0.001$) but was not significant between attempts 2 and 3 ($p = 0.28$).

Discussion

The increase in total score on the questionnaire suggests a generalized improvement in knowledge about cricoid pressure is related to the simulated training, educational session, and hands-on practice provided. Some questions, specifically numbers 2, 6, 8, 9, and 11, showed no significant change in score, which implies that the subject matter of those questions was less effectively retained by the participants compared to that of the questions in which improvement was statistically significant. Of those questions, three of them pertained to situations in which to use or to avoid the use of cricoid pressure.

Based on the overall significant improvement of scores and the specific categories in which improvement was deemed statistically significant, the hybrid intervention was successful at teaching cricoid pressure use and technique to the participants. The posttest average scoring of 69.1% offers more room for improvement, but the directional change was a net positive. The notable area in which the intervention did not improve knowledge of cricoid pressure was the identification of times when cricoid pressure is indicated versus contraindicated, and the ability to locate the cricoid cartilage on a picture of a human neck. These were demonstrated by score decreases or limited increases, with no significant changes found between pretest and posttest values. This affords opportunity to improve upon either the intervention, the questionnaire, or both to fill these gaps.

The manikin practice data provided a more distinct global improvement. Average force of pressure started at 10.88 pounds of pressure, outside the range of 6.75 to 9 pounds that equates to the accepted values of 30 to 40 Newtons. The second attempt allowing for view of real time pressure feedback still fell outside this range at 9.25 pound, but the final blinded attempt averaged within the target range, at 7.11 pounds of pressure. This was significantly improved from both the first and second attempts ($p = 0.002$, $p = 0.019$), which suggests that repeating the cricoid pressure attempts was successful at improving the participants' ability to reach the target value.

The average deviation outside the target range shrunk with each attempt, from 4.53 pounds to 2.3 pounds to 1.42 pounds. While the final blind attempt had significantly less deviation from the target range than the first blind attempt ($p < 0.001$), it was not significantly less than the deviation of the attempt that included feedback ($p = 0.28$). This information implies that providing feedback was a necessary step in improving the participants' ability to reach the target range. The implication of this is that providing a method to practice a force of digital pressure that provides feedback is imperative to ascertaining the correct amount of pressure in situations without an available measurement, such as the actual clinical use or cricoid pressure. Overall, the hybrid simulation, educational session, and practice pressure with feedback served to improve the participants' understanding of and ability to perform cricoid pressure. The questionnaire and/or the educational session could still use some fine tuning to improve outcomes further, but as a model for future educational interventions on this topic, this affordable and reproducible method has shown to be a viable option.

Strengths and Limitations

Some of the strengths of this project were that it required little monetary or human capital and would be relatively simple to replicate. On the scale of an individual university, it would require a thorough understanding of cricoid pressure and the time and resources to teach, demonstrate, and practice cricoid pressure on an airway manikin. The availability of these at the project site was helpful in creating a cohesive project setting and testing the reliability of the pressure output readings on the manikin prior to participant involvement. Combining the RSI simulation class with the education and training session was especially valuable for synergizing the topics and maximizing participation in the intervention. Limitations to the project were relative to the timeframe given. The window of time between project approval and the scheduled RSI simulation class was narrow, allowing little time for participants to fill out the pretest questionnaire in advance of the intervention. The educational session itself was not fully scripted or recorded and may not have been the same for each participant, increasing the variability of its effectiveness. The questionnaire was viewed and validated by a select few CRNAs with experience and expertise performing cricoid pressure, but the verbiage may not have been universally clear and certain questions could still have been subject to individual interpretation.

Conclusion

After reviewing the body of research presently available about the use of cricoid pressure, it is clear that improper placement is at best a hinderance to achieving endotracheal intubation, and at worst, dangerous or damaging to the patient. It is performed incorrectly more often than not and does not have a standardized training, yet it is still widely utilized in anesthesia practice and has no accepted alternative. Areas of failing in particular are the accuracy of placement and amount of force of cricoid pressure, and this project was developed in an attempt to test a method of standardizing the education and training of cricoid pressure to aspiring anesthesia providers. In combining simulated RSI training with specific education about cricoid pressure, questionnaire results improved from baseline in a significant way, though with room for further enhancement. Providing repeated practice with actual application of force and allowing for participants to view the measurement of that force yielded more effective changes still, improving the likelihood of reaching the target force that correlates with appropriate cricoid pressure without continued visual feedback. These have been determined to beget positive changes in participants' knowledge of and ability to place cricoid pressure as per the project aim.

Overall, this project has determined that force of pressure can be taught with a few short practice attempts, particularly in which feedback is permitted at least once. Also, knowledge of cricoid pressure utility and technique can be taught with simulated RSI training and a brief educational presentation. This is not to say this is a guaranteed success, but that these interventions can effectively improve current levels of understanding. Future studies may consider more finite or specific areas of knowledge to improve upon in order to refine the educational intervention further. A more thoroughly vetted educational tool and/or questionnaire may be merited for practice standardization, but this project shows that standardized education using these techniques is possible and would make a difference. Eventually this would likely yield better patient outcomes through the avoidance of excessive or subtherapeutic levels of pressure and knowledge of situations in which cricoid pressure is or is not indicated. As the first step in future research on the subject, a standardized education could also lead to a conclusive answer as to the efficacy of cricoid pressure as a clinical technique.

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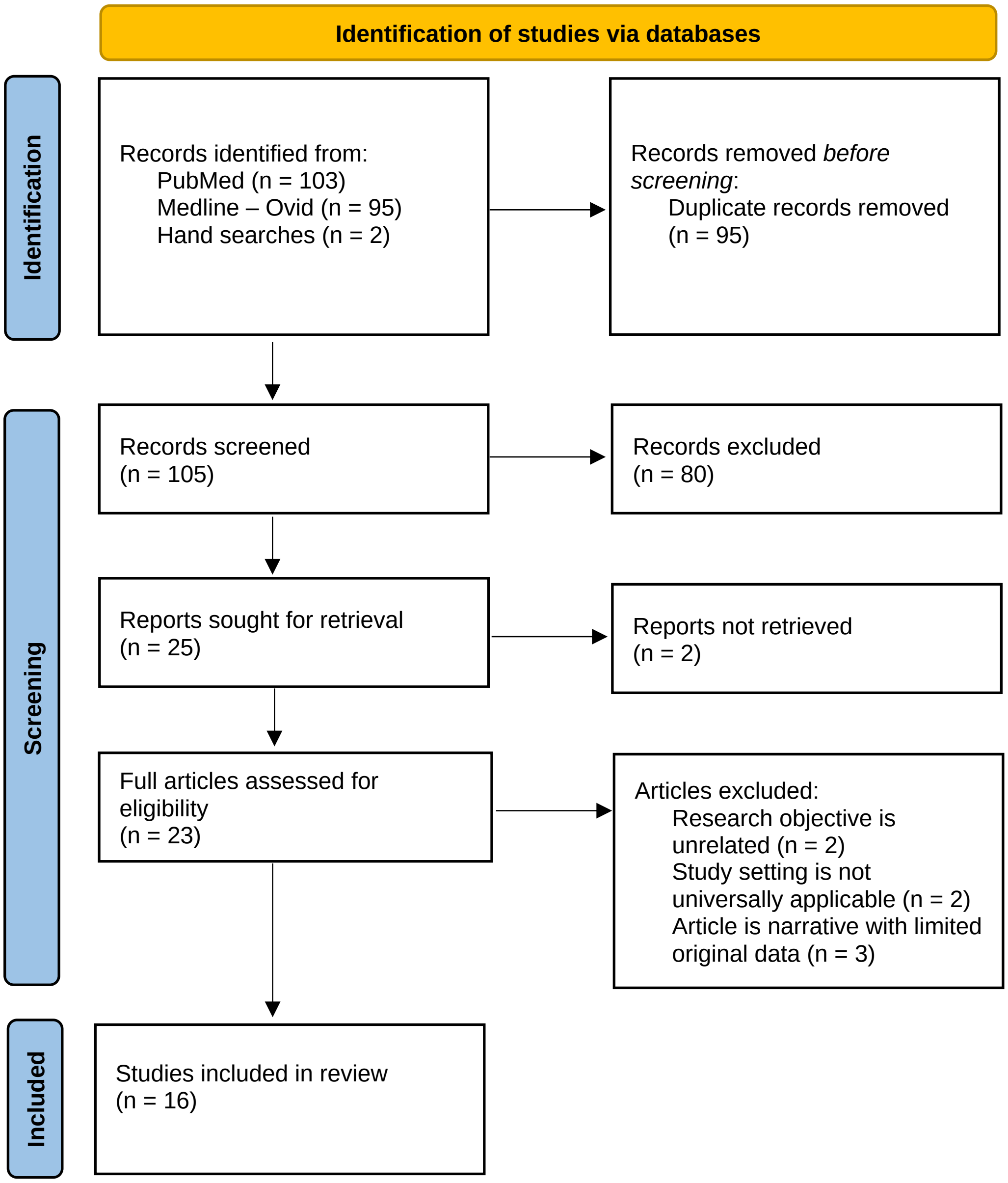
Appendix A


Identification of studies via databases
Identification
Records identified from:
PubMed (n = 103)
Medline – Ovid (n = 95)
Hand searches (n = 2)
Records removed *before screening*:
Duplicate records removed
(n = 95)
Screening
Records screened
(n = 105)
Records excluded
(n = 80)
Reports sought for retrieval
(n = 25)
Reports not retrieved
(n = 2)
Full articles assessed for eligibility
(n = 23)
Articles excluded:
Research objective is unrelated (n = 2)
Study setting is not universally applicable (n = 2)
Article is narrative with limited original data (n = 3)
Included
Studies included in review
(n = 16)

Appendix B

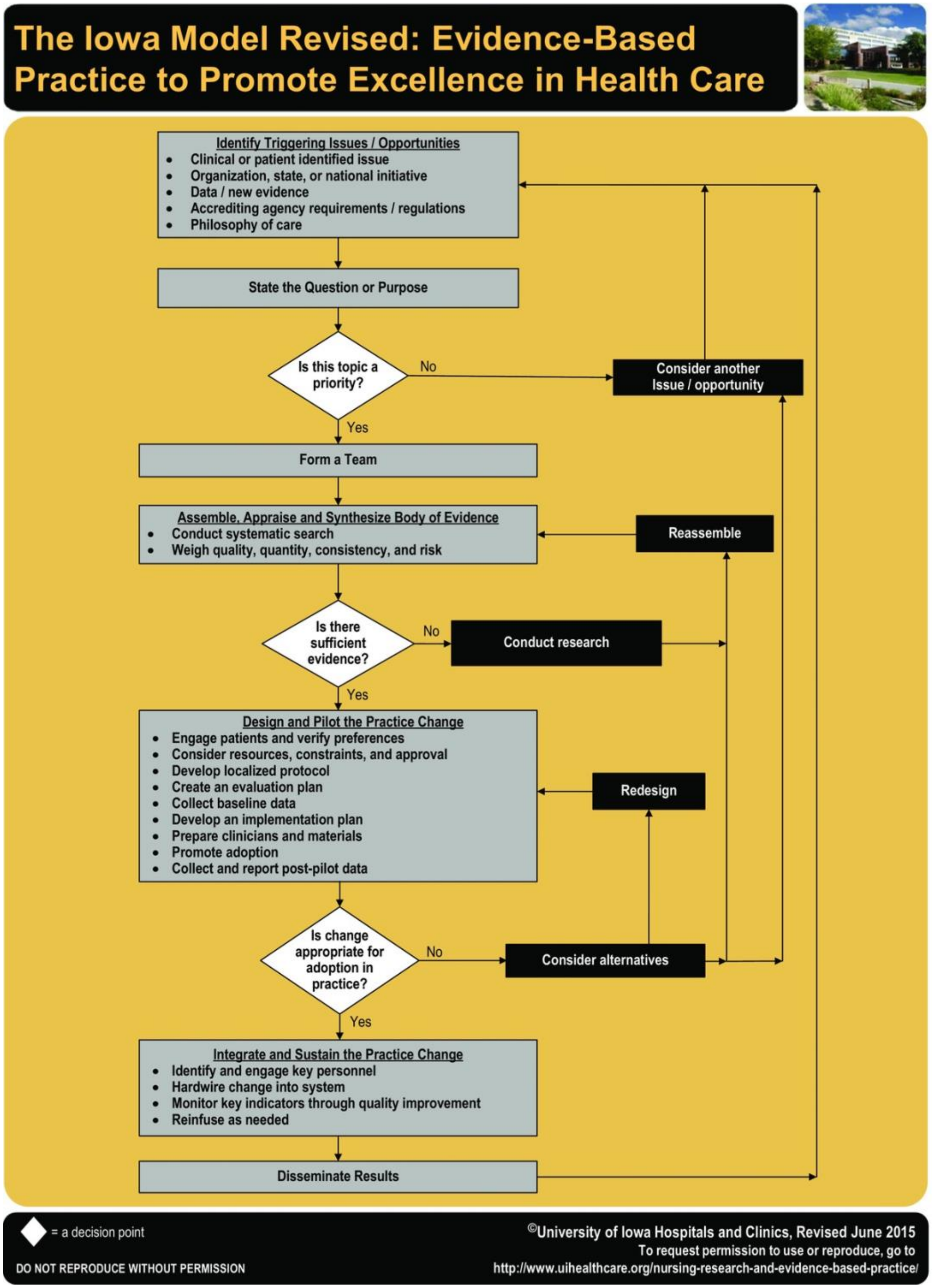
Reference	Research Design & Level of Evidence	Population/Sample n=x	Variables	Instruments/Data Collection	Results
Andruszkiewicz et al., 2017	Non-experimental prospective observational study; level 4	n=206; anesthetists and anesthetic nurses	Occupation, identification of cricoid cartilage, amount of force applied; prior knowledge of cricoid pressure	Laerdal® airway model; electronic weight scale; 2-attempts at pressure placement	49% correct identification of cricoid cartilage; 16.5% correct pressure first attempt; 20.4% correct pressure second attempt; 18% knowledge of correct amount of pressure (p<.001)
Beckford et al., 2018	Systematic review & meta-analysis; level 1	n=8; studies included from database searches	Designs and results of individual studies; selection criteria for analysis; accurate application of cricoid pressure; educational intervention	7 databases searched; Fisher's combined probability testing; R-statistical software	Data compiled and tested against each other to determine that simulated and/or educational training has a statistically significant correlation to improved application of cricoid pressure (p<.001)
Birenbaum et al., 2019	Randomized clinical trial; level 2	n=3472; patients over 18 years age, requiring RSI	Application of pressure or sham procedure; incidence of pulmonary aspiration; incidence of secondary morbidities; intubation time; Cormack & Lehane laryngeal view grade	Training session with occluded 50mL syringe; randomized assignment software; pulmonary aspiration as determined by visualized gastric contents at glottic level or diagnosed tracheal aspiration	Longer intubation times and poorer laryngoscopy views were seen with cricoid group (p<.001). No significance was found for difference in any morbidity (all p≥.28) or positive case of aspiration (p=.14)
Bohman et al., 2018	Randomized clinical trial; level 2	n=95; surgical patients "at-risk" for microaspiration	Application of cricoid pressure; presence of pepsin A in gastric contents; ventilation difficulty; laryngoscopy difficulty, incidence of pots-surgical pulmonary disease	Sampled secretions from the lower airway; pepsin A presence in lower airway secretions; measured pepsin A concentration > 0.1 ng/mL	No reduction in pepsin A in the lower airway with cricoid pressure (p=.529). 19% patients developed microaspiration, 8.5% from each group, and 2% that received intermittent treatment (p=.748).

Fischer et al., 2018	Randomized controlled trial; level 2	n=118; fourth to sixth year medical students	Format of training provided; numeric examination scores; exam topic; rated satisfaction with training method	PowerPoint video training; Mentice VIST-Lab coronary angiography simulator training; 40 question multiple-choice exam including varying topics; student satisfaction questionnaire	Simulation group scored higher overall: 59.8 points versus 43.8 points (*p*<.001), and in each exam topic: (all *p*<.001). Satisfaction scores higher in the simulation group at 98% compared to 75% (*p*<.001).
Hee et al., 2020	Quasi-experimental cross-sectional study; level 3	n=22; anesthetic nurses	Presence of real-time feedback during pressure application, force of application, reproducibility of cricoid pressure technique	Laerdal® Airway Management Trainer manikin placed; electronic weight scale; biofeedback sensor system; computerized visual display	81.1% and 88.3% of attempts achieved target force with real-time feedback whereas the non-feedback group achieved the target 26.5% and 33.3% of the time (*p*<.001).
Lee et al., 2018	Quasi-experimental prospective study; level 3	n=100; elective surgical patients undergoing general anesthesia	Use of palpation and landmarks; location of finger placement; distance from actual cartilage; BMI; age; sex	S-Nerve™ Ultrasound; craniocaudal midpoint of the cricoid cartilage; skin marker with measuring scale; recorded demographic information including height, weight, age, and gender	Distance from cricoid cartilage greater than 5mm in 41% of patients. No significant relation between this and BMI (*p*=.539), age (*p*=.843), or sex (*p*=.138).
Lim et al., 2021	Quasi-experimental cross-sectional study; level 3	n=51; elective surgical patients undergoing general anesthesia	Anatomical alignment of esophagus; use of cricoid pressure vs paralaryngeal pressure (PLP) with ultrasound; esophageal occlusion	SonoSite M-Turbo Ultrasound with HFL38x probe; visualized compression of esophagus under both pressures	Cricoid pressure occluded 27% of laterally displaced esophagi to PLPs 30% (*p*=1.0). 100% of midline esophagi achieved occlusion with cricoid pressure
Noll et al., 2019	Quasi-experimental pretest-posttest; level 3	n=100; clinicians who have to perform cricoid pressure routinely	Practice with a force measurement or not; number of attempts at pressure; amount of force applied	Model trachea and larynx; Vernier Software & Technology Model FP-BTA force plate, force recording computer interface	After four attempts with a force measurement, success rate increased by 16% (*p*<.001). Each successive attempt in simulation environment had a larger success rate (*p*<.001) through all 30 cycles performed.

Pellrud & Ahlstrand, 2018	Randomized controlled trial; level 2	n=17; healthy student volunteers	Placement of cricoid pressure; upper esophageal sphincter (UES) pressure; proximal esophagus pressure; alfentanil vs placebo administration	High-resolution solid-state manometry nasal catheter; medications to administer: IV alfentanil, IV saline (placebo), IV propolipid	No significant differences in pressures relative to medication administered (all *p*.>.05). Average UES pressures increased from 44-46mmHg to 167-173mmHg with determined 30N of pressure.
Qasem et al., 2019	Non-experimental prospective observational study; level 4	n=53; caregivers involved in patient airway management	Occupation of clinician; accuracy of locating cricoid cartilage; speed of locating cricoid cartilage; patient BMI	SonoSite MicroMaxx linear array ultrasound; Invisible Ink Spy Pen with Built in UV Light Magic Marker; 30 random volunteer subjects and their airway surface landmarks	Overall success of locating the cricoid was 42%. 60% of respiratory therapists (RTs), 53% of anesthesia residents, 40% of anesthesia consultants, and 13% of nurses were successful. No significant noted across professions (all $p>.05$). RTs were significantly faster than: consultants ($p<.001$), residents ($p=.002$), and nurses ($p=.071$).
Trethewy et al., 2017	Randomized controlled trial; level 2	n=54; patients presenting to ED requiring RSI to intubate	Measured force of cricoid pressure before & during intubation; presence of real-time feedback; incidence of aspiration	Cricoid pressure instructional video; Model PT270 platform scale with mounted liquid crystal display; Photologic serial data logger	Both groups able to achieve adequate pressure; no significant difference between feedback group and blind group ($p=.416$). Both groups fell outside recommended pressure during intubation; no significance between groups ($p=.742$). About 13% of patients had aspiration after.
White et al., 2020	Systematic review & meta-analysis; level 1	n=12; studies included from database searches	Designs and results of individual studies; selection criteria for analysis; incidence of aspiration; time to intubation; use of cricoid pressure	5 databases searched; RevMan 5.3 data analysis software; Mantel-Haenszel random effects model	Data compiled and tested against each other to determine that cricoid pressure application had no significant reduction in incidence of aspiration ($p=.51$) Time to intubation significantly increased with cricoid pressure ($p<.001$).

Williams & Umranikar, 2017	Quasi-experimental comparative prospective cohort study; level 3	n=30; anesthetic and non-anesthetic surgical nurses	Ultrasound guidance for locating the cricoid cartilage or surface landmarks; distance to target, patient body mass index, age, sex, neck circumference, and cricoid depth	GE LOGIQ Ultrasound probe; InvisibleWriter invisible ink marker; red dot stickers; 10 volunteer elective surgery patients	Median distance away from target was 10mm. Large neck circumference was found to have greater distance from target as was larger body mass index, although associations were not significant (*p*=.243) and (*p*=.285).
You-Ten et al., 2018	Randomized controlled trial; level 2	n=15; anesthesia residents, fellows, and assistants	Practice with or without ultrasound; distance from cricothyroid midpoint; use of surface landmarks	Zonare Medical System, Inc, portable ultrasound; invisible ink; 10 human volunteers and their surface airway landmarks	Median accuracy rate of ultrasound group was 65% to the non-ultrasound groups' 30% (*p*=.025) and its mean distance from the target was 3.6mm to the non-ultrasound groups' 6.8mm (*p*=.001).
Zeidan et al., 2017	Quasi-experimental prospective study; level 3	n=60; surgical patients undergoing general anesthesia	Patient gender; ability to insert a gastric tube; amount of cricoid pressure force	20F gastric tube; Glidescope video laryngoscope; cricometer force measurement	Mean force required to occlude the esophagus and prevent gastic tube insertion was 18.7N for women and 30.8 for men (*p*<.001)

Appendix C



(Iowa Model Collaborative, 2017)

Appendix D

SWOT ANALYSIS TEMPLATE

STRENGTHS

- Easily reproducible
- Cost effective with few resources required
- Relevant to current practice
- Potential to improve anesthesia practice
- Efficient/Timely
- Few to no risks for participants

WEAKNESSES

- Small size
- Decreased generalizability
- Short-term follow-up only
- Limited data/results
- Program specific

OPPORTUNITIES

- Examine a multifaceted educational approach (simulation, education, specific measured parameters)
- Benefit future providers and their patients
- Promote standardized approach for future studies on cricoid pressure
- Increased awareness of present cricoid pressure controversy
- Adjunct education for rapid sequence inductions

THREATS

- Decreased participation would hinder results
- Potential for skewed results secondary to sample size
- Limited time available for training sessions
- Schedule conflicts or other unavoidable absences could further limit results

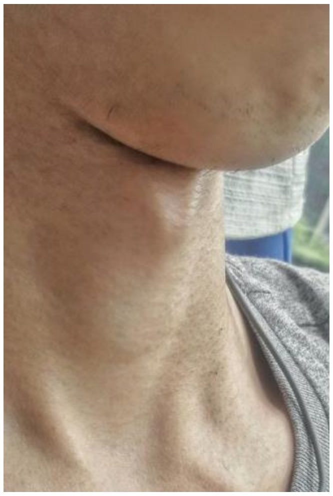
Appendix E

Please create a four-character unique test code using the last 4 numbers of your Marian student ID.

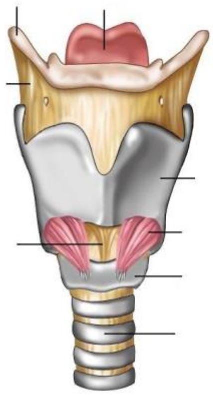
_ _ _ _

1. How confident do you feel that you can correctly place cricoid pressure during rapid sequence induction?
- Very confident
- Somewhat confident
- Neutral or Unsure
- Somewhat doubtful
- Very doubtful

2. Place the indicator mark on the location where cricoid pressure should be applied (Nagelhout & Elisha, 2018)



3. Place the indicator mark on the location where cricoid pressure should be applied (Nagelhout & Elisha, 2018)



4. How much force in Newtons should you apply after the patient is unconscious for proper cricoid pressure placement? (Nagelhout & Elisha, 2018)

____

5. Which of the following surgical patients receiving general anesthesia would require rapid sequence induction with cricoid pressure placement? (Nagelhout & Elisha, 2018)

- Morbidly obese patient with history of obstructive sleep apnea and hypothyroidism
- Elderly patient with paroxysmal atrial fibrillation not on blood thinners presenting with hip fracture
- 24-week gestation parturient with biliary obstruction who is actively vomiting
- Patient with uncontrolled diabetes presenting with neuropathic gangrenous foot for amputation

6. Which of the following precludes the use of cricoid pressure during rapid sequence induction? (Landsman, 2004)

- Esophageal stricture
- Difficult mask ventilation
- Cervical spine instability
- All of the above

7. Rank these events in chronological order: (Landsman, 2004)

- Cricoid pressure placed on the cricoid cartilage
- Force of 30-40N applied to the cricoid cartilage
- Cricoid pressure released from the cricoid cartilage
- Anesthesia induction and loss of consciousness
- Endotracheal tube insertion
- Confirmation of endotracheal tube placement

8. True or False: When encountering difficulty intubating while performing RSI with cricoid pressure, pressure should not be released until intubation is confirmed. (Hines & Jones, 2021)

- True
- False

9. True or false: Placement of cricoid pressure 20N or more on an awake patient can cause gagging or pain (Landsman, 2004)

- True
- False

10. Cricoid pressure placed in which manner can result in increased difficulty attaining laryngeal view and longer time to achieve intubation? (Select all that apply) (Nagelhout & Elisha, 2018)

- Not directly on the cricoid cartilage
- Force of pressure greater than 40N
- Force of pressure less than 30N

11. Which of the following is NOT a surgical scenario in which cricoid pressure is merited? (Nagelhout & Elisha, 2018)

- Exploratory laparotomy following a motor vehicle accident
- Emergency surgery without time to abide by NPO guidelines
- Laparoscopic gallbladder removal with intraoperative cholangiogram
- C-section requiring general anesthesia

12. What is another term for cricoid pressure? (Nagelhout & Elisha, 2018)

- Muller's maneuver
- Larson's maneuver
- Valsalva's maneuver
- Sellick's maneuver