11-23-2021

An Educational Module of the Effect of Improved/Increased Training of Anesthesia Providers on Adherence to Difficult Airway Algorithms and Successful Performance of a Cricothyrotomy

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An Educational Module of the Effect of Improved/Increased Training of Anesthesia Providers on Adherence to Difficult Airway Algorithms and Successful Performance of a Cricothyrotomy

A DNP Project Presented to the Faculty of the
Nicole Wertheim College of Nursing and Health Sciences

Florida International University

In partial fulfillment of the requirements
For the Degree of Doctor of Nursing Practice

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Approval Acknowledged _____, DNA Program Director

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Abstract

Airway complications, including those that may be caused by the inability to maintain oxygenation, are major causes of anesthesia-related injury and death. Difficult intubation rates are relatively high with even higher associated complication rates. The success rate for cricothyrotomy procedures is also inappropriately low. Research has found that a lack of experience and/or insufficient training possibly plays a role in the low success rate and increased incidence of airway complication-associated morbidity and mortality. The purpose of this study is to assess current training and confidence levels in practitioners as well as to evaluate the impact of improved training, sustained training or interval training. Since CICO situations and emergency cricothyrotomies are rare, independent work experiences are vital in order to preserve appropriate provider awareness and abilities. Improving the standard of difficult airway management, CICO guidelines, and cricothyrotomy efficiency training is expected to boost provider ability and confidence, resulting in less deviations from the DAA and hesitancy during CICO situations, as well as lower anesthesia-related morbidity and mortality, hospital costs, and duration of stay.

INTRODUCTION

Description of Problem

The major causes of anesthesia-related injury and death are airway complications.[1,2] Such complications may be caused by inability to maintain oxygenation.[3] In a 2005 closed-claims analysis, more than 50% of the recorded perioperative claims and all claims for incidents out of the operating room (OR) resulted in brain injury or death due to ineffective oxygenation.[4] It is necessary to consider what can lead to such events in order to reduce these airway related complications. Poor Oxygenation is attributed to difficulty securing a definitive airway. The 2013 American Society of Anesthesiologists (ASA) practice guidelines define a difficult airway as an occurrence in which mask ventilation, tracheal intubation or both are difficult for a trained anesthesia provider to manage.[5] It is not easy to predict a complicated airway. Unexpected difficult airways continue to be a problem for anesthesia providers since predictors are not 100% accurate.[1,2] For example, the Mallampati score is a graded 4-level pictorial scale generated to predict difficult intubation before general anesthesia.[6] The Mallampati assessment provides a score of 1-4 based on the anatomic descriptions of the patient's airway. A Mallampati 1 describes an airway where all anatomical structures are visible when the patient opens their mouth and presumes an "easy airway". A Mallampati 4 describes an airway where only hard palate is visible when the patient opens their mouth and posits a "difficult airway". However, The Mallampati score is not enough to predict a difficult airway.[6] A Mallampati 1 patient can have a difficult airway due to a variety of other factors. The Mallampati score is proposed to complement, but not substitute, the baseline clinical decision of a general multidimensional airway assessment.[6] This assessment includes a history and physical examination of the craniofacial structures to distinguish risk factors such as short neck, obesity, obstructive sleep apnea, long upper incisors or overbite, limited mouth opening, micrognathia, macroglossia, laryngomalacia, tonsillar hypertrophy, airway edema, blood or vomit in the airway, cervical immobility, and facial or neck trauma.[6] Although thorough, it is important to recognize that the reliability of this

airway assessment can sometimes be obscured or limited by emergency circumstances, compromised patient cooperation, and unknown or incomplete medical history.[6] Reports show that in patients who do not have any difficult airway indicators, there is a 6.2% incidence of difficult intubation.[4] Difficult airway scenarios can easily lead to emergencies, raising the risk of fatal complications or death.[7] A "cannot intubate, can not oxygenate" (CICO) airway emergency can result from an unforeseen difficult intubation. Researchers have demonstrated that practical preparation can assist practitioners in managing an unexpected difficult airway.[8]

Background

With the occurrence of difficult intubation ranging from 9% to 12% and complications rates ranging from 4.2% to 28%, emergent airway management outside of the OR is especially difficult.[9,10,11] In some hospitals, adverse airway incidents frequently rank among the leading 5 adverse events.[12] Brain injury or death were cited in half of all perioperative claims and all claims outside of the OR according to a 2005 closed claims analysis.[1] The associated payments for these claims ranged from $2,200 to $8,500,000.[13] Improved morbidity & mortality will directly convalesce patient satisfaction as a result of enhanced recovery and outcomes. Studies revealed the success rate for cricothyrotomy in CICO situations to be 74% with a survival rate of 48%.[3] The success rate for cricothyrotomy procedures leaves great room for improvement.

Possible Contributing Factors

Research has found that a lack of experience and/or insufficient training possibly plays a role in the low success rate and increased incidence of airway complication-associated morbidity and mortality.[8,14,15] Research has demonstrated that practical preparation in cricothyrotomy results in decreased deviations from the ASA difficult airway algorithm but also resulted in delayed calls for help.[8]

Objectives of the systematic review

The aim of this systematic review is to classify available evidence and analyze the results of each study regarding the training of anesthesia providers and the performance of difficult

airway management and cricothyrotomy performance. The purpose of this analysis is to assess current training and confidence levels in practitioners and success rates of performance as well as to evaluate the impact of improved training, sustained training or interval training. This systematic review includes RCTs, Meta-analyses and systematic reviews whose findings will ultimately be used to suggest improved training/simulation and/or interval training to maintain psychomotor skills and critical thinking during these rare, emergency situations. This systematic review answered the PICO question: Does improved/increased training (I) of anesthesia providers (P) decrease deviations from difficult airway algorithms and improve cricothyrotomy success rates (O) compared to current training practices (C)?

DEFINITION OF TERMS

CRNA (CRNA) is an advanced practice nurse who administers anesthesia during surgery or other surgical treatments.

Cannot Intubate, Cannot Oxygenate (CICO) Situations A situation in which the healthcare provider is unable to intubate the patient or ventilate the patient to provide adequate oxygenation.

Difficult Airway Algorithm systematic guidelines designed by the ASA to facilitate the management of a difficult airway and to reduce the likelihood of adverse outcomes.

Cricothyrotomy an incision created into the skin and cricothyroid membrane to produce a patent airway in some life-threatening cases, such as airway obstruction by a foreign body, angioedema, or major facial trauma,

REVIEW OF THE LITERATURE

Methodology of Literature Review

A literature search was conducted limiting results to full-text articles of English language. A combination of search terms related to Population, training and outcomes were entered into CINAHL, Medline (ProQuest) and PubMed. Table 1 lists the terms in each search category. The

combination of searches yielded a total of 34 results for the CINAHL database, 114 results for the Medline (ProQuest) database and 106 results for the PubMed database.

Table 1. Database Search

	Population	Training	Outcome	Filters	Results
CINAHL	Anesthesia OR Anesthesia provider* OR clinicians OR practitioner* OR Anesthetist* OR Anesthesiologist* or CRNA* OR Registered nurse anesthetist* OR MDA*	training OR education OR simulation OR confidence OR "interval training" OR "Continuing education" OR "Continued education" OR "frequent training"	"surgical airway" OR "Cricothyrotomy performance" OR "Deviations from difficult airway algorithm" OR "Deviations from DAA" OR "cricothyroidotomy performance" OR "Cannot Intubate cannot oxygenate" OR "CICO" OR "Cannot intubate Cannot Ventilate" OR "Difficult airway situations" OR "Difficult airway scenarios" OR "difficult airway events"	Full-Text Article English Language	34 Results
Medline (Proquest)	Anesthesia OR Anesthesia provider* OR clinicians OR practitioner* OR Anesthetist* OR Anesthesiologist* or CRNA* OR Registered nurse anesthetist* OR MDA*	training OR education OR simulation OR confidence OR "interval training" OR "Continuing education" OR "Continued education" OR "frequent training"	"surgical airway" OR "Cricothyrotomy performance" OR "Deviations from difficult airway algorithm" OR "Deviations from DAA" OR "cricothyroidotomy performance" OR "Cannot Intubate cannot oxygenate" OR "CICO" OR "Cannot intubate Cannot Ventilate" OR "Difficult airway situations" OR "Difficult airway scenarios"	Full-Text Article English Language	114 results

			OR "difficult airway events"		
PubMed	Anesthesia OR Anesthesia provider* OR clinicians OR practitioner* OR Anesthetist* OR Anesthesiologist* or CRNA* OR Registered nurse anesthetist* OR MDA*	training OR education OR simulation OR confidence OR "interval training" OR "Continuing education" OR "Continued education" OR "frequent training"	"surgical airway" OR "Cricothyrotomy performance" OR "Deviations from difficult airway algorithm" OR "Deviations from DAA" OR "cricothyroidotomy performance" OR "Cannot Intubate cannot oxygenate" OR "CICO" OR "Cannot intubate Cannot Ventilate" OR "Difficult airway situations" OR "Difficult airway scenarios" OR "difficult airway events"	Full-Text Article English Language	106 results

Study Selection and Screening Method with inclusion/Exclusion Criteria

Table 2. Inclusion and Exclusion Criteria

Inclusion	Exclusion

• Population:
  ○ Anesthesiologists
  ○ Anesthesia Residents
  ○ Certified Registered Nurse Anesthetists (CRNAs)
  ○ Student Nurse Anesthetists
  ○ Post Graduate Residents
  ○ ENT residents/surgeons
  ○ EM physicians
  ○ Trauma physicians
• Intervention:
  ○ Stand-alone assessments of prior training
  ○ Stand-alone assessments of current management of difficult airways
  ○ Stand-alone assessments of current cricothyrotomy performance
  ○ Before and after additional training assessments of difficult airway management
  ○ Before and after additional training assessments of cricothyrotomy performance
• Outcomes:
  ○ Practitioner confidence levels in management of difficult airways
  ○ Practitioner confidence levels in cricothyrotomy performance
  ○ Deviations from difficult airway algorithms
  ○ Cricothyrotomy performance success rates
  ○ Cricothyrotomy performance times
• Type of Study:
  ○ Randomized Controlled Trials
  ○ Systematic reviews
  ○ English language
  ○ Meta-analyses
	• Population:
	  ○ Medical Students
	  ○ Practitioners who do not practice anesthesia or airway management
	• Intervention:
	  ○ Specific Cricothyrotomy techniques
	  ○ Anything other than difficult airway algorithms and cricothyrotomy performance
	• Outcomes:
	  ○ Anything other than practitioner confidence levels, deviations from difficult airway algorithms and cricothyrotomy success rates
	• Type of Study:
	  ○ Non-English
	  ○ Dissertations

DISCUSSION OF LITERATURE REVIEW

Summary of Evidence

The opportunity to reduce airway complications and increase the cricothyrotomy success rate summons an important practice question: Would interval and/or improved training improve adherence to difficult airway algorithms and improve the success rate and decrease time of performing a cricothyrotomy? This practice problem affects all anesthesia providers including Medical Degree Anesthesiologists and Certified Registered Nurse Anesthetists. Anesthesia provider training is often limited to the time they have in the program. Considering total coursework and other skills and responsibilities they must cover; it can be assumed that not much time is spent in difficult airway management and cricothyrotomy performance. Once in practice, the limited opportunities to perform the procedure can result in skill and knowledge deterioration. The role of simulation and its effective use in training experienced practitioners to improve adherence to emergency airway guidelines may be relevant to improving provider confidence and outcomes during difficult airway situation.[4, 8, 16, 18, 19, 22] The repetition of simulated CICO situations may be useful for improving adherence to DAA and help providers recall steps in cricothyrotomy performance.[15] Researchers found that general experience does not improve cricothyrotomy success rates but increasing actual Cricothyrotomy experience improves success rates and decreased performance times.[20, 21] This finding may translate to interval training and simulation being useful to improving difficult airway management and airway rescue procedure performance times.[20,21]

Gaps in Knowledge

Underlying causes of deviations to airway guidelines and underperformance of cricothyrotomy during CICO situations should be further investigated such as clinician's orientation to the facility, availability of supplies and clinician familiarity of specific brands/kits. Although clinicians have reported decreased confidence in using advanced airway equipment, it is not clear whether standardization of difficult airway carts, cricothyrotomy kits and difficult

airway algorithms and devices will help improve provider confidence and improve management of the difficult airway.[17, 18] Another gap in knowledge is whether clinicians need time to reflect on their learning, training or experience. It is possible that performance soon after training may not provide enough time for clinicians to process what was learned and readapt their practice.[16] It should also be noted that the majority of these studies concerned simulated CICO events and it should be acknowledged that improved simulation outcomes may not translate to real life. Long term surveying of real-life outcomes associated with enhanced or interval training would provide more useful results relevant to this practice problem. Considering these studies were of relatively small sample sizes, national or internationally survey of anesthesia providers and surgeons would be more useful to establish broader insight into this practice concern and its contributing factors.

METHODOLOGY OF QUALITY IMPROVEMENT PROJECT

Project Design

Institutional Review Board (IRB) approval for this study was FIU and Broward Health Medical Center as a way of securing the rights of all participants in the study. There are no financial interests to be revealed by the authors of this report relating to the production or implementation of this study.

Advantages/risks.

The increased awareness to difficult airway situations and the role insufficient training and continuous education plays in deviation from DAA and cricothyrotomy performance would demand enhancement of current difficult airway training. There was no overt risk to participating in this study.

Informed Consent

A letter relaying information regarding the study was distributed to all CRNA participants explaining the study and the associated advantages and risks of participation. All potential respondents were also given a recruitment flyer via hand delivery offering a brief

abstract of the study. A web-based survey platform, Qualtrics, was used to distribute the surveys through an anonymous connection sent to CRNA participants by email. The URL connection was used by participating providers to gain access to the survey, indicating their informed consent to participate. Without using the URL connection to continue the exercise, Qualtrics did not allow a participant to gain access to or take a survey.

Confidentiality and privacy of data.

There was no obligation for participants to include their names or other identifying information. In the Qualtrics website database for which access was password protected, all survey information collected was stored. Access to the data obtained was open only to the principal investigator. Although survey participants were recruited via an email address, the email address or survey responses generated by the email address were not linked to any demographic information. Data obtained was by no means exported or transported. At all times, data stayed inside the website database. Anonymity, confidentiality and data protection have therefore been ensured.

Settings and Participants

The study took place at Broward Health in Broward County, Florida. Primary study participants include Broward Health Anesco Certified Registered Nurse Anesthetists. The participants were recruited voluntarily via an email list provided by Broward Health Medical Center Anesthesia Department. They received the proposed intervention and completed a questionnaire regarding their experience and learning through an anonymous survey. The anticipated sample size was 8 adult participants of both genders.

Description of Approach and Subject Procedures

The primary methodology of the proposed project administered an online educational intervention to anesthesia providers that focused on difficult airway situations and algorithms. With written consent, the participants completed an anonymous pre-test survey to assess their

knowledge and current clinical practices regarding difficult airway situations and their associated morbidity and mortality. The survey was completed individually and took up to 5-15 minutes to complete. The survey identified providers' existing knowledge and determined whether learning took place following educational intervention.

Next, the participants viewed an educational PowerPoint presentation based on the results of the systematic review regarding difficult airway situations described previously. Identification and management of difficult airway situations falls within the responsibilities of a CRNA. It is important that providers have the knowledge to be able to determine whether patients are at risk of a difficult airway situation and manage a situation if it arises with minimal complications. The evidence supports the need for regular intervention with comprehensive information regarding difficult airway situations.

The third phase of the project asked participants to complete the post-test and was identical to the pre-test. The post-test survey took up to 5-15 minutes to complete. This information provided feedback regarding the impact of the educational intervention and whether learning took place amongst participants. The pre/post-testing provided relevant information regarding the effectiveness of this online intervention in influencing CRNAs practice.

Protection of Human Subjects

For this study, the recruitment population included Broward Health Anesco Certified Registered Nurse Anesthetists. This population is directly responsible for delivery of anesthesia to thousands of patients in South Florida every year and can influence the care provided to patients undergoing surgeries and procedures requiring anesthesia services in their respective facilities. Recruitment activities for this study were conducted by email invitations to providers on the email list provided by Broward Health Medical Center Anesthesia Department. There were penalties if any participants decided to withdraw from the quality improvement project at any stage. Participants were not expected to experience any risks, harms, or discomforts though participation in this project. Potential benefits to participants included improved knowledge of

difficult airway situations, difficult airway algorithms and associated incidence and morbidity. There was no compensation or incentives. This study only required the time spent by each participant in the educational intervention.

Intervention

A quasi-experiment using a pretest-posttest design was conducted using a convenient sample of CRNAs employed at Broward Health Medical Center. Qualtrics, an online survey software product, was used to create and deliver the pretest and posttest surveys to all participants. CRNAs were given a pretest survey that assessed baseline knowledge of CICO situations, DAAs and associated confidence levels. Thereafter, an educational module created by the researcher, regarding CICO situations and associated guidelines, was made available on Google Drive for CRNA perusal. File access for all CRNAs was communicated vie an email message that provided a URL link to the PowerPoint presentation. Qualtrics launched the posttest survey 24 hours after the dissemination of the education module.

The educational module "Importance of Adherence to Difficult Airway Algorithms and Successful Performance of a Cricothyrotomy" represents the treatment of this quasi-experiment. This PowerPoint presentation was a voiced-over presentation of 15-minute duration that described CICO situations, Difficult Airway Algorithms, Relevance to practice including associated morbidity and mortality and possible contributing factors.

Each CRNA received an informational letter via electronic mail describing the study, its components and all participatory tasks required of this project. In addition, a recruitment study flyer was delivered to all potential participants. The pretest and posttest surveys were created within Qualtrics and launched within the Qualtrics platform.

The investigator predicted that watching the education module would have a beneficial effect on the awareness of CRNAs regarding the DAA and cricothyrotomy results. In addition, higher scores, indicating expected self-directed learning capacity and optimistic attitudes towards

safety in direct patient care, were predicted. Overall, the predicted result for this analysis was enhanced post-test efficiency.

Data Collection

For the study, the primary method used included a pre-assessment and post- assessment testing application to determine the effects of the educational intervention. Both tests were identical and were conducted using surveys that determined participants' understanding of difficult airway situations. It also determined the efficacy of a PowerPoint educational intervention to meet this objective.

The survey consisted of 10 questions that focused on knowledge and clinical interventions associated with difficult airway situations using Qualtrics. In this manner, the pretest survey gauged each providers' foundational knowledge of difficult airway situations. The post-test survey determined if learning took place amongst participants. The reliability and validity were measured in accordance with the intervention and its effectiveness. The data collected was confidential and anonymous, and no identifiable private information was collected during any component of the study. Demographic data, including gender, age, ethnicity, and title was obtained as part of the survey.

Data Management and Analysis Plan

The co-investigator for the project was the DNP student who was responsible for administering the survey. To evaluate the responses provided on the pre-test and the post-test, each question was measured and the responses recorded to identify the knowledge base before and after the intervention. No personal identifiers were recorded for study participants and confidentiality were protected. The impact of the intervention was based upon the results of the pre-test and post-test survey instruments. Through statistical analysis, the study results identified patterns that will be used to determine the effectiveness of educational intervention and how it affects CRNAs actions and behaviors. The co-investigator stored the data collected in a password-protected laptop computer.

RESULTS

Demographics.

Table 3: Demographics	n (%)
Total Participants	8 (100%)
Gender	
Male	2 (25%)
Female	6 (75%)
Age	
18-29	0 (0%)
30-49	6 (75%)
>50	2 (25%)
Ethnicity	
Caucasian	3 (37.5%)
Other	5 (62.5%)
Position	
CRNA	8 (100%)
No response	0 (0%)
Education	
Masters	2 (25%)
Doctorate	6 (75%)

There were eight participants in the study and survey. Majority of the participants were female (n=6, 75%), as opposed to male (n=2, 25%). Ethnicities represented were: Caucasian (n=3, 37.5%) and other (n=5, 62.5%). All eight of the participants were CRNAs. It must be noted that the survey was only sent out to CRNAs employed by Broward Health Anesco; therefore, everyone who had access to the survey was a CRNA. Age of participants included 18-29 years old (n=0, 0%), 30-49 years old, (n=6, 75%), 50+ years old (n=2, 25%). Highest level of education included master's degree (n=2, 25%) and doctorate degree (n=6, 75%).

Method of Evaluation

A survey was used as a pre-test and posttest to assess CRNA knowledge of airway emergencies. More specifically, the analysis consisted of 15 questions in the multiple-choice format that assessed knowledge of CICO situations, associated guidelines and performance of cricothyrotomy. In compliance with EB recommendations for challenging airway procedures in

CICO conditions, clinical scenarios were used to test the capacity of CRNAs to apply knowledge and make clinical decisions.

Pre-Test Findings

The pre-test gauged participants' starting knowledge regarding difficult airway situations. Majority of participants were aware that difficult airway scenarios can lead to brain death, increased hospital lengths of stays and inability to ventilate (n= 7, 87.5%). Majority of participants were aware that it is not always possible to identify a difficult airway (n=7, 87.5%). Only 37.5% of CRNAs surveyed knew that 50% of perioperative claims and all claims for incidents outside of the OR result in brain injury or death due to ineffective oxygenation (n=3, 37.5%). Most participants did not know the incidence rate for difficult intubation for patients with no indicators of a difficult airway (n=1, 12.5%). Most participants didn't know the success rate for cricothyrotomy in CICO situations (n=1, 12.5%). However, 75% of participants knew that low confidence levels of providers is a contributing factor to cricothyrotomy failure (n=6, 75%). 50% of participants knew that increasing cricothyrotomy experience may help improve success rates (n=4, 50%). 50% of participants knew that repeating simulation of CICO situations may help improve adherence to difficult airway algorithms (n=4, 50%). Only 3 participants were able to identify that blind nasal intubation was not part of the difficult airway algorithm (n=3, 37.5%). Only 1 participant knew that approximately 42% of CRNAs have participated in difficult airway courses (n=1, 12.5%).

Post-Test Findings

The same eight participants that completed the pre-test also participated in a post-test survey. The post-test gauged participants' knowledge regarding difficult airway situations after viewing an educational module. In the post-test, the same majority of participants were aware that difficult airway scenarios can lead to brain death, increased hospital lengths of stays and inability to ventilate (n= 7, 87.5%). 75% of participants were aware that CICO situations can't always be prevented. Most of the participants surveyed knew that 50% of perioperative claims

and all claims for incidents outside of the OR result in brain injury or death due to ineffective oxygenation (n=5, 62.5%). Most participants knew the incidence rate for difficult intubation for patients with no indicators of a difficult airway (n=6, 75%). This was a major difference from the pre-test where only one participant knew the incidence rate of difficult intubation (n=1, 12.5%). Similarly, most participants knew the success rate for cricothyrotomy in CICO situations (n=5, 62.5%). The majority of participants were also able to identify low confidence levels as a contributing factor to cricothyrotomy failure (n=6, 75%). Most of participants knew that increasing cricothyrotomy experience may help improve success rates (n=6, 75%). Only one participant failed to recognize that repeating simulation of CICO situations may help improve adherence to difficult airway algorithms (n=7, 87.5%). There was an increase in the number of participants that were able to identify that blind nasal intubation was not part of the difficult airway algorithm (n=4, 50%). This mild increase may suggest that repeated exposure and education to difficult airway algorithms may be required for a larger improvement in knowledge. In post-survey, most participants knew that approximately 42% of CRNAs have participated in difficult airway courses (n=5, 62.5%). Table 4 shows the differences in responses from pre- to post-test.

Table 4: Difference in Pre- and Post-Test Findings	**Pre-test**	**Post-test**	**Difference**
Difficult Airway Scenarios can lead to:	87.5%	87.5%	0%
How can you prevent a Cannot Intubate/Cannot Oxygenate situation?	87.5%	75%	-12.5%
What percentage of perioperative claims and all claims for incidents outside of the OR result in brain injury or death due to ineffective oxygenation?	37.5%	62.5%	25%
What is the incidence rate for difficult intubation for patients with no indicators of difficult airway?	12.5%	75%	62.5%
What is the success rate for cricothyrotomy in cannot intubate/cannot oxygenate situations?	12.5%	62.5%	50%
What is a contributing factor to cricothyrotomy failure?	75%	75%	0%
What can help improve cricothyrotomy success rates?	50%	75%	25%

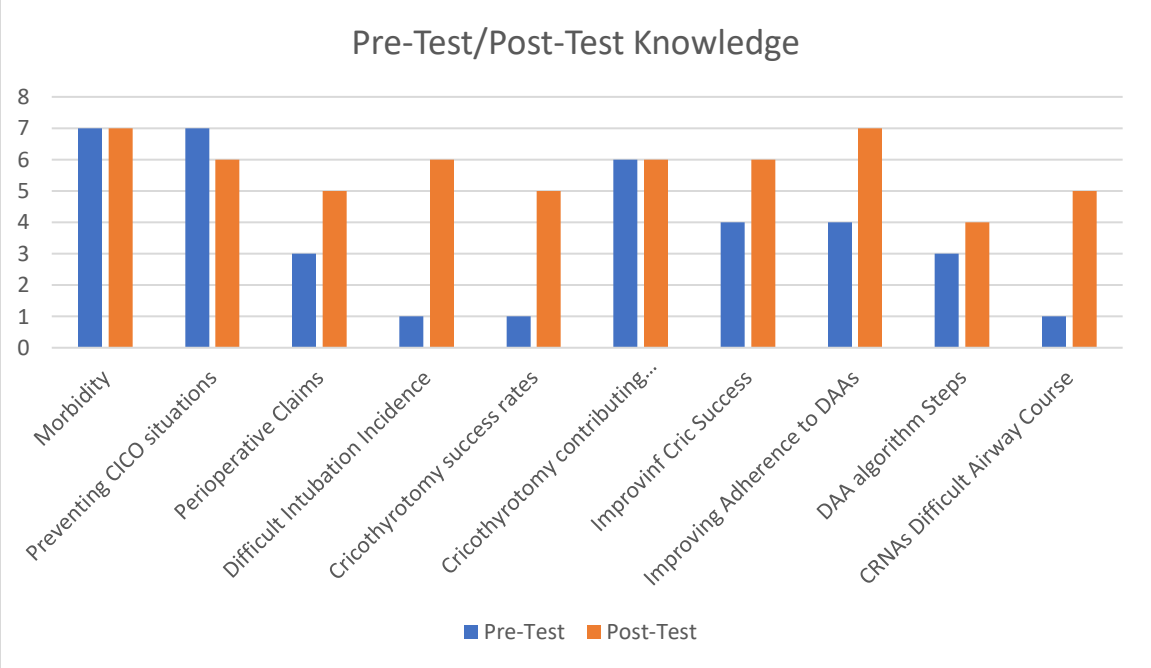
What can help improve adherence to difficult airway algorithms?	50%	87.5%	37.5%
All of the following are part of the difficult airway algorithm except:	37.5%	50%	12.5%
According to research, what is the approximated percentage of CRNAs that have participated in a difficult airway course?	12.5%	62.5%	50%

As seen in Table 4, learning took place on the vast majority of questions to varying degrees. Significantly more CRNAs that repeating simulation of CICO situations may help improve adherence to difficult airway algorithms.

Summary

Overall, the results show that there was a difference from pre-test to post-test. There was an increase in knowledge for most questions. See Graph 1 for visual representation of the study's findings.

Graph 1



Limitations of Study

Limitations of the study include the small sample size. The study was done using an anesthesia group in South Florida. A larger group would have been more preferrable to increase the strength of the study. The delivery method was another significant limitation. The email list provided by the participating anesthesia group was not updated; several email addresses on the distribution list were no longer valid, and more recently hired staff was not included. Furthermore, since the project was asynchronous and was entirely done online, self-selection bias was also present. Survey recipients were allowed to decide entirely for themselves whether they participated or not.

CONCLUSION

Considering the infrequency of CICO situations and emergency cricothyrotomies, it is necessary to maintain relevant provider knowledge and skill through means of independent practice experiences. Improving the quality of training associated with difficult airway management, CICO guidelines, and cricothyrotomy performance is likely to improve provider skill and confidence that will lead to decreased deviations from the DAA and hesitancy during CICO events leading to decreased anesthesia-related morbidity and mortality, healthcare expense, and length of stays.

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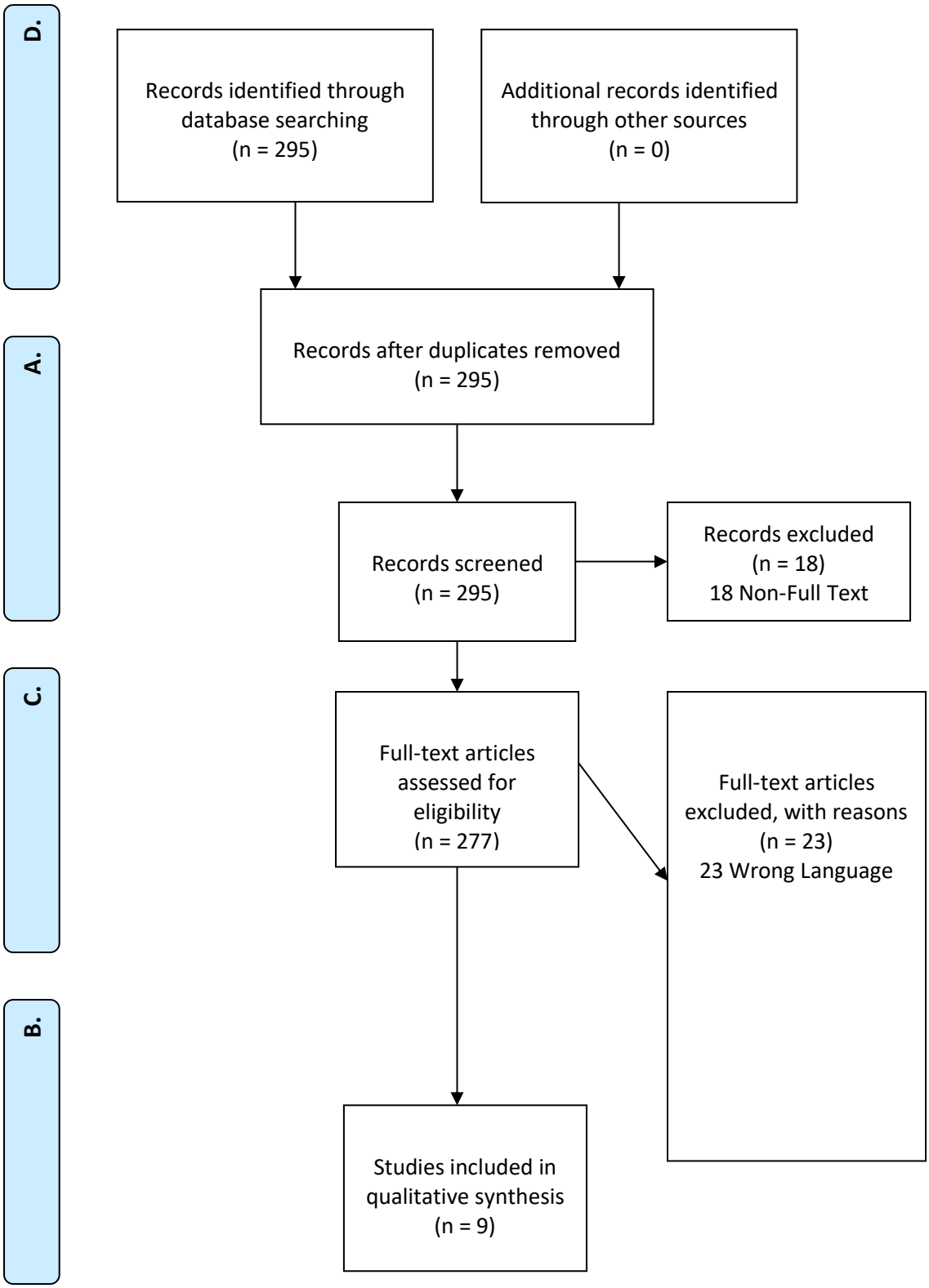
APPENDIX A: PRISMA FLOW DIAGRAM



APPENDIX B: LITERATURE MATRIX

Author (Year) & Level of Evidence	Design/Method	Sample/Setting	Training	Result	Implication to Practice
Borges et al. (2010)	Pre and post simulation/Training evaluation of Anesthesiologists' management of simulated CICV scenario	38 Anesthesiologists	Varied educational and clinical experiences Majority of participants had no airway training simulation prior to the study (84%) 1 training/simulation between pre- and post-evaluations	No differences regarding number of participants committing major deviations[15] More participants showed a failure to call for help during second session (7 vs 16)[15] Mean time to initiate cricothyrotomy and times to achieve ventilation were significantly better in the second session (205.5 s vs. 179.7 s & 356.9 s vs. 269.4 s respectively)[15]	The role of simulation and its effective use in training experienced practitioners to improve adherence to emergency airway guidelines may be relevant[15] The repetition of simulation sessions may be useful for improving adherence[15]
Mark et al. (2015)	Describes implementation of the "DART" program between July 2008 and June 2013 designed to: (1) Identify difficult airway patients (2) Mobilize physicians and staff efficiently (3) Deliver Airway	30 anesthesiologists, 6 Otolaryngologists, 5 Trauma surgeons, and 4 EM physicians at John Hopkins Hospital in Baltimore, Maryland (1059 licensed patient beds, 46,864 inpatient admissions and 421,933 outpatient encounters annually)	Educational component of DART consisted of in-person, skills-based courses tailored for physicians, nurses, respiratory therapists and educational materials for all staff. It is a 1 day course, held quarterly and is comprised of topics	360 difficult airway events between July 2008 and June 2013[4] No deaths, Sentinel events or malpractice claims related to airway management of patients in the first 5 years of the program[4]	Considering the risk of life-threatening complications or death related to difficult airway management, the development of interventions and educational program to improve complex airway management may help improve outcomes[4]

	equipment within time metrics (4) Implement appropriate airway algorithms (5) Document airway techniques used (6) Disseminate airway information to providers		including complex airway management, simulation, skills training on mannequins and pig trachea models and training in teamwork and communication.		
Mendonca et al. (2018)	17-Question Questionnaire of 5 sections related to difficult airway management Conducted over 2 week period	189 Anesthetists & Surgeons across 4 hospitals	Varied clinician experience and educational background 37.6% of participants indicated formal cricothyrotomy training No pre-questionnaire training or simulation was provided	59% of participants were aware of difficult airway guidelines[116] Of those aware of difficult airway guidelines, 83% knew the recommended Front of Neck Access (FONA) technique was surgical cricothyrotomy[16]	The need for standardized universal teaching of FONA in emergency situations has been emphasized[16] Results suggest that current difficult airway and FONA training is mainly during generic courses in-program[16] Very low confidence levels among all participants in performing cricothyrotomy when cricothyroid membrane not palpable[16] The stress of emergent situations call for standardized training and equipment[16] Minority of participants felt they received regular FONA training[16] Most anesthetists were not sure about the equipment available in their difficult airway cart[16]

Rajesh et al. (2015)	Post-difficult airway workshop Questionnaire	127 Anesthesiologists	Recent attendance of a Continuing Medical Education (CME) workshop on Difficult Airways	> 95% or participants routinely perform preoperative airway assessments[17] Less than 50% of participants reported wide availability of advanced airway equipment such as video laryngoscope, Fiberoptic bronchoscope (FOB), and Retrograde wire sets[17] 45% of participants were comfortable with using FOB[18] 18% of participants were comfortable with Cricothyrotomy techniques[17] 34% of participants had encountered a CICV situation at least once[17]	Availability of advance airway equipment vary between facilities[17] Results suggest a need for further training with advanced airway equipment[17] Lack of equipment and confidence in using equipment may cause deviations from difficult airway algorithms[17]
Scott-Herring et al. (2020)	Survey of educational needs among CRNAs Simulation of CICV situation Random selection, "surprise" simulation	43 CRNA participants at a large academic medical center	No pre-course material or preparation	Cricothyrotomy was identified as the #1 critical event that CRNAs wished to review[18] 42% of participants reported participation in a difficult airway course at some point[18] 16% of participants reporting prior	Maintenance and readiness training in CICV situations are essential[18] Considering the rarity of CICV events, interval exposure to training and simulation may help improve difficult airway management outcomes and cricothyrotomy success rates[18]

				participation in DA course stated it had been between 2 and 5 years since they had done so[18] Most of the participants who attended DA workshop did so through their CRNA program[18] 7% of participants reported performing Cricothyrotomy on a live patient[18] Cricothyrotomy placement times decreased with each subsequent attempt[18]	
Qi et al. (2020)	Participants performed Cricothyrotomy tasks on a virtual reality simulator	47 physician participants divided into More Experience (ME) and Less Experienced (LE) groups	Different actual (cricothyrotomy) experience groups (1, 5, 10) Levels of experience range: residents - attendings	No significant difference between experience groups when AE was 1.[19] The ME group performed significantly better than the LE group when AE of Cricothyrotomy was at least 5.[19] ME group took less time than the LE to complete the entire procedure[19]	Cricothyrotomy is a rare event, even for attendings[19] General experience does not improve cricothyrotomy success rates[19] Increasing actual Cricothyrotomy experience improves success rates and decreased performance times[19] Interval training and simulation may improve success rates, performance times [19]
Shetty et al. (2013)	Participants provided with study materials ahead of a scheduled training session	30 participants at Westmead hospital, a large university-affiliated hospital	60% of participant were critical care trainees	Significant decrease in average time to completion of cricothyrotomy from	Increasing actual airway experience decreases performance times[20]

	Multiple choice questionnaire was administered to assess previous experience in airway resuscitation procedures Cricothyrotomy video was shown on day of training		33% had no previous experience in performing cricothyrotomy 10% had several years of airway skills and more than 20 years of clinical work experience	1st attempt to 5th attempt.[20] Improvement in time to completion decreased even between the 4th and 5th attempt.[20] The 3 participants who completed cricothyrotomy within 60 seconds on their first attempt were all physicians with more than 10 years of airway experience.[20]	Instruction using visual aid/demonstration and simulation coupled with repeated practice may improve difficult airway management outcomes and cricothyrotomy success rates and performance times[20]
Veenstra et al. (2019)	Advanced surgical airway curriculum Evaluation with cognitive tests, procedure checklists and questionnaire	78 participants total General surgery residents Student Nurse Anesthetists	Trainees with limited to no experience	Participants agreed that the curriculum provided the cognitive and psychomotor skills necessary to perform cricothyrotomy[21]	Simulation-based training with a focus on individualized, active learning may be particularly useful in high-risk, low frequency scenarios such as CICV events and cricothyrotomy[21]
You-Ten et al. (2015)	Randomized Controlled Trial All participants received a pre-test teaching session Control group: No further training or practice Intervention group: Received hands-on cricothyrotomy training with 5 practice sessions and performance of	21 post graduate year 2 residents	Participants who had performed a cricothyrotomy in a clinical or simulated setting within the past 6 months were excluded	Significantly more non-trained than trained participants committed at least one major DAA deviation.[7]	Hands-on training in difficult airway management and cricothyrotomy results in greater adherence to DAA[7]

	cricothyrotomy on human cadaver Simulated CICV scenario 2-3 wks later				

APPENDIX C: FIU IRB EXEMPTION LETTER

FLORIDA INTERNATIONAL UNIVERSITY

Office of Research Integrity
Research Compliance, MARC 414

MEMORANDUM

To:	Dr. Yasmine Campbell
CC:	Michelle Martinez
From:	Elizabeth Juhasz, Ph.D., IRB Coordinator EJ
Date:	April 7, 2021
Protocol Title:	**""The effect of enhanced anesthesia provider training on adherence to difficult airway algorithms and successful performance of the cricothyrotomy: An evidence-based education module""**

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-21-0130 **IRB Exemption Date:** 04/01/21
TOPAZ Reference #: 110240

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.
2) 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.
3) 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 D: BROWARD HEALTH IRB EXEMPTION LETTER

BROWARD HEALTH

Institutional Review Board - Human Research Protections

Broward Health Medical Center
Broward Health Coral Springs
Broward Health Imperial Point
Broward Health North
Salah Foundation Children's Hospital
Broward Health Weston
Community Health Services
Broward Health Physician Group

DATE: 04/27/2021

TO: Michelle Martinez

FROM: Broward Health Institutional Review Board

RECORD NUMBER: 2021-055

STUDY TITLE: "The effect of enhanced anesthesia provider training on adherence to difficult airway algorithms and successful performance of the cricothyrotomy: An evidence-based education module"

RE: NOT HUMAN SUBJECT RESEARCH DETERMINATION

Dear Michelle Martinez:

This is to advise you that your project, " "The effect of enhanced anesthesia provider training on adherence to difficult airway algorithms and successful performance of the cricothyrotomy: An evidence-based education module" " was reviewed on behalf of the Broward Health Institutional Review Board and was declared "not research involving human subjects" based on the definitions provided in the U.S. Department of Health and Human Services Code of Federal Regulations found at 45 CFR 46.102.

Please note, this determination does not absolve the Principal Investigator from complying with other federal, state, or local laws or institutional policies and procedures that may be applicable in the conduct of this project. This determination applies to your project in the form and content as submitted to the IRB for review. Any variations or modifications to this project involving the participation of human subjects must be approved by the IRB prior to implementing such changes. Please maintain a copy of this determination for your records.

Thank you for submitting your project to the IRB for consideration.

The Broward Health Institutional Review Board – FWA00001248 operates in accordance with the Office of Human Research Protections and U.S. Food and Drug Administration (FDA) regulations. The Broward Health Institutional Review Board complies with the ICH guidelines on Good Clinical Practice (GCP) where they are compatible with the FDA and HHS regulations.

This letter has been electronically signed in accordance with all applicable regulations, and a copy is retained within Broward Health IRB's records.

APPENDIX E: ANESCO LETTER OF SUPPORT

ANESCO™
Driving Results in Anesthesia

March 1, 2021

Valerie J. Diaz, DNP, CRNA, APRN, CAPT, NC, USN
Assistant Professor
Department of Nurse Anesthetist Practice
Florida International University

Dr. Diaz,

Thank you for inviting Broward Health Medical Center to participate in the Doctor of Nursing Practice (DNP) project conducted by **Michelle Martinez** entitled ***"The effect of enhanced anesthesia provider training on adherence to difficult airway algorithms and successful performance of the cricothyrotomy: An evidence-based education module"*** in the Nicole Wertheim College of Nursing and Health Sciences, Department of Nurse Anesthetist Practice at Florida International University. I have granted the student 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 proposed quality improvement project seeks to investigate and synthesize the latest evidence.

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: Michelle Martinez and Dr. Valerie Diaz.

Once the Institutional Review Board's approval is achieved, this scholarly project's execution will occur over two weeks. Michelle Martinez will behave professionally, follow standards of care, and not impede hospital performance. We support the participation of our Anesthesiology providers in this project and look forward to working with you.

March 1, 2021

Edward Punzalan, DNP, CRNA, APRN — Date
Administrative Director of Nurse Anesthesia
Healthcare Performance Anesco
Broward Health

APPENDIX F: RECRUITMENT LETTER

Nicole Wertheim College of Nursing and Health Sciences
Department of Nurse Anesthetist Practice

"The effect of enhanced anesthesia provider training on adherence to difficult airway algorithms and successful performance of the cricothyrotomy: An evidence-based education module"

Dear Broward Health Anesco Anesthesia Provider:

My name is Michelle Martinez 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 effect of improved and or increased training of anesthesia providers on adherence to difficult airway algorithms and successful performance of a cricothyrotomy. You are eligible to take part in this project because you are a member of the Anesthesia Department for Anesco at Broward General.

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 approximately 15 minute long 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 mmart104@fiu.edu or 305-582-3599.

Thank you very much.

Sincerely,

Michelle Martinez, SRNA, BSN

APPENDIX G: PROJECT CONSENT

FIU | FLORIDA INTERNATIONAL UNIVERSITY

CONSENT TO PARTICIPATE IN A QUALITY IMPROVEMENT PROJECT

"The effect of enhanced anesthesia provider training on adherence to difficult airway algorithms and successful performance of the cricothyrotomy: An evidence-based education module"

PURPOSE OF THE PROJECT

You are being asked to be in a quality improvement project. The goal of this project is to determine the effect of improved and/or increased training of anesthesia providers on adherence to difficult airway algorithms and successful performance of a cricothyrotomy in order to improve outcomes following cannot intubate and cannot ventilate situations.

DURATION OF THE PROJECT
Your participation will require about 20 minutes of your time.

PROCEDURES
If you agree to be in the project, we will ask you to do the following things:

-Complete and sign a consent form for participation.
-Complete a pre-test questionnaire, expected to take approximately 5 minutes.
-View an educational presentation online, expected to take approximately 15 minutes
-Complete the post-test questionnaire, expected to take approximately 5 minutes.

RISKS AND/OR DISCOMFORTS
There are no foreseeable risks with you for participating in this project.

BENEFITS
The following benefits may be associated with your participation in this project:
beneficial effect on the awareness of DAA deviations and cricothyrotomy performance results. In addition, higher post-presentation scores, indicating expected self-directed learning capacity, increased knowledge pertaining to difficult airway management, improved confidence levels, and optimistic attitudes towards safety in direct patient care. The overall objective of the project is to increase the quality of healthcare delivery thus improving the health outcomes of our patients.

ALTERNATIVES
There are no known alternatives available to you other than not taking part in this project. However, if you like to receive the educational material given to the participants in this project, it will be provided to you at no cost.

CONFIDENTIALITY
The records of this project will be kept private and will be protected to the fullest extent provided by law. If, in any sort of report, we might publish, we will not include any information that will make it possible to identify you as a participant. Records will be stored securely, and only the project team will have access to the records.

COMPENSATION & COSTS
There is no cost or payment to you for receiving the health education and/or participating in this project.

RIGHT TO DECLINE OR WITHDRAW
Your participation in this project is voluntary. You are free to participate in the project or withdraw your consent at any time during the project. Your withdrawal or lack of participation will not affect any benefits to which you are otherwise entitled. The investigator reserves the right to remove you without your consent at such time that they feel it is in the best interest.

RESEARCHER CONTACT INFORMATION
If you have any questions about the purpose, procedures, or any other issues relating to this research project, you may contact Michelle Martinez. at 305-582-3599, mmart104@fiu.edu or Dr. Valerie Diaz at 305-348-4871, vdiaz@fiu.edu

IRB CONTACT INFORMATION
If you would like to talk with someone about your rights of being a subject in this project or about ethical issues with this project, you may contact the FIU Office of Research Integrity by phone at 305-348-9027 or by email at ori@fiu.edu

PARTICIPANT AGREEMENT
I consent by participating in the survey. I have read the information in this consent form and agree to participate in this project.

APPENDIX H: PRE/POST TEST SURVEY QUESTIONS

FIU | FLORIDA INTERNATIONAL UNIVERSITY

Pretest and Posttest Questionnaire:

"The effect of enhanced anesthesia provider training on adherence to difficult airway algorithms and successful performance of the cricothyrotomy: An evidence-based education module"

INTRODUCTION

The goal of this project is to determine the effect of improved and/or increased training of anesthesia providers on adherence to difficult airway algorithms and successful performance of a cricothyrotomy in order to improve outcomes following cannot intubate and cannot ventilate situations.

Please answer the question below to the best of your ability. The questions are either in multiple choice or true/false format and are meant to measure knowledge and perceptions on difficult airway management and cannot intubate/cannot ventilate scenarios

PERSONAL INFORMATION

1. **Gender:** Male Female Other_____
2. **Age:** _____
3. **Ethnicity:**

   Hispanic Caucasian African American Asian Other_____
4. **Position/Title:** _____
5. **Level of Education:** Associates Bachelors Masters Other _____
6. **How many years have you been an anesthesia provider?**

Over 10 5-10 years 2-5 years 1-2 years

QUESTIONNAIRE

1. Difficult airway scenarios can lead to:
    a. Brain death
    b. Increased hospital lengths of stays
    c. Inability to Ventilate
    d. All of the above
2. **How can you prevent a Cannot Intubate/Cannot oxygenate situation?**
    a. Thorough airway assessment
    b. Complete physical and medical history assessment
    c. Adequate preoxygenation
    d. It is not always possible to identify a difficult airway, leading to CICO situations
3. **What percentage of perioperative claims and all claims for incidents outside of the OR result in brain injury or death due to ineffective oxygenation?**
    a. 20%
    b. 50%
    c. 60%
    d. 80%
4. **What is the incidence rate for difficult intubation for patients with no indicators of difficult airway?**
    a. 6%
    b. 1%

c. 10%

d. 0.2%

5. **What is the success rate for cricothyrotomy in cannot intubate/cannote oxygenate situations?**

   a. 97%

   b. 65%

   c. 80%

   d. 74%

6. **What is a contributing factor to cricothyrotomy success?**

   a. Low confidence levels of providers

   b. Noisy environment

   c. Lack of assistance

   d. Provider fatigue

7. **What can help improve cricothyrotomy success rates?**

   a. General experience

   b. Calling for help

   c. Increasing cricothyrotomy experience

   d. High quality equipment and tools

8. **What can help improve adherence to difficult airway algorithms?**

   a. Repeated simulation of Cannot Intubate/Cannot Oxygenate scenarios

   b. Monthly staff meetings with reminders to follow algorithms

   c. Increased studying

   d. Required systematic charting

9. All of the following are part of the difficult airway algorithm except:

a. Cricothyrotomy

b. Subglottic device

c. Wake up the patient

d. Blind nasal intubation

10. According research, what is the approximated percentage of CRNAs that have participated in a difficult airway course?

a. 16%

b. 42%

c. 67%

d. 82%

APPENDIX I: EDUCATIONAL MODULE

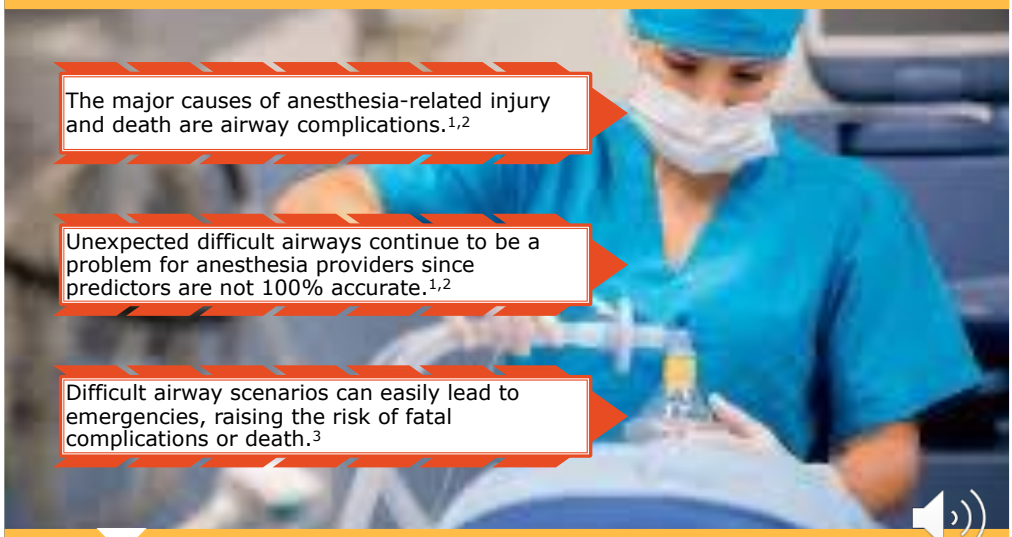
The effect of enhanced anesthesia provider training on adherence to difficult airway algorithms and successful performance of the cricothyrotomy: An evidence-based education module

Presented by: Michelle Martinez, SRNA, BSN
Florida International University

Learning Objectives

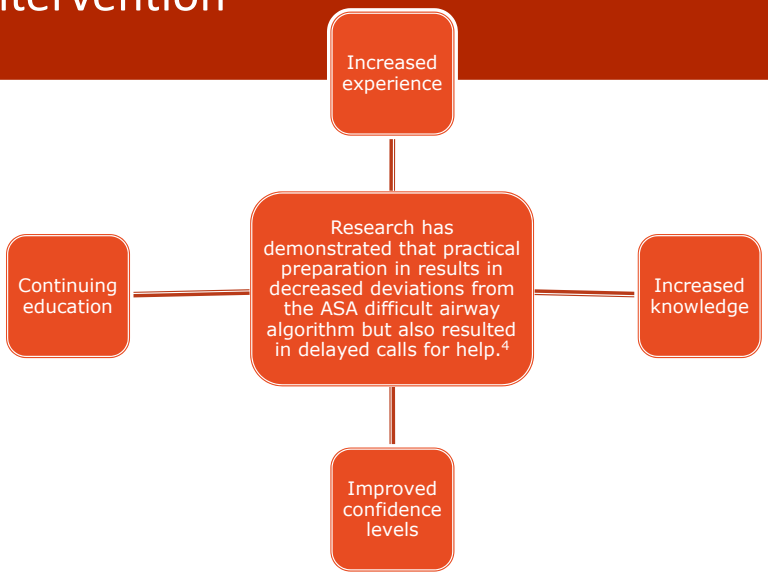
Determine the effect of improved and/or increased training of anesthesia providers on adherence to difficult airway algorithms and successful performance of a cricothyrotomy in order to improve outcomes following cannot intubate and cannot ventilate situations.	Awareness of DAA deviations and cricothyrotomy performance results
	Higher post-presentation scores, indicating expected self-directed learning capacity
	Increased knowledge pertaining to difficult airway management
	Improved confidence levels
	Optimistic attitudes towards safety in direct patient care.

Background



Possible Contributing Factors

Intervention



Increased Experience

- Continuing education
- Interval simulation sessions
- Exercises to reinforce learning

Enhanced Training

- Required difficult airway courses
- Multi modal education
- Clinical experience

Improved Confidence

- Confidence in experience
- Confidence in skill
- Confidence in resources

Summary

Maintaining relevant provider knowledge and skill is key

- Improved quality of training
- CICO guidelines
- Skill performance

Improved confidence levels decrease deviations and hesitancy

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APPENDIX J: CITI TRAINING CERTIFICATE INVESTIGATOR

CITI PROGRAM

Completion Date 10-Oct-2020
Expiration Date 10-Oct-2023
Record ID 38905283

This is to certify that:

Michelle Martinez

Has completed the following CITI Program course:

Not valid for renewal of certification through CME. Do not use for TransCelerate mutual recognition (see Completion Report).

Basic/Refresher Course - Human Subjects Research (Curriculum Group)
Biomedical Human Research Course (Course Learner Group)
1 - Basic Course (Stage)

Under requirements set by:

Florida International University

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?w3c823d41-4230-465b-b745-b00048fee539-38905283

APPENDIX K: CITI TRAINING CERTIFICATE SUPERVISOR

CITI PROGRAM

Completion Date 08-Feb-2020
Expiration Date 07-Feb-2023
Record ID 35312850

This is to certify that:

Valerie Diaz

Has completed the following CITI Program course:

Basic/Refresher Course - Human Subjects Research (Curriculum Group)
Biomedical Human Research Course (Course Learner Group)
1 - Basic Course (Stage)

Under requirements set by:

Florida International University

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?w4e8a4763-3494-44c6-9857-91f65cf90d0b-35312850