THE ROLE OF POINT OF CARE ULTRASOUND DURING AIRWAY ASSESSMENT

by

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Dedication and Acknowledgments

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Abstract

Background/Purpose: An assessment of the airway is an essential component of the pre-anesthesia evaluation. The purpose of assessing the airway is to predict potential problems and develop a safe anesthetic management plan. The goal is to avoid an unanticipated difficult airway that can lead to a cannot-ventilate/cannnot-intubate scenario. Current (bedside) airway evaluation methods are subjective, have limited specificity, sensitivity, and often lack diagnostic accuracy. Point- of- care ultrasound of the airway (POCUS-A) has shown promise as an additional airway assessment diagnostic tool, and when used together with current evaluation methods, may serve as a solution for the existing assessment limitations. For example, POCUS-A can be utilized to establish measurements of the upper airway, determine airway size, predict the appropriate diameter of single-lumen and double lumen endotracheal tubes (ETTs), identify upper airway anomalies such as subglottic stenosis, vocal cord pathologies, foreign body obstructions, airway masses, and accurately identify the cricothyroid membrane for emergency airway access as well as identify tracheal rings for ultrasound guided tracheostomy.

The purpose of this DNP scholarly project is twofold: 1) to gather baseline data about CRNA current practice patterns related to assessment of the difficult airway, opportunities for POCUS-A, and possible barriers of implementation into clinical practice; 2) to inform CRNAs about the utility of POCUS-A by collating the results of the survey and develop an educational program for two different hospital-based anesthesia departments, located in Kalamazoo and in Marquette.

Methods: In order to meet the objectives of this DNP project, a three-part methodologic process was established. First, an IRB approved online survey was distributed to members of the Michigan Association of Nurse Anesthetists (MANA). The purpose was to identify current

methods of airway assessment and level of familiarity with POCUS-A, as well as its inclusion in the updated ASA difficult airway management guidelines. Based on the survey results, a curricular scholarly presentation was developed and offered to the providers within the anesthesia departments who requested the information. Lastly, a semi-formal hands-on practicum commenced in the summer of 2023 at a monthly department educational meeting allowing members of the respective departments to practice and gain competency in performing POCUS-A.

Results: The survey was distributed to over 2200 CRNA members of MANA. Although the response rate was very low (3%), it did reveal important information. For example, most respondents (99%) rely on and use current methods of airway assessment that have low diagnostic accuracy and are very subjective; 99% do not use POCUS-A for an additional pre-anesthesia diagnostic tool; 82% were unaware of the inclusion of POCUS-A in the updated ASA difficult airway management guidelines; and 74% have an interest in learning more about POCUS-A. The results of the survey were used to develop the scholarly curricular presentation on POCUS-A and offered to the providers within the respective departments. The hands-on practicum took place in June 2023.

Discussion/Conclusion: This project identified a lack of awareness of POCUS-A of members of MANA and providers within the two anesthesiology departments. The members of the anesthesiology departments received a formal didactic presentation specific to POCUS-A via a PowerPoint voice-over lecture and with embedded pictures and videos of the live scanning technique. The attendees of the hands-on practicum provided the authors with favorable feedback and consideration is given for a scholarly presentation at an upcoming MANA meeting.

Keywords: Airway, ultrasound, POCUS, airway ultrasonography, difficult airway.

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Background and Significance

It is the responsibility of the Certified Registered Nurse Anesthetist (CRNA) to perform a pre-anesthesia assessment on every patient presenting for surgery and/or other procedures necessitating anesthesia. A significant feature of the assessment involves the airway; the purpose of performing an airway assessment is to identify and predict problems with securing the airway prior to surgery, and to determine the ability to ventilate and oxygenate throughout the surgery. Based on the findings of the pre-anesthesia airway assessment, a plan for safely managing and securing the airway must be established ahead of time.

There are numerous conventional airway assessment techniques used to determine whether or not a patient's airway can be secured with an endotracheal tube (ETT), including the modified Mallampati classification, hyomental distance, thyromental distance, neck range of motion, inter-incisor gap, BMI, neck circumference, and upper lip bite tests. Unfortunately, none of these assessment techniques offer a significant degree of assurance and their diagnostic accuracy in predicting difficult intubation is low (Harjai et al., 2021).

Roth et al. (2018) published a meta-analysis comparing the diagnostic accuracy of commonly used airway examination methods (Mallampati, thyromental distance, sternomental distance, mouth opening, upper lip bite test) to predict a difficult airway. Despite being designated as screening tests, these methods demonstrated low sensitivities and high variability. The authors concluded that standard bedside airway examination tests do not appear to be good screening tests and should be interpreted with caution.

Failure to recognize and predict a difficult airway can lead to a "cannot intubate cannot ventilate" scenario, and ultimately result in morbidity and mortality. Fulkerson et al., 2017, identified that the cannot ventilate cannot intubate scenario occurs in one of every 1000 elective

cases, and one in 250 rapid sequence cases. Also noteworthy, the unpredicted difficult laryngoscopy is estimated to occur in 13% of intubations (Alessandri et al., 2019).

The standard of care for CRNAs is to consistently perform a pre-anesthesia physical airway assessment that includes anatomy, condition of teeth or dentures, Mallampati classification, and previous airway issues experienced during prior anesthetics (AANA Board of Directors, 2019). Providers should exhaust all opportunities to predict a difficult airway.

Acknowledging the limitations and subjectivity of current pre-anesthesia assessment techniques, and the potentially devastating consequences of an unanticipated difficult airway, one can appreciate the need for a reliable airway evaluation method. This knowledge gap specific to difficult intubation prediction methods emphasizes the need for further investigation. The goal of future research should focus on obtaining reliable, accurate, and highly specific and sensitive methods for predicting the difficult airway upon examination and prior to laryngoscopy (Koundal et al., 2019).

Employing point of care ultrasound (POCUS) shows promise as a reliable airway assessment diagnostic tool. It may be a solution for shortcomings of current airway assessment methods (Koundal et al., 2019) and has become increasingly popular. This has led the DNP project authors to investigate its use for predicting a difficult airway. Additionally, Yao & Wang, 2017, considered it a quick and inexpensive method that provides visualization and objective measurements of airway structures such as the tongue, epiglottis, vocal cords, and cartilage. Yao and Wang assert it can be used to predict difficult laryngoscopy, identify appropriate endotracheal tube size, identify the cricothyroid membrane for cricothyrotomy, and detect airway anomalies. Despite the numerous published applications of airway POCUS (POCUS-A), its use in practice is not widespread.

The purpose of this DNP project is threefold:

1) to gather baseline data (via a survey) about CRNA current practice patterns related to assessment of the difficult airway, opportunities for POCUS-A, and possible barriers of implementation into clinical practice.

2) to determine the relevance of POCUS-A and clarify its applicability during pre-anesthetic airway assessment.

3) to inform CRNAs about the utility of POCUS-A by collating the results of the survey and developing an educational program that will be piloted at two different hospital-based anesthesia departments, located in Kalamazoo and in Marquette. Based on the feedback of these two departments, the program may be offered to all members of the Michigan Association of Nurse Anesthetists (MANA) in the future.

Congruence of Needs and Organizational Strategic Plan

Knowledge of key factors that facilitate and improve anesthesia care during airway management is important to promote safety and quality (Larson et al., 2019). POCUS is emerging as an innovative, critical, and core skill, and its application to airway assessment shows promise for practice improvement. CRNAs should obtain and enrich their expertise in POCUS to complement their existing foundation of knowledge and skills with professional development and continued learning (Lukyanova et al., 2021). Further exploration regarding POCUS-A as an innovative tool to improve efficiency and accuracy during airway assessment could enable CRNAs to enhance patient care outcomes.

Anesthesia research has traditionally focused on gaining a greater understanding of the interactions between anesthesia methods, human anatomy, and physiology within the context of perioperative safety (McKeen et al., 2020). Emphasis has historically been placed on 'patient and anesthesia-related episodic occurrences' during surgical procedures. However, recent anesthesiology research has demonstrated a broadened focus which has expanded to include care modalities in the preoperative and postoperative settings (Lane-Fall et al., 2020). This suggests many anesthesia departments nationwide have needs that are unmet by the results of previous studies. This demonstrates receptiveness to innovative research and signals a readiness for change in current practices. By investigating the application of POCUS-A during preoperative assessment, the need for more accurate and efficient airway assessment could provide the necessary process improvement for anesthetic airway management.

Literature Review

Methods

Multiple online databases were searched for evidence supporting the use of airway ultrasound for predicting a difficult airway, including CINAHL Plus (Cumulative Index to Nursing and Allied Health Literature) through EBSCOhost, PubMed, and Cochrane Library. Search terms, inclusion criteria, exclusion criteria, and dates of publications were used to identify relevant research to the topic of interest. Additional articles were located by manual processes after accessing the reference sections of previously selected publications; this ensured relevant and related data was not missed.

Search terms used included "airway" and "ultrasound or POCUS"; synonym search words used included "airway ultrasonography," "ultrasound," and "difficult airway". Initial keyword search was "airway AND ultrasound OR POCUS". Subsequent keyword searches

included every possible combination of the original search terms as well as their synonyms. Publications were excluded if published in a language other than English, prior to 2016, missing links to full text. Publications therefore were included if they were available in full text, written in the English language, and published after 2010. An exception was made for closed claims articles which were predominantly written before 2010.

The database search yielded a total of 170 publications with three additional articles identified through manual processes. After screening for duplicity, meeting inclusion criteria, upholding exclusion criteria, and if research was currently in progress, 139 were disregarded. The abstracts of the remaining 34 articles were further evaluated and 19 articles were omitted for small sample sizes and/or irrelevance to POCUS-A. Ultimately, a total of 15 articles were accepted for this literature review.

Limitations of Existing Airway Assessment Methods

Several traditional methods for assessing airway anatomy are widely recognized, including neck circumference, thyromental distance, and Mallampati score; however, no single method is presently considered the "gold standard" and it appears that combinations of methods are utilized. The Mallampati score – arguably the most notable assessment method widely used during preoperative evaluation – demonstrates low predictability as a clinical indicator of the difficult airway (Lundstrom et al., 2011). The Mallampati classification has been evaluated for diagnostic validity using the Grey Zone Approach, a statistical tool which more accurately simulates the reality of clinical practice. This analysis revealed large inconclusive zones, which may explain inconsistency when used as an airway assessment tool for predicting difficult laryngoscopy (Min et al., 2016). The Mallampati test could be considered a more reliable screening tool if it is conducted while the patient is in the supine – not sitting – position, since

intubation is usually performed with the patient in the supine position (Patel et al., 2014). However, most anesthesia providers do not require the patient to be supine during their preoperative evaluation. Unanticipated difficult airways are still estimated to occur in up to 13% of intubation cases (Alessandri et al, 2019); this prompts investigation into other screening methods.

The Cormack-Lehane (CL) scale was first introduced in 1984 as a method of grading the laryngeal view obtained during exposure via direct laryngoscopy (Pearce et al., 2021). The four grades described, ranging from grade I (easiest) to grade IV (most challenging), have formed the basis of difficult tracheal intubation classification. This grading system simply describes the glottic view obtained upon laryngeal exposure, which may or may not translate to ease of actual tracheal intubation. Review of prior CL views can give the anesthesia provider an idea of difficulty for future airway management, however this is dependent on the availability of documentation as well as having enough time to access and review the report. CL grading itself does not offer information regarding patient position, type of laryngoscope blade used, or any trauma or adverse events that may have occurred while obtaining the glottic view. As such, the CL scale can not be considered a tool for predicting difficult laryngoscopy.

Closed Claims Studies Related to Risk Predictors for the Difficult Airway

Airway injury is a significant source of liability for anesthesia providers (Domino et al., 1999). Failure to identify and predict adifficult endotracheal intubation is the leading cause of anesthesia-related morbidity and mortality (Patel et al., 2014). Unfortunately, 75-93% of difficult intubations are unanticipated (Tavolara et al., 2021). Careful assessment and planning for the difficult airway must occur prior to inducing general anesthesia. If a difficult airway is identified and its subsequent management is planned accordingly, it is unlikely to result in legal action.

Closed claims data can provide an indirect assessment of factors contributing to complications and liability risks related to identification and management of the difficult airway (Peterson et al., 2005). A closed claim research process after a claim has been made against the provider and ultimately closed because of a poor anesthetic outcome includes analysis of: relevant hospital and medical records, narrative statements from involved healthcare personnel, expert and peer reviews, deposition summaries, outcome reports, and the settlement or jury award (Caplan et al., 1990). Detailed reviews of closed malpractice claims provide insight into the most common events resulting in litigation. The goal is to learn from the analysis and modify care accordingly, potentially amending standards of care, and prevent injuries from occurring again.

The American Society of Anesthesiologists (ASA) Closed Claims Project database is a standardized collection of structured evaluations of cases when the patient experienced an adverse outcome. The data is obtained from the closed claims files of 35 U.S. professional liability insurance companies representing anesthesiologists (Peterson et al., 2005). Joffe et al. (2019) compared difficult intubation claims from 2000-2012 to claims in 1993-1999. Analysis was conducted specifically for preoperative predictors of the difficult airway and appropriateness of airway management. The authors concluded that outcomes have remained poor in more recent malpractice claims related to difficult intubation, and that inadequate airway planning and judgment errors continue to be contributors to patient harm. Metzner et al. (2011) analyzed anesthesia-related closed claims from 1990 to 2007 and determined the most common respiratory system event leading to anesthesia claims to be difficult intubation (27% of the total related adverse events). In their analysis of factors contributing to anesthesia-related closed claims data between 2007 and 2014 from an ambulatory surgery center and hospital operating rooms, Ranum et al. (2021) reported inadequate patient assessment in the preoperative setting as the second

leading factor contributing to closed claims due to airway injury.

The American Association of Nurse Anesthetists (AANA) Foundation also conducts an ongoing study of closed malpractice claims that includes only CRNAs. The predominant occurrence of respiratory events in 27% of claims was related to an undocumented airway assessment (Moody & Kremer, 2001). Of note, Kremer et al., (2019) identified that taking adequate time to perform a thorough preoperative airway assessment is challenge in fast-paced environments that prioritizes productivity. It was recognized that failure to perform a complete preoperative airway assessment that ultimately resulted in brain damage or death due to an inability to maintain oxygenation or ventilation, were peventable. Larson and Jordan (2001) also reported that most claims related to respiratory incidents involving airway problems are preventable, and reiterated that a documented airway assessment is standard of care and must be considered routine when performing a preoperative assessment.

2022 Difficult Airway Algorithm Update

The ASA Practice Guidelines for Management of the Difficult Airway, first published in 1992, included a difficult airway algorithm meant to place emphasis on safe airway management. Recently, the ASA put forth the third-ever revision of the guidelines. The update specifically expanded its purpose to include optimizing the success of the first attempt at airway management (Rosenblatt, 2022). New evidence was obtained from recent scientific literature and from surveying the experts. It was concluded that ultrasound of the airway is a reliable evaluation method and diagnostic test when used to predict risk of a difficult airway. It is suggested that ultrasound measurements be obtained during bedside risk prediction for difficult airways and should include skin-to-hyoid distance, tongue volume, and distance from skin to epiglottis (Apfelbaum et al., 2022). Rosenblatt (2022) acknowledged that common techniques used to

evaluated that airway at the bedside are limited; it was reiterated that ultrasound may be used for pre-management airway evaluation and confirmation of tracheal intubation. Other applications for use of POCUS-A include, but are not limited to: identification of anomalies such as subglottic stenosis, identification of masses and other anatomic lung abnormalities, confirmation of correct placement of the endotracheal tube, use of the correct size of endotracheal tube, and more. Most of these, if identified during POCUS-A, can prompt a patient-specific plan for securing the airway prior to an anesthetic and can significantly decrease the risk of failure to oxygenate and ventilate.

Airway POCUS (POCUS-A) and Respective Relevancy to this DNP Project

The developing body of evidence regarding POCUS-A supports its use as an adjunct assessment tool for the difficult airway (You-Ten et al., 2018). POCUS-A is safe, reliable, fast, repeatable, and can be used with pregnancy, children, and infants; it does not require strict immobility (unlike MRI or CT), and has no claustrophobic effects (Sutagatti & Kurdi, 2016). Li et. al (2018) provided an overview of the use of POCUS-A and described it as an emerging practice amongst anesthesia providers; the emphasis now is to incorporate training in programs and to train more professionals on its use. The authors described how POCUS-A can be used in all phases of perioperative care including a preoperative airway assessment, confirmation of tracheal intubation and of one-lung ventilation, and postoperative assessment of subglottic edema. Several researchers demonstrated success in teaching anesthesia providers how to use POCUS-A using various formats such as videos or cadaver practice (Osman & Meng-Sum, 2016).

Austin et al. (2021) discussed the practicality of using airway ultrasound during emergent airway situations and the increased risk such situations entail. The authors believe POCUS-A can

mitigate those risks during an emergent situation, confirm ETT placement, identify the cricothyroid membrane, and assess aspiration.

In recent years, research regarding ultrasound-based airway assessment has shown promise in its use as a noninvasive and useful bedside adjunct tool to clinical airway assessment (Zheng et al., 2021). Further investigation has revealed numerous studies regarding ultrasound's potential to provide detailed anatomical description, thus aiding in the identification of difficult airways (Sharma & Bhalla, 2020).

POCUS-A

Predicting difficult laryngoscopy

Sotoodehnia et al. (2021) conducted a systematic review and meta-analysis of 26 articles, from 11 different countries that examined a total of 45 ultrasound indicators for predicting difficult intubation. The findings revealed the two most prominently used indicators were distance from the surface skin of the anterior neck to the epiglottis, and anterior neck soft tissue thickness measured at vocal cord and hyoid bone levels. Several other indicators were described that could accurately predict difficult intubation, however they lack external validity. Possible explanations for this conflicting result include heterogeneity specific to the operator performance, the Cormack-Lehane measurement, and differences in demographic characteristics of the sample (BMI and ethnicity). Several other ultrasound parameters were assessed including skin thickness at the epiglottis and hyoid bone levels, hyomental distance, and hyomental distance ratio; these all correlated with difficult laryngoscopy, suggesting that ultrasound can be used for predicting difficult airways.

In addition, Xu et al. (2022) did a case-cohort study comparing traditional airway assessment methods – such as the Mallampati rating, ability to open the mouth wide, and

thyromental distance – to ultrasound measurements. Ultrasound was able to predict both difficult laryngoscopy and difficult tracheal intubation more accurately than the traditional methods. This study emphasizes the shortcomings of traditional airway assessment methods and highlights ultrasound for predicting the difficult airway.

Determining appropriate ETT size and confirming ETT placement

Adler et al. (2020) summarizes various uses of POCUS-A in adults and pediatrics, and suggest increasing the use of POCUS in the pediatric population. The authors explain that height and weight are poor predictors for selecting the correct ETT size, especially in children. POCUS measures the diameter of the trachea, which is a valid and reliable measurement that should be used to select the correct ETT size. In addition, ultrasound of the airway is used to confirm ETT depth and thus prevent endobronchial intubation. The authors also emphasize that POCUS can be used to measure the subglottic space diameter, which is the narrowest part of the airway in children. Since the narrowest tracheal diameter is the limiting factor for ETT size, this measurement provides critical information that could impact airway securement during anesthesia induction.

Salvadori et al. (2021) reiterated the use of POCUS-A as a rapid, tolerable, and highly reliable method used to confirm ETT placement in term and preterm infants using the right pulmonary artery as a landmark. Furthermore, the authors suggested investigating this use of POCUS-A for future routine use as a means to reduce radiation exposure (otherwise necessary with other imaging modalities) to this vulnerable population.

Gottlieb et al. (2020) summarizes the multiple applications of POCUS-A including but not limited to predicting difficult laryngoscopy, confirming intubation, and identifying subglottic stenosis. When predicting ETT tube size, the authors note POCUS is as accurate as MRI and CT

scan for pediatrics and more precise than age-based calculations. Emphasis is placed on confirmation of correct ETT placement and depth. Interestingly, the authors state that POCUS may be the only indicator of correct ETT placement during cardiac arrest, as end-tidal CO2 and capnography may not be reliable. With regards to determining ETT depth, the authors determined that POCUS can reliably prevent bronchial intubation, and also ensures that ETT depth is not too shallow, minimizing risk of being dislodged at any point in time.

Detecting upper airway pathologies

POCUS has been used to evaluate the anatomy of the upper airway and depict pathologic anomalies often related to varying physical attributes such as short and thick necks, large overall body habitus, and/or limited neck mobility and extension (Daniel et al., 2020). Lun et al. (2016) surmised that as a point-of-care non-invasive device, POCUS dynamically evaluates the upper airway in subjects with upper airway disorders in real-time and during respiration. In an observational study that compared upper airway structure anatomical views obtained by ultrasound to "real anatomy" observed in cadaver models, Gomez-Lopez et al. (2018) reported similar accuracy.

Several case studies provide examples of how airway ultrasound can be used to detect airway anomalies and potentially prevent the inability to secure an airway. Adi et al. (2021) discussed a case of a patient who arrived at the emergency department with worsening shortness of breath and a hoarse voice. Airway ultrasound was used to reveal a large mass that was invading the subglottic space, which was later confirmed on CT scan. Had this patient been induced for anesthesia necessitating airway securement, a lethal catastrophic event may have happened. Lee et al. (2021) published pediatric case studies where intubation failed even when using ETTs that were small for the age and size of the children. Their use of POCUS-A allowed

for rapid and noninvasive assessment to guide further intubation attempts; it was discovered that one of the children had grade III subglottic stenosis, was unable to be intubated at all, and subsequently underwent an emergent tracheostomy. Another published case study involved an 8-year-old child who had unexpected severe subglottic stenosis during an intubation attempt. After placing an emergent tracheostomy, POCUS-A revealed a previously undiagnosed foreign body obstruction as the cause of the subglottic stenosis (Tsuji et al., 2019). If the child had been assessed with POCUS-A prior to the intubation attempt, the tracheostomy may have been avoided.

Lastly, Mishra et al. (2018) conducted a prospective randomized single center study in a level one trauma center emergency department. They reported success using POCUS-A to identify potentially fatal conditions such as tracheal injury, abnormal neck vessels (as part of preparation for surgical airway in case of failed intubation), paratracheal hematoma, vocal cord pathology, pneumothorax, and other pathology during trauma related resuscitation.

Limitations of POCUS-A

Given its relative novelty as an airway assessment technique, POCUS-A does demonstrate limitations with regards to its use and implementation. Although much available evidence highlights an improved diagnostic accuracy and reduced time to diagnosis, there is no current evidence to suggest a difference in patient outcomes, though this data may accumulate with time (Smallwood & Dachsel, 2018).

The ability to use POCUS-A in the manner described in this literature review hinges upon institutions having the necessary equipment available and the anesthesia provider's ability to learn and gain competency in its performance. Several studies cited a lack of training pathways or supervisory guidance to explain why anesthesia providers may be unable or unwilling to use

POCUS-A (Park et al., 2019; Smallwood & Dachsel, 2018). POCUS-A is dependent on operator experience and expertise. Successful use in performing technical skills and subsequent improved outcomes are reliant on proper training to gain proficiency as well as the ability to select the proper technology/transducer (Osman & Sum, 2016; Sutagatti & Kurdi, 2016). Accurate interpretation of sonogram images also requires a thorough understanding of relevant airway anatomy being imaged, consideration of the physics of the ultrasound beam, and the ability to identify target structures (Novitch et al., 2019; Sutagatti & Kurdi, 2016). For example, using POCUS-A to identify correct ETT placement depends on the clinician's skill in visualizing the vocal cords and on clinical methods to look for equal air entry on both lungs (Thomas et al., 2017).

One limitation that is specific to ultrasound itself is that ultrasound waves cannot travel well through air or bone. Intraluminal air demonstrates high acoustic impedance, will not transmit ultrasound signals properly, and produces a poor image (Sutagatti & Kurdi, 2016). Since the airway is an air-filled structure, POCUS-A can only be used to visualize anterior laryngeal structures (O'Carroll et al., 2021). Visualizing the epiglottis can be challenging because it is suspended in air. The thyroid bone, calcification of the thyroid cartilage, cricoid arch, and larynx can also create acoustic shadowing and artifact, making visualization of the vocal cords and laryngeal structures difficult (Song et al., 2016). Furthermore, the presence of soft tissue air may hinder visualization using POCUS-A (Gottleib et al., 2020). A large epiglottis or a pre-epiglottic space filled with fat may also obstruct the view of laryngeal structures and hinder measurements. This is because the fat deposit in the neck region can not be differentiated from other soft tissue structures (Sutagatti & Kurdi, 2016).

Another limitation to POCUS-A is the lack of guidelines or reference standards. The role

of POCUS-A in the preoperative setting is currently limited to available evidence-based recommendations (Meier et al., 2020). Despite the growing number of studies published seeking to identify an effective ultrasound indicator to predict a difficult airway, these studies themselves are limited in that they demonstrate a large variability of the sample and restrict the demographics of the population included for study. Furthermore, published research does not follow a standardized protocol for ultrasound assessments, because no such thing has yet been developed (Carsetti et al., 2022). A reference standard is not available for comparison to determine the accuracy of sonographic measurements of the upper airway lumen; this may be due in part to the expensive cost of MRI scans, and because radiation exposure from CT scans can not be used in evaluating healthy volunteers for research (Lun et al., 2016).

Conclusion

Our literature review demonstrates that POCUS-A shows great clinical promise but that research on this topic is in its infancy. While investigations have begun to unlock the potential of POCUS-A, there is more exploration to accomplish. The goal of this project is to help increase that awareness and help close the knowledge gap that may exist.

The objectives of this DNP scholarly project are:

1) To gather baseline data (via a survey) about CRNA current practice patterns related to assessment of the difficult airway, opportunities for POCUS-A, and possible barriers of implementation into clinical practice.
2) To determine the relevance of POCUS-A and clarify its application during pre-anesthetic airway assessment.
3) To inform CRNAs about the utility of POCUS-A by collating the results of the survey, and develop and present an educational program at two different hospital-

based anesthesia departments, located in Kalamazoo and in Marquette. Based on the feedback of these two departments, the program may be offered to members of MANA in the future

Problem Statement

Current airway assessment tools are poor predictors of the difficult airway. Despite the recent ASA difficult airway algorithm revision which highlights POCUS-A as an emerging tool to consider using for identification of the difficult airway and/or airway pathology, there is a lack of awareness and education regarding this topic among Michigan CRNAs.

Project Questions

1) What are the current practice patterns of the CRNAs who practice in the state of Michigan related to assessment of the difficult airway?
2) Are the CRNAs aware of the updated ASA difficult airway guidelines for POCUS – A, and respective difficult airway algorithm?
3) What are the opportunities for CRNAs in Michigan to incorporate POCUS-A into their clinical practice?
4) What are the barriers of implementation into CRNA clinical practice?

The assessment techniques currently used by CRNAs to predict the difficult airway are not highly sensitive nor specific, often unreliable, and subject to varying interpretation. The application of POCUS is a more contemporary method to assess the airway for difficulty prior to an anesthetic; it has great potential to reduce adverse outcomes. Airway POCUS is simple, non-invasive, portable, has a shallow learning curve, and is a relatively easy skill to master with appropriate training; therefore, increasing awareness of its feasibility is certainly a practical undertaking (Adi et al., 2019). Given the available evidence of its relevance as a pre-intubation

screening tool and its potential to improve outcomes of care, airway POCUS warrants further investigation and education regarding its place as an adjunct to routine clinical practice.

The incorporation of POCUS into airway assessment is a significant advancement in the field of anesthesiology, giving providers an important adjunct and tool to continue improvement in coordinating safe patient airway management (Li et al., 2020). Our literature view demonstrates that a relationship does exist between airway POCUS measurements and the CL grade view obtained during laryngoscopy, and delineates which measurements provide useful information for successful intubation.

The purpose of this Doctor of Nursing Practice (DNP) project is:

1) To illuminate how CRNAs currently proceed with an anesthetic induction requiring intubation for the adult patient when a known or suspected difficult airway has been preoperatively identified
2) To ascertain if there is perceived value and interest for incorporating POCUS-A into the preoperative airway assessment.
3) To provide a scholarly presentation to the anesthesia departments at Bronson Methodist Hospital in Kalamazoo (BMH) and Upper Peninsula Health System in Marquette (UPHS-Mqt) specific to the updated ASA difficult airway algorithm, including: an introduction to POCUS-A as an additional tool to enhance the prediction of the difficult airway, and a hands-on competency demonstration and practice of technical skills.

Conceptual Framework

Stevens (2013) ACE Star Model of Knowledge Transformation evidence-based practice (EBP) framework will be applied to this project. The ACE Star Model framework conceptualizes the knowledge transformation that must occur in an EBP environment by describing the cycle of

change that knowledge must go through to be "clinician ready" (Kring, 2008). The model itself delineates the steps used to develop EBP as 5 distinct points on a star connected by a circular ring (see Fig 1) and serves to provide tangible outcomes for the EBP process (Kring, 2008). The first point on the star is "Discovery Research" where new knowledge is discovered. The second point on the star is the "Evidence Summary" in which the knowledge gained during the "Discovery Research" phase is synthesized, summarized, and analyzed to draw conclusions. The third star point is the "Translation to Guidelines" phase where it is determined how the knowledge gained in the first two phases can be applied to the clinical setting. The fourth point is the "Practice Integration" phase where the new knowledge is applied, and practices are changed to follow that knowledge. The fifth point on the star is the "Process, Outcome Evaluation" phase where the practice changes and outcomes are evaluated based on various endpoints.

This proposed DNP Clinical Research project closely follows the ACE Star Model. The "Discovery Research" and "Evidence Summary" phases were fulfilled through completion of the literature review, which involved summarizing the most current evidence about methods and measurements most applicable to identify a difficult airway with POCUS. The "Translation to Guidelines" phase occurred when providing an overview to providers, and describing the technique, specific to airway measurements that are reliable for predicting difficulty. The "Practice Integration" phase occurred during the hands-on conducting of the technique, as well as interacting with colleagues on how to incorporat this new knowledge into standard clinical practice. Emphasis is placed on the potential to improve outcomes of care. Finally, the "Process, Outcome Evaluation" phase is ongoing. Evaluation of changes in practice patterns and descriptions of patient-care outcomes based on peer feedback will allow the authors of this project to collaborate with peers regarding accepting airway POCUS as a permanent addition to

practice.

Project Methodology

Design

This evidence-based DNP project is both new program development and part quality-improvement initiative. It is designed:

1. To assess familiarity with POCUS-A amongst MANA CRNAs
2. To develop a new program via a professional scholarly educational presentation (based on responses from the MANA survey) and present to the CRNA and Physician Anesthesiology staff at BMH and UPHS-Mqt.

Setting

After Oakland University IRB approval, participating members of MANA completed the survey (see Appendix B) online at a location of their choosing. The professional scholarly educational presentation -via powerpoint format- (see Appendix G) during department-required anesthesia personnel meetings in Kalamazoo (BMH) and Marquette (UP-Mqt).

Key Personnel / Stakeholders

Primary stakeholders were identified as individuals and personnel whose support was solicited in order to influence project activities and the eventual implementation of EBP changes. Theresa Murphy (FUJIFILM Sonosite Senior Clinical Specialist) was instrumental in providing education on performing POCUS-A. Anesthesia department CRNAs and MDAs at Marquette and Kalamazoo supported the development of this project. And the MANA management team members Jennifer Dickie, CAE CMP (MANA Staff Association Manager Specialist) and Aaron Wittbrodt (MANA Account Manager) facilitated disseminating the survey to MANA members.

Participants / Population

The participants in this DNP project are members of MANA who completed the survey, the CRNAs and Physician Anesthesiologists who viewed the voice-over PowerPoint and offered a verbal evaluation, and the CRNAs/Physician Anesthesiologists who participated in the hands-on practicum.

Recruitment Strategies

After Oakland University IRB approval (see Appendix A), CRNAs who are members of MANA were sent an email (see Appendix D) from the management team of MANA that introduced information about the survey research (see Appendix C) and provided a link to participate anonymously via Qualtrics. The presentation and in-service for the CRNAs and Physician Anesthesiologists at BMH and UPHS took place May 4th (BMH) and May 11th (UPHS-Mqt) of each month. Attendance for these meetings is mandatory for all anesthesia staff members, per their respective department administration policies.

Implementation – Additional Detail

A Qualtrics survey (see Appendix B) and survey information sheet (see Appendix C) were created and modified by the project team members which included questions based on the objectives of this project. After meticulously evaluating and organizing the survey to ensure the information included aligned with the goals of this DNP project, the final survey consisted of 16 questions regarding CRNA demographics and current employment arrangement, clinical practice and approach to identifying the difficult airway, POCUS, and POCUS-A. After IRB approval, Jennifer Dickie, CAE CMP (MANA Staff Association Manager Specialist) and Aaron Wittbrodt (MANA Account Manager) were emailed the survey and recruitment email (see Appendix D); they anonymously distributed it to MANA members who agreed to receive such emails. A total of 74 responses were recorded and analyzed.

The professional scholarly educational program was developed after the survey was finalized and completed. This presentation included the results of the survey, current evidence-based information, and relevant clinical applications of POCUS-A with graphics and videos. The hands-on semi-formal POCUS-A practicum was created in accordance with the ASA Difficult Airway Algorithm update following personalized guidance and scanning practice sessions with Theresa Murphy (FUJIFILM Sonosite Clinical Senior Specialist).

Data Collection Instruments

Qualtrics software was utilized to develop the format of the survey. Qualtrics is a simple, easy to use, web-based survey tool used to conduct survey research, evaluations, and other data collection activities; Qualtrics is supported by Oakland University. The anonymous reusable survey link was embedded in the recruitment email (see Appendix D) sent to MANA members. This link was untraceable and could not be used to identify respondents. Participant responses were automatically saved by Qualtrics. Returned data was extracted and analyzed by the DNP project student authors.

Potential Barriers to Implementation & Sustainability

Survey-based research is associated with low response rates. The low response rate experienced with this project's survey could be due to the amount of time required for completion of the survey, CRNAs unwilling to respond, or unfamiliarity with POCUS-A. The number of incomplete responses could be a result of allowing participants to start and stop the survey in more than one sitting. This inadvertently allowed for the possibility of forgetting to complete it. It is also possible for the email to be sent to spam folders.

Barriers to implementation include anesthesia providers' reluctance to change their practice, unfamiliarity with ultrasound, policy-based restrictions to ultrasound access, or lack of

desire to learn. Furthermore, not all CRNAs may have been able to attend the anesthesia department meeting when the presentation and in-service occurred. Barriers to CRNAs obtaining competency with POCUS-A include facility equipment availability, supervisory capability, and the desire to learn.

Ethical Considerations & Risks

There are no ethical risks related to this project other than the possible breach of confidentiality for survey participants. This risk was by minimized by adhering to IRB mandated policy and procedure.

Potential Benefits & Outcomes

This project offers numerous benefits both to providers of anesthesia care and to recipients of anesthesia care (the patient). By offering information specific to POCUS-A, CRNAs are informed of the most recent evidence that supports quality processes on performing pre-anesthesia airway assessment, and prevention of the “cannot intubate cannot ventilate” scenario. The educational presentation and hands-on practice are comprehensive learning activities that enhance the anesthesia provider's airway assessment skills, which may decrease airway-related adverse events, and improve patient outcomes. The anesthesia providers also have the opportunity to learn about the new 2022 ASA Difficult Airway Algorithm, a vital algorithm for their practice with which they may yet be unfamiliar.

Timeline

IRB approval was obtained from Oakland University on September 14, 2022 (see Appendix A). Participating members of MANA received an initial ‘recruitment’ email (see Appendix D) that contained the information sheet (see Appendix C) and anonymous link to the Qualtrics survey (see Appendix B) on September 19, 2022. A follow-up email was sent on

October 10, 2022. The survey link was made inactive on November 1, 2022.

The professional scholarly educational presentation and semi-formal hands-on practicum was delivered to the anesthesiology staff at BMH in Kalamazoo, Michigan in a hybrid format which allowed anesthesiology staff members to attend either in-person or via Zoom, and at UPHS-Mqt at Marquette, Michigan, on May 11, 2023, in an in-person meeting format. Informal feedback from anesthesia personnel at both sites was positive, indicated an understanding of POCUS-A as a useful adjunct assessment tool, and included an interest for further education in the future. This DNP project was disseminated on the Oakland University School of Nursing DNP Project dissemination day (June 9, 2023) at Oakland University.

Anticipated Resources, Budget, & Funding Plan

Expenses for this project included travel to meet with the FUJIFILM Sonosite educational representatives. These expenses were paid by the researchers and no funds were received during the creation of this project.

Evaluation of Objectives

Our project purpose was to achieve greater awareness of POCUS and POCUS-A amongst Michigan CRNAs, to provide education to anesthesia providers, and to offer an opportunity for hands-on practice and achievement of technical competency of POCUS-A.

Achievement of the first project objective was completed. A survey was created to gather baseline data about CRNA current practice patterns related to assessment of the difficult airway, opportunities for POCUS-A, and possible barriers of implementation into clinical practice.

Achievement of the second project objective was completed. We determined the relevance of POCUS-A and clarified its anesthetic applications through completion of our literature review and survey.

Achievement of the third project objective was completed. The survey results were collated, and a scholarly educational presentation developed that included video recordings and images of our hands-on practice performing POCUS-A. The presentation to our colleagues in the respective hospital-based anesthesia departments at BMH and UPHS-Mqt was well-received. The intent to inform CRNAs about the utility of POCUS-A was accomplished. Non-written informal evaluation of the educational program was obtained. CRNA feedback was extremely positive; they valued the content and many did not realize the numerous applications of POCUS-A. Comments includes evidence of great potential and some commented that it may also serve the ear, nose, and throat (ENT) multi-disciplinary care team (and for anesthesiology) as well.

Results

A total of 2,200 CRNA members of MANA received the survey via email. The survey remained open for 6 weeks, during which a total of 74 responses were recorded and analyzed; 11 participants did not complete the survey in its entirety. Responses were considered incomplete if the survey was not finished within two weeks of beginning it. Both complete and incomplete responses were recorded for analysis. Survey data was automatically compiled into an Excel report, and the results for each question was generated as a PDF report. To view the total responses for all questions of the survey in their entirety, see Appendix E.

Survey results

The demographic of survey participants is depicted in Table A below. The denominator of the respondents is n=66.

Table A:

Survey Demographics	
Years Practicing	
<5 years	15
6-10 years	6
11-15 years	13
16-20 years	6
>21 years	26
Practice Setting	
Ambulatory Surgery Center	6
Hospital	58
Pain Center	0
Endoscopy Center	2
Obstetric Department	0
Geographic Setting	
Urban	29
Rural	15
Suburban	22
# of CRNAs in pratice	
Solo	2
2-10	23
11-20	4
>20	37

Survey results regarding pre-anesthesia airway assessment methods revealed that Mallampati score was most commonly used, followed by thyromental distance, atlantoaxial range of motion, and interincisor distance. Comments for other methods used for airway assessment included: “experience”, “just look”, “look at previous records or patient history”, or “can’t consistently do an exam due to work environment”.

The majority of participants reported they do not regularly use POCUS in their practice (n=38/64). Those that do use POCUS (n=14/64) reported common uses: placing peripheral IV access (n=23/63), obtaining arterial or central venous access (n=22/63), or performing peripheral nerve blocks (n=13/63). Only one response (n=1/63) reported using POCUS during airway assessment. Most participants (n=50/61) were unaware of the ASA difficult airway algorithm update. Responses indicated a general awareness that POCUS-A can be used to predict a difficult airway (n=53/61), determine appropriate ETT size (n=49/61), confirm ETT placement (n=53/61), facilitate needle cricothyrotomy (n=67/61), and detect upper airway pathologies (n=50/61); however, the overwhelming majority (n=58/61) have not used POCUS for any of

these reasons.

Most importantly, the preponderance of participants (n=45/61) indicated an interest in learning more about POCUS-A. This expressed desire to learn, as well as lack of awareness of the ASA Difficult Airway Algorithm update and the utility of POCUS-A, demonstrated the need for our project and prompted the development of our presentation.

Discussion

This DNP scholarly project sought to determine current use and perceptions of POCUS-A. The literature review validated the need for raising awareness of evidence-based airway assessment methods for improving outcomes of care. Great potential exists with advancements in technology and assessment methods, including POCUS-A. Our survey depicted a knowledge gap specific to the utility, potential, and value of POCUS-A. Only one CRNA reported that they use ultrasound for assessing the airway. A majority of the CRNAs who completed the survey were also unaware of the new ASA Difficult Airway Algorithm, making it likely that they did not previously know that ultrasound is now a recommended assessment technique. The survey also showed a large amount of variability amongst preoperative airway assessment methods, which was also identified in the literature review.

There is clear evidence that performing POCUS-A during a pre-anesthesia assessment is not a current practice pattern among CRNAs in Michigan. What is exciting, however, is that the CRNAs practicing at both BMH in Kalamazoo and UPHS in Marquette want to learn more about POCUS-A. These providers are most likely a subset of the greater CRNA population who want to improve quality of care and outcomes for their patients.

Facilitators, in general, for incorporating airway ultrasound into common anesthesiology practice include the desire to improve patient care and prevent harm, to perform additional

research and offer more supporting evidence, and to conduct clinical quality projects like ours to familiarize anesthesia providers with POCUS-A. In addition, departments do need to add to the numbers of ultrasound machines/associated technology within each facility. Availability of the technology and a lack of restrictions on its use will no doubt increase competencies and ultimately improve care.

Barriers to incorporating airway POCUS include a lack of desire to learn, a real or perceived lack of time to learn, a lack of expert personnel to teach and train providers, a lack of comfort associated with straying from traditional (yet antiquated) techniques, not wanting to take the time or perform the technique preoperatively, or not having an ultrasound machine or resources available.

Facilitators & Barriers

There were no barriers to our project. The anesthesia team members at both of our clinical sites in Kalamazoo and Marquette were supportive, expressed interest in our project topic, and served to facilitate its development and dissemination.

Unintended Consequences

Airway POCUS is non-invasive and safe but there may be unintended consequences associated with its use. As with any new skill or technique, there will be a learning curve associated with beginning to incorporate POCUS-A into clinical practice. While proficiency and familiarity will develop over time and with increased exposure, there could be a risk that providers who are new to POCUS-A may perform or interpret measurements inaccurately. A false positive for a difficult airway could result in an inappropriate use of resources or time, while a false negative could lead to a lack of preparedness for a difficult airway.

This project revealed that POCUS-A as an airway assessment method is progressively

emerging. There remains much to learn and research. Ongoing studies may delineate more specific applications and measurements in the future. There is clearly an opportunity for POCUS-A integration into current practice as an adjunct strategy for pre-anesthesia airway assessment. However, our project did highlight the need for appropriate education and program setup. As POCUS and POCUS-A continue to grow in popularity amongst providers, programs need to determine how to allocate time and resources to training, clinical use, and quality assurance (Liu et al., 2017).

Project Limitations & Recommendations

There were multiple limitations to this DNP project. One notable limitation is the small sample size: only 74 of the 2,200 total MANA members who received our emailed survey link chose to participate by completing the survey, and only 63 participants completed the survey in its entirety. This small sample size prevents our findings from being extrapolated to larger populations. In addition, our survey was only distributed to Michigan CRNAs who are members of MANA, and the sampled workplace was reported to primarily be in an urban hospital setting. It is reasonable to assume that anesthesia practices vary according to region and state, and the homogeneity of respondents we experienced could further hinder the accuracy and applicability of our results. Future POCUS-A research should endeavor to survey a broader sample more representative of a heterogeneous population. Finally, the authors of this DNP project were taught the basics of airway ultrasound procedure, but the opportunity for more in-depth practice of advanced scanning techniques would help improve their understanding and enhance their ability to teach.

Recommendations for Sustaining Intervention

In order to sustain and continue the advancement of POCUS-A as an effective

intervention, future studies should focus on gathering data regarding its accuracy for predicting the difficult airway. To date, a gold standard POCUS-A scan measurement has not yet been established. Our literature review did highlight some specific measurements that demonstrate the potential to be such, however the majority of articles included for review strongly reiterated the need for future high-quality studies. Many of the applications of POCUS are also based on case studies, which rank low on the hierarchy of evidence pyramid (Academic Guides, 2023)

Michigan CRNAs need to take initiative to gain more experience with airway POCUS to sustain this intervention. Strategies for achieving this include seeking out additional teaching modules, hands-on workshops, creating information sheets, sharing knowledge with their peers, and incorporating POCUS-A into their daily practice. Creating a protocol regarding airway POCUS may also be beneficial to its successful implementation (Carsetti et al., 2022).

Applications in Other Settings or Populations

While the focus of this literature review was the use of airway POCUS on the general surgery population, there are some populations for which airway POCUS may be particularly beneficial. POCUS can improve patient care by significantly reducing time to diagnosis (Smallwood & Dachsel, 2018), facilitating the development of a safe and efficient plan for airway establishment. For instance, providers may use airway POCUS to assess the patient undergoing ENT surgery involving the neck or glottic region. Airway POCUS may also enhance assessment of the patient who has had oral or neck cancer and/or has undergone radiation to these areas. Paramedics and other first responders with intubation capabilities could consider using POCUS-A to rapidly identify esophageal intubation in the field (Lema et al., 2018). Pediatricians, otolaryngologists, and Emergency Department providers may find POCUS-A to be useful in identifying aspirated or esophageal foreign bodies and guiding their plan of treatment

(Goussard et al., 2021). POCUS-A can be used as an initial assessment for certain indicators that require a radiology referral for CT or X-ray confirmation, such as broken bones, ligament tears, or other acute injuries (Arnold et al., 2020). This could mitigate healthcare costs, streamline treatment, minimize unnecessary radiation exposure, and foster judicious use of resources.

Implications for Practice & Career Development

In our opinion as authors of this project, we believe POCUS-A has the potential to become a standard of care. While it is still a newer technique, CRNAs should take ownership of their own professional responsibility by incorporating POCUS-A into their daily practice. Anecdotally, the broader use of POCUS has become increasingly popular, evidenced by its use during peripheral nerve blocks, Focused Assessment with Sonography in Trauma (FAST) exams, and more. This further underlines that POCUS is an actively emerging invaluable tool with innumerable applications that can be used in a wide variety of settings. The utility of POCUS-A may become even more evident as future studies are conducted regarding the effectiveness of airway POCUS in predicting difficult airways, determining ETT sizes, and detecting pathologies and anomalies. Additionally, an increased comfort level and proficiency at performing POCUS-A will enable the anesthesia provider to efficiently gather an abundance of valuable information about the airway in a short amount of time.

Contribution of Project in Achieving DNP Essentials

The American Association of Colleges of Nursing's (AACN) Essentials of Doctoral Education for Advanced Nursing Practice outline the curricular elements and competencies that must be present in programs conferring the DNP degree. Designed to prepare nurse scientists and scholars with a focus in practice, the foundational DNP Essentials I through VIII are described in detail by the AACN DNP Taskforce (Hathaway et al., 2006). Throughout its creation and

completion, this project succeeded in fulfilling multiple DNP Essentials.

Essential I, scientific underpinnings for practice, was achieved by using science-based theories and concepts to determine the nature and significance of the health care delivery phenomenon of the difficult airway. This knowledge served as the impetus for developing a project to address practice issues in preanesthesia airway assessment. By investigating advanced strategies involving airway ultrasound technology, new practice approaches were developed based on nursing science and nursing theories to use POCUS-A to alleviate the phenomena of the difficult airway. Appropriate knowledge and actionable strategies were effectively communicated with peer CRNAs to foster positive changes.

To fulfill Essential II, organizational and systems leadership for quality improvement and systems thinking, this project evaluated health care delivery approaches and developed a new strategy to better meet patient needs. By using scientific findings from nursing and other clinical disciplines that outlined opportunities for improvement in airway assessment methods, POCUS-A was identified as an effective strategy for managing the dilemma of the difficult airway. Advanced communication skills were used to lead this quality improvement and patient safety initiative in the setting of the preanesthesia airway assessment, and this was driven by the need to ensure accountability for quality of health care and patient safety for the population we serve as anesthesia providers.

Essential III, clinical scholarship and analytical methods for evidence-based practice, was achieved by conducting a literature review to critically appraise existing literature and other evidence such as the updated ASA Difficult Airway Algorithm to determine the latest data regarding best evidence for airway ultrasound use. Relevant findings were applied to the development of practice guidelines regarding POCUS-A with the intent of promoting safe,

timely, effective, efficient, equitable, and patient-centered care.

The authors of this project were able to gather information from CRNAs throughout Michigan to gain an understanding of current practices, thereby fulfilling Essential VI, interprofessional collaboration for improving patient and population health outcomes. Furthermore, the authors were able employ effective communication and collaborative skills to develop new practice guidelines based on literature review findings and education obtained from meeting with airway ultrasound experts. This scholarly presentation was relayed to peer CRNAs in the hopes of creating positive change in practice and facilitating improved patient outcomes.

Contribution of Project in Achieving Personal Goals

Throughout this project's development and implementation, we learned how important it is to maintain professional accountability by keeping up with scientific and scholarly advancements. CRNAs truly are accountable to the public for professional excellence through lifelong learning and practice, continued certification, continuous engagement in quality improvement and professional development, and compliance with the AANA standards for nurse anesthesia practice (AANA Board of Directors, 2019). This project exposed us to the process of identifying current evidence based practices, highlighted relevant sources, and underlined the importance of never losing a questioning attitude and curious mind. We also feel grateful for the exposure to POCUS and its relevant applications, and feel this will only serve to enhance our own practice and confidence as CRNAs.

References

AANA Board of Directors. (2019, February). *Standards for nurse anesthesia practice*. American Association of Nurse Anesthesiology Professional Practice Division. Retrieved March 16, 2023, from https://www.aana.com/docs/default-source/practice-aana-com-web-documents-(all)/professional-practice-manual/standards-for-nurse-anesthesia-practice.pdf?sfvrsn=e00049b1_20

Academic guides: Evidence-based research: Levels of Evidence Pyramid. Levels of Evidence Pyramid - Evidence-Based Research - Academic Guides at Walden University. (n.d.). Retrieved March 14, 2023, from https://academicguides.waldenu.edu/library/healthevidence/evidencepyramid

Adi, O., Fong, C. P., Sum, K. M., & Ahmad, A. H. (2021). Usage of airway ultrasound as an assessment and prediction tool of a difficult airway management. *The American journal of emergency medicine*, *42*, 263.e1–263.e4. https://doi.org/10.1016/j.ajem.2020.09.011

Adi, O., Kok, M. S., & Abdull Wahab, S. F. (2019). Focused airway ultrasound: An armamentarium in future airway management. *Journal of Emergency and Critical Care Medicine*, *3*(31). https://doi.org/10.21037/jeccm.2019.06.05

Adler, A. C., Matisoff, A. J., DiNardo, J. A., & Miller-Hance, W. C. (2020). Point-of-care ultrasound in pediatric anesthesia: perioperative considerations. *Current opinion in anaesthesiology*, *33*(3), 343–353. https://doi.org/10.1097/ACO.0000000000000852

Alessandri, Antenucci, G., Piervincenzi, E., Buonopane, C., Bellucci, R., Andreoli, C., Alunni Fegatelli, D., Ranieri, M. V., & Bilotta, F. (2019). Ultrasound as a new tool in the assessment of airway difficulties: An observational study. European Journal of Anaesthesiology, 36(7), 509–515. https://doi.org/10.1097/EJA.0000000000000989

Apfelbaum, J., Hagberg, C., Connis, R., Abdelmalak, B., Agarkar, M., Dutton, R., Fiadjoe, J., Greif, R., Klock, P., Mercier, D., Myatra, S., O'Sullivan, E., Rosenblatt, W., Sorbello, M. & Tung, A. (2022). 2022 American Society of Anesthesiologists Practice Guidelines for Management of the Difficult Airway. *Anesthesiology, 136* (1), 31-81. doi: 10.1097/ALN.0000000000004002.

Arnold, M. J., Jonas, C. E., & Carter, R. E. (2020). Point-of-Care Ultrasonography. *American family physician*, *101*(5), 275–285.

Austin, Chang, M. G., & Bittner, E. A. (2021). Use of Handheld Point-of-Care Ultrasound in Emergency Airway Management. Chest, 159(3), 1155–1165. https://doi.org/10.1016/j.chest.2020.09.083

Caplan, R. A., Posner, K. L., Ward, R. J., & Cheney, F. W. (1990). Adverse respiratory events in anesthesia: a closed claims analysis. *Anesthesiology*, *72*(5), 828–833. https://doi.org/10.1097/00000542-199005000-00010

Carsetti, A., Sorbello, M., Adrario, E., Donati, A., & Falcetta, S. (2022). Airway ultrasound as predictor of difficult direct laryngoscopy: A systematic review and meta-analysis. *Anesthesia & Analgesia*, *134*(4), 740–750. https://doi.org/10.1213/ane.0000000000005839

Daniel, S. J., Bertolizio, G., & McHugh, T. (2020). Airway ultrasound: Point of care in children-The time is now. *Paediatric anaesthesia*, *30*(3), 347–352. https://doi.org/10.1111/pan.13823

Domino, K. B., Posner, K. L., Caplan, R. A., & Cheney, F. W. (1999). Airway injury during anesthesia: a closed claims analysis. *Anesthesiology*, *91*(6), 1703–1711. https://doi.org/10.1097/00000542-199912000-00023

Fulkerson, J. S., Moore, H. M., Anderson, T. S., & Lowe, R. F., Jr (2017). Ultrasonography in the preoperative difficult airway assessment. *Journal of clinical monitoring and computing*, *31*(3), 513–530. https://doi.org/10.1007/s10877-016-9888-7

Gómez-López, L., Torres, B., Bergé, R., Aguirre, O., Luis, M., & Sala-Blanch, X. (2018). Ultrasound measurement of anatomical parameters of the upper airway in adults. Medición ecográfica de parámetros anatómicos de la vía aérea superior en adultos. *Revista espanola de anestesiologia y reanimacion*, *65*(9), 495–503. https://doi.org/10.1016/j.redar.2018.05.007

Gottlieb, M., Holladay, D., Burns, K. M., Nakitende, D., & Bailitz, J. (2020). Ultrasound for airway management: An evidence-based review for the emergency clinician. *The American journal of emergency medicine*, *38*(5), 1007–1013. https://doi.org/10.1016/j.ajem.2019.12.019

Goussard, P., Pohunek, P., Eber, E., Midulla, F., Di Mattia, G., Merven, M., & Janson, J. T. (2021). Pediatric bronchoscopy: recent advances and clinical challenges. *Expert review of respiratory medicine*, *15*(4), 453–475. https://doi.org/10.1080/17476348.2021.1882854

Harjai, M., Alam, S., & Bhaskar, P. (2021). Clinical Relevance of Mallampati Grading in Predicting Difficult Intubation in the Era of Various New Clinical Predictors. *Cureus*, *13*(7), e16396. https://doi.org/10.7759/cureus.16396

Hathaway, D., Allan, J., Hamric, A., Honig, J., Howe, C., Keefe, M., Lenz, B., Mooney, M. M., Sebastian, J., Taylor, H., Thompson, E., Bednash, P., Stanley, J., & McGuinn, K. (2006, October). *The Essentials of Doctoral Education for Advanced Nursing Practice*. American Association of Colleges of Nursing: The voice of academic nursing . Retrieved March 17, 2023, from https://nursing.lsuhsc.edu/Docs/Quality/AACN%20Essentials%20of%20Doctoral%20Education%20for%20Adv%20Nsg%20Practice%20(2006).pdf

Joffe, A. M., Aziz, M. F., Posner, K. L., Duggan, L. V., Mincer, S. L., & Domino, K. B. (2019). Management of Difficult Tracheal Intubation: A Closed Claims Analysis. *Anesthesiology*, *131*(4), 818–829. https://doi.org/10.1097/ALN.0000000000000281

Koundal, V., Rana, S., Thakur, R., Chauhan, V., Ekke, S., & Kumar, M. (2019). The usefulness of point of care ultrasound (POCUS) in preanaesthetic airway assessment. *Indian journal of anaesthesia*, *63*(12), 1022–1028. https://doi.org/10.4103/ija.IJA_492_19

Kremer, M. J., Hirsch, M., Geisz-Everson, M., Wilbanks, B. A., Clayton, B. A., Boust, R. R., & Jordan, L. (2019). Preventable Closed Claims in the AANA Foundation Closed Malpractice Claims Database. *AANA journal*, *87*(6), 468–476.

Kring, D. (2008). Clinical Nurse Specialist Practice Domains and Evidence-Based Practice Competencies: A Matrix of Influence. Clinical Nurse Specialist, 22(4), 179–183. https://doi.org/10.1097/01.NUR.0000311706.38404.cf

Lane-Fall, M. B., Bedell, V. M., & Eckenhoff, R. G. (2020). The future of research in anesthesiology. *International anesthesiology clinics*, *58*(4), 41–45. https://doi.org/10.1097/AIA.0000000000000291

Larson, S. L., & Jordan, L. (2001). Preventable adverse patient outcomes: a closed claims analysis of respiratory incidents. *AANA journal*, *69*(5), 386–392.

Larson, F., Nyström, I., Gustafsson, S., & Engström, Å. (2019). Key Factors for Successful General Anesthesia of Obese Adult Patients. *Journal of perianesthesia nursing : official journal of the American Society of PeriAnesthesia Nurses*, *34*(5), 956–964. https://doi.org/10.1016/j.jopan.2019.01.009

Lee, J. H., Cho, S. A., Ji, S. H., Jang, Y. E., Kim, E. H., Kim, H. S., & Kim, J. T. (2021). Use of Airway Ultrasound in Infants With Unexpected Subglottic Stenosis During Anesthesia Induction: A Case Report. *A&A practice*, *15*(2), e01369. https://doi.org/10.1213/XAA.0000000000001369

Lema, P. C., O'Brien, M., Wilson, J., James, E. S., Lindstrom, H., DeAngelis, J., Caldwell, J., May, P., & Clemency, B. (2018). Avoid the Goose! Paramedic Identification of Esophageal Intubation by Ultrasound. *Prehospital and disaster medicine*, *33*(4), 406–410. https://doi.org/10.1017/S1049023X18000651

Li, L., Yong, R. J., Kaye, A. D., & Urman, R. D. (2020). Perioperative Point of Care Ultrasound (POCUS) for Anesthesiologists: an Overview. *Current pain and headache reports*, *24*(5), 20. https://doi.org/10.1007/s11916-020-0847-0

Liu, R. B., Donroe, J. H., McNamara, R. L., Forman, H. P., & Moore, C. L. (2017). The Practice

and Implications of Finding Fluid During Point-of-Care Ultrasonography: A Review. *JAMA internal medicine*, *177*(12), 1818–1825. https://doi.org/10.1001/jamainternmed.2017.5048

Lukyanova, V. V., Pellegrini, J., Greenier, E., Anderson, B., & Morgan, B. (2021). Point-of-Care Ultrasound in Anesthesia Care: New AANA Practice Document Adopted by AANA Board of Directors. *AANA journal*, *89*(1), 9–11.

Lun, H. M., Zhu, S. Y., Liu, R. C., Gong, J. G., & Liu, Y. L. (2016). Investigation of the Upper Airway Anatomy With Ultrasound. *Ultrasound quarterly*, *32*(1), 86–92. https://doi.org/10.1097/RUQ.0000000000000163

Lundstrom, Vester-Andersen, M., Moller, A. M., Charuluxananan, S., L'Hermite, J., & Wetterslev, J. (2011). Poor prognostic value of the modified Mallampati score: a meta-analysis involving 177 088 patients. British Journal of Anaesthesia : BJA, 107(5), 659–667. https://doi.org/10.1093/bja/aer29

McKeen, D. M., Banfield, J. C., McIsaac, D. I., McVicar, J., McGavin, C., Earle, M. A., Ward, C., Burns, K. K., Penner, D., Blaise, G., de Greef, T., Cowan, K., Laupacis, A., & Perioperative Anesthesia Clinical Trials Group (PACT) (2020). Top ten priorities for anesthesia and perioperative research: a report from the Canadian Anesthesia Research Priority Setting Partnership. *Canadian journal of anaesthesia = Journal canadien d'anesthesie*, *67*(6), 641–654. https://doi.org/10.1007/s12630-020-01607-6

Meier, I., Vogt, A. P., Meineri, M., Kaiser, H. A., Luedi, M. M., & Braun, M. (2020). Point-of-care ultrasound in the preoperative setting. *Best practice & research. Clinical anaesthesiology*, *34*(2), 315–324. https://doi.org/10.1016/j.bpa.2020.04.010

Metzner, J., Posner, K. L., Lam, M. S., & Domino, K. B. (2011). Closed claims' analysis. *Best practice & research. Clinical anaesthesiology*, *25*(2), 263–276. https://doi.org/10.1016/j.bpa.2011.02.007

Min, J. J., Kim, G., Kim, E., & Lee, J. H. (2016). The diagnostic validity of clinical airway assessments for predicting difficult laryngoscopy using a grey zone approach. *The Journal of international medical research*, *44*(4), 893–904. https://doi.org/10.1177/0300060516642647

Mishra, P. R., Bhoi, S., & Sinha, T. P. (2018). Integration of point-of-care ultrasound during rapid sequence intubation in trauma resuscitation. *Journal of Emergencies, Trauma, and Shock*, *11*(2), 92–97. https://doi.org/10.4103/jets.jets_56_17

Moody, M. L., & Kremer, M. J. (2001). Preinduction activities: a closed malpractice claims perspective. *AANA journal*, *69*(6), 461–465.

Novitch, M., Prabhakar, A., Siddaiah, H., Sudbury, A. J., Kaye, R. J., Wilson, K. E., Haroldson, A., Fiza, B., Armstead-Williams, C. M., Cornett, E. M., Urman, R. D., & Kaye, A. D. (2019). Point of care ultrasound for the clinical anesthesiologist. *Best practice & research. Clinical anaesthesiology*, *33*(4), 433–446. https://doi.org/10.1016/j.bpa.2019.06.003

O'Carroll, J., Endlich, Y., & Ahmad, I. (2021). Advanced airway assessment techniques. *BJA Education*, *21*(9), 336–342. https://doi.org/10.1016/j.bjae.2021.04.004

Osman, & Meng-Sum, K. (2016). Role of upper airway ultrasound in airway management. Journal of Intensive Care, 4(1), 52–52. https://doi.org/10.1186/s40560-016-0174-z

Park, S., Lee, S., Do, H. H., Kim, J. S., & Seo, J. S. (2019). Effectiveness of limited airway ultrasound education for medical students: a pilot study. *Clinical and experimental emergency medicine*, *6*(3), 257–263. https://doi.org/10.15441/ceem.18.061

Patel, B., Khandekar, R., Diwan, R., & Shah, A. (2014). Validation of modified Mallampati test with addition of thyromental distance and sternomental distance to predict difficult endotracheal intubation in adults. *Indian journal of anaesthesia*, *58*(2), 171–175

Pearce, A. C., Duggan, L. V., & El-Boghdadly, K. (2021). Making the grade: has Cormack and Lehane grading stood the test of time?. *Anaesthesia*, *76*(5), 705–709. https://doi.org/10.1111/anae.15446

Peterson, G. N., Domino, K. B., Caplan, R. A., Posner, K. L., Lee, L. A., & Cheney, F. W. (2005). Management of the difficult airway: a closed claims analysis. *Anesthesiology*, *103*(1), 33–39. https://doi.org/10.1097/00000542-200507000-00009

Ranum, D., Beverly, A., Shapiro, F. E., & Urman, R. D. (2021). Leading Causes of Anesthesia-Related Liability Claims in Ambulatory Surgery Centers. *Journal of patient safety*, *17*(7), 513–521. https://doi.org/10.1097/PTS.0000000000000431

Rosenblatt, W. (2022, August 12). *The 2022 ASA Practice Guidelines for Management Of the Difficult Airway: A Closer Look*. Anesthesiologynews.com. Retrieved November 15, 2022, from https://www.anesthesiologynews.com/Review-Articles/Article/08-22/ASA-Practice-Guidelines/67631

Roth, D., Pace, N. L., Lee, A., Hovhannisyan, K., Warenits, A. M., Arrich, J., & Herkner, H.

(2018). Airway physical examination tests for detection of difficult airway management in apparently normal adult patients. *The Cochrane database of systematic reviews*, *5*(5), CD008874. https://doi.org/10.1002/14651858.CD008874.pub2

Salvadori, S., Nardo, D., Frigo, A. C., Oss, M., Mercante, I., Moschino, L., Priante, E., Bonadies, L., & Baraldi, E. (2021). Ultrasound for Endotracheal Tube Tip Position in Term and Preterm Infants. *Neonatology*, *118*(5), 569–577. https://doi.org/10.1159/000518278

Sharma, A., Bhalla, S. (2020). Ultrasonographic Prediction of Difficult Laryngoscopy in Obese Patients. *Indian Journal of Medical Specialities*, 11(2), 76. https://doi.org/10.4103/injms.injms_128_19.

Smallwood, N., & Dachsel, M. (2018). Point-of-care ultrasound (POCUS): unnecessary gadgetry or evidence-based medicine?. *Clinical medicine (London, England)*, *18*(3), 219–224. https://doi.org/10.7861/clinmedicine.18-3-219

Song, K., Yi, J., Liu, W., Huang, S., & Huang, Y. (2016). Confirmation of laryngeal mask airway placement by ultrasound examination: a pilot study. *Journal of clinical anesthesia*, *34*, 638–646. https://doi.org/10.1016/j.jclinane.2016.06.019

Sotoodehnia, M., Rafiemanesh, H., Mirfazaelian, H., Safaie, A., & Baratloo, A. (2021). Ultrasonography indicators for predicting difficult intubation: a systematic review and meta-analysis. *BMC emergency medicine*, *21*(1), 76. https://doi.org/10.1186/s12873-021-00472-w

Stevens. (2013). The Impact of Evidence-Based Practice in Nursing and the Next Big Ideas. *Online Journal of Issues in Nursing*, 18(2), 122.

https://doi.org/10.3912/OJIN.Vol18No02Man04

Sutagatti, J. G., & Kurdi, M. S. (2016). Upper Airway Imaging and its role in preoperative airway evaluation. *Medical Journal of Dr. D.Y. Patil University*, *9*(3), 300–306. https://doi.org/10.4103/0975-2870.182496

Tavolara, T. E., Gurcan, M. N., Segal, S., & Niazi, M. K. K. (2021). Identification of difficult to intubate patients from frontal face images using an ensemble of deep learning models. *Computers in biology and medicine*, *136*, 104737. https://doi.org/10.1016/j.compbiomed.2021.104737

Thomas, V. K., Paul, C., Rajeev, P. C., & Palatty, B. U. (2017). Reliability of ultrasonography in confirming endotracheal tube placement in an emergency setting. *Indian Journal of Critical Care Medicine*, *21*(5), 257–261. https://doi.org/10.4103/ijccm.ijccm_417_16

Tsuji, T., So, M., & Sobue, K. (2019). Subglottic stenosis due to an unexpected foreign body diagnosed after emergency tracheostomy in a child. *JA clinical reports*, *5*(1), 46. https://doi.org/10.1186/s40981-019-0268-4

Xu, Wang, B., Wang, M., Yao, W., & Chen, Y. (2022). The value of multiparameter combinations for predicting difficult airways by ultrasound. BMC Anesthesiology, 22(1), 1–311. https://doi.org/10.1186/s12871-022-01840-0

Yao, W., & Wang, B. (2017). Can tongue thickness measured by ultrasonography predict difficult tracheal intubation?. *British journal of anaesthesia*, *118*(4), 601–609. https://doi.org/10.1093/bja/aex051

You-Ten, Siddiqui, N., Teoh, W. H., & Kristensen, M. S. (2018). Point-of-care ultrasound

(POCUS) of the upper airway. *Canadian Journal of Anesthesia*, 65(4), 473–484. https://doi.org/10.1007/s12630-018-1064-8

Zheng, Z., Ma, W., & Du, R. (2021). Effectiveness and validity of midsagittal tongue cross-sectional area and width measured by ultrasound to predict difficult airways. *Minerva anestesiologica*, *87*(4), 403–413. https://doi.org/10.23736/S0375-9393.20.14769-2

Figure 1. ACE Star Model of Knowledge Transformation

Appendix A. IRB Approval Letter

OAKLAND UNIVERSITY

Institutional Review Board

Date: September 14, 2022

Study #: IRB-FY2022-398

Study Tile: The Value of Airway POCUS in Recognizing the Difficult Airway

Submission Type: Initial

IRB Decision: Exempt

Research Team:
Kathryn Van't Hof
Mary Golinski, Nicholas Benda

Based on applicable federal regulations, the above referenced study has been determined to be Exempt, with the following categories:
Category 2.(i). Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording).
The information obtained is recorded by the investigator in such a manner that the identity of the human subjects cannot readily be ascertained, directly or through identifiers linked to the subjects.

Letter and Consent Document:
This letter along with the IRB approved (date-stamped) consent document can be found in Cayuse in the Submission Details page under Letters and Attachments, respectively. Please make sure to use the most recent IRB approved version of the consent form in consenting participants.

Permission from Research Sites:
Please note the following:

- This IRB exemption determination letter means that this research has met one or more of the federal criteria for exemption per 45 CFR 46.104- Exempt Research.
- Before the research is initiated, permission to conduct research at a given site must be obtained from all research locations listed in the IRB submission. You must keep copies of all such permission letters for your files.
- It is the responsibility of each researcher to follow all applicable policies and procedures of any outside institution where the research will be conducted.

Modifications:
Any changes to this exempt project must be reviewed by the IRB prior to initiation by submitting a MODIFICATION

request. Do not collect data while the changes are being reviewed. Data collected during this time cannot be used in research.

Record Retention:
Exempt projects will be retained by the IRB office for three years after the last action on the project.

You are approved to start the research. Please retain a copy of this notification for your records.

If you have any questions, please contact the IRB office.

Thank you.

The Oakland University IRB

Appendix B. MANA Survey – Data Collection Tool

Qualtrics MANA Survey

Survey Flow

Block: Survey Questions Block (21 Questions)
Standard: Comments Block (1 Question)

Page Break

Start of Block: Survey Questions Block

INTRODUCTION THE ROLE OF POINT OF CARE ULTRASOUND IN PREDICTING THE DIFFICULT AIRWAY

Thank you for agreeing to participate in this survey. When you are finished, please click on the submit button.

Page Break

SECTION 1 Demographics and Current Employment Arrangement

Q1 How many years have you been practicing as a CRNA? Consider the length of time in years after passing the NBCRNA National Certification Examination. (select only one)

- ○ **less than 5 years (1)**
- ○ **6 - 10 years (2)**
- ○ **11 - 15 years (3)**
- ○ **16 - 20 years (4)**
- ○ **more than 21 years (5)**

Q2 Which best describes the setting where you spend the majority of your time administering anesthesia (for example, your clinical setting where you practice anesthesia)

- ○ **Ambulatory surgery facility (1)**
- ○ **Hospital (2)**
- ○ **Pain Center (3)**
- ○ **Endoscopy Center (4)**
- ○ **Obstetric Department within a hospital (5)**

Q3 What best describes the geographic of where you spend the majority of your time practicing anesthesia?

- ○ **Urban (1)**
- ○ **Rural (2)**
- ○ **Suburban (3)**

- Other (please explain) (4)

_____

Q4 Approximately how many CRNAs are in your primary setting? (select only one)

- I am the only CRNA (1)
- 2-10 (2)
- 11-20 (3)
- more than 20 (4)

Q5 Which anesthesia practice model best describes your primary practice setting?

- Medical direction (one physician anesthesiologist oversees < 4 CRNAs concurrently) (1)
- Medical supervision (one physician anesthesiologist oversees > 4 CRNAs simultaneously) (2)
- Independent CRNA practice (3)

Page Break

SECTION 2 Clinical practice and approach to identifying the difficult airway

Q6 Consider an average 8-hour shift: how often do you perform an endotracheal

intubation in the operating room or in non-operating room areas?

- ○ **0-1 time (1)**
- ○ **2-3 times (2)**
- ○ **4 or more times (3)**

Q7 In your primary clinical practice, indicate which of the following is part of your responsibility as a CRNA: (select all that apply)

- ☐ **Responding as a member of a hospital-based Rapid Response Team for airway management (1)**
- ☐ **Responding for airway management of hospitalized patients, either on a medical surgical unit or in the ICU (2)**
- ☐ **Responding for airway management for patients in cardiopulmonary arrest (3)**
- ☐ **Responding for airway management for patients in the emergency department (4)**
- ☐ **Other (please list): (5)**

_____

- ☐ **None of the above (6)**

Q8 Considering the pre-anesthesia assessment, indicate all methods you use to assess the airway: (select all that apply)

- ☐ **Mallampati scoring (1)**

- [ ] **LEMON assessment method (2)**
- [ ] **Measurement of thyromental distance (3)**
- [ ] **Measurement of neck circumference (4)**
- [ ] **Upper incisor distance (and general condition and appearance of dentition) (5)**
- [ ] **Upper lip bite test (6)**
- [ ] **Neck / atlantoaxial range of motion (7)**
- [ ] **POCUS (point of care ultrasound) (8)**
- [ ] **Other (please describe): (9)**

_____

Q9 If the pre-anesthesia assessment indicates a potential or true difficult airway, what tools are available to you? (select all that apply)

- [ ] **A video laryngoscope (1)**
- [ ] **An intubating LMA set (2)**
- [ ] **Bougies or other devices used to facilitate intubation (please describe) (3)**

_____

- [ ] **Difficult airway supply cart (4)**

- [ ] A fiberoptic bronchoscope (5)
- [ ] Availability of surgical consultation (i.e. ENT, general/trauma surgeons) (6)
- [ ] Easy access to the ASA difficult airway algorithm (please describe) (7)
- [ ] Ultrasound (8)
- [ ] Other (please describe) (9)

_____

Q10 Reflecting back on the past 2-3 years, how often did you review the ASA Difficult Airway Algorithm? (select only one)

- ○ 0-1 (1)
- ○ 2-4 (2)
- ○ 5 or more times (3)

Q11 How do you usually review the ASA Difficult Airway Algorithm?

- ○ Attend conferences regularly that offer difficult airway curriculum (1)
- ○ Departmental M & M conferences (2)
- ○ Departmental morning meetings (3)
- ○ Other (please explain) (4)

_____

Q12 Are you a member of the Difficult Airway Society? (select only one)

- ○ **No (1)**
- ○ **Yes (2)**

Page Break

SECTION 3 POCUS

Q13 Do you routinely use POCUS for any reason in your clinical practice? (select only one)

- ○ **Yes (1)**
- ○ **No (2)**
- ○ **Rarely (3)**

Q14 If you answered "yes" or "rarely" to the previous question, please indicate all the ways you incorporate POCUS into your clinical practice: (select all that apply)

- ☐ **For inserting central venous and / or arterial catheters (1)**
- ☐ **For inserting peripheral intravenous catheters (2)**
- ☐ **For performing preoperative Gastric Ultrasound (3)**

- [ ] For performing Transthoracic Echocardiography (4)
- [ ] For performing assessment of inferior vena cava collapsibility (5)
- [ ] For performing ultrasound-guided peripheral nerve blocks (6)
- [ ] For assessing the airway (7)
- [ ] Other (please list): (8) _____

Page Break

SECTION 4 POCUS for the airway

Q15 Please answer with True or False for the following questions:

	True (1)	False (2)
Airway POCUS can be used for: predicting a difficult airway (12)	○	○
Airway POCUS can be used for: determining appropriate endotracheal tube size (13)	○	○
Airway POCUS can be used for: confirming endotracheal tube placement (14)	○	○

Airway POCUS can be used for: identifying landmarks for needle cricothyrotomy (15)	○	○
Airway POCUS can be used for: detecting upper airway pathologies. (16)	○	○
I have used airway POCUS before for one of the above-mentioned reasons. (17)	○	○
I am aware that this year (2022) the ASA released an updated difficult airway algorithm that specifically lists bedside ultrasound as a method for risk prediction for a difficult airway. (18)	○	○

Q16 Would you be interested in receiving additional information to learn more about airway ultrasound?

- ○ **Yes (1)**
- ○ **No (2)**

Page Break

End of Block: Survey Questions Block

Start of Block: Comments Block

COMMENTS Please add any additional comments you may have regarding POCUS of the airway and its applicability to your clinical nurse anesthesiology practice:

_____

End of Block: Comments Block

Appendix C. Survey Information Sheet

INFORMATION SHEET

FOR EXEMPT SURVEY RESEARCH ONLY

Point of Care Ultrasound during Airway Assessment

Introduction

You are being asked to participate in a DNP scholarly project being done by Nicholas Benda BSN, SRNA, and Kathryn Van't Hof BSN, SRNA, under the direction of Mary Golinski PhD, CRNA, FAANA, as the faculty chairperson for this project. This project is titled: Point of Care Ultrasound and Predicting the Difficult Airway. Nick and Kate are both DNP students enrolled in the Oakland University-Beaumont Graduate Program of Nurse Anesthesia, class of 2023.

Your decision to participate is strictly voluntary. You can choose to stop your participation at any time or skip any part of the study if you are not comfortable. Your decision will not affect your present or future relationship with Oakland University, the Oakland University School of Nursing, the researchers, or the student body.

What is the purpose of this project?

The purpose of this research study is to determine the relevance of point of care ultrasound (POCUS) of the airway, and to offer evidence-based information related to airway POCUS as one tool to predict the difficult airway. To do this we will:

1. Gather baseline data (via a survey) about CRNA current practice patterns related to assessment of the difficult airway, opportunities for airway POCUS, and possible barriers of implementation into clinical practice.

2. Collate the results of the survey and develop an airway POCUS educational program that will be piloted at two different anesthesia departments, located in Kalamazoo and in Marquette. Based on the feedback of these two departments, the program may be offered to all MANA members in the future.

Who can participate in this study?

You are being asked to participate in this study because you are a CRNA member of the Michigan Association of Nurse Anesthetists (MANA) and have previously indicated your willingness to participate in such surveys through MANA.

What do I have to do?

You will be asked to complete a 15-20-minute online survey with 16 questions about CRNA current practice patterns related to assessment of the difficult airway, opportunities for airway POCUS, and possible barriers of implementation into clinical practice. There is a link to the survey at the end of this email. Please complete the survey to the best of your ability and click on 'submit' when you have completed it.

Are there risks to me?

There are no potential risks for this study. By completing and submitting your responses, your consent for participation is implied. This survey is being sent to you via email by the MANA. We do not know the email addresses of MANA members, and therefore will not be able to identify CRNA participants. No personal data will be collected, and participants and responses will remain completely anonymous. If you agree to take part in this research study, you will be asked to complete the survey online and at a time and place of your choosing.

Are there any benefits to me?

Although there may be no direct benefits to you, the comprehensive results of this project may benefit the practice of nurse anesthesiology in the future as well as the patients we serve.

Will I receive anything for participating?

You will not receive anything for participating in this study.

What if I want to stop participating in this study?

If you want to stop participating, close your browser before clicking 'submit.' If you click 'submit,' it will not be possible to stop participating.

Who can I contact if I have questions about this study?

Please direct questions regarding this project to Nicholas Benda by email nbenda@oakland.edu, Kathryn Van't Hof by email kvanthof@oakland.edu, and Dr. Mary Golinski (faculty advisor) by email golinski@oakland.edu or phone (248) 364-8776.

For questions regarding your rights as a participant in human subject research, you may contact the Oakland University Institutional Review Board, 248-370-4898.

This form was approved by the Oakland University Institutional Review Board on 09/14/2022 under Cayuse # 2022-398.

Appendix D. Survey Recruitment Email

Hello MANA Members,

We are Nicholas Benda BSN, SRNA, and Kathryn Van't Hof BSN, SRNA, both DNP students enrolled in the Oakland University-Beaumont Graduate Program of Nurse Anesthesia, class of 2023. Under the direction of Mary Golinski PhD, CRNA, FAANA, as the faculty chairperson, we are conducting a research study titled 'Point of Care Ultrasound and Predicting the Difficult Airway' to determine the relevance of point of care ultrasound (POCUS) of the airway, and to offer evidence-based information related to airway POCUS as one tool to predict the difficult airway.

We are recruiting individuals who are CRNA members of the Michigan Association of Nurse Anesthetists (MANA) to participate in a survey gathering baseline data about CRNA current practice patterns related to assessment of the difficult airway, opportunities for airway POCUS, and possible barriers of implementation into clinical practice. The 16-question survey will take approximately 15-20 minutes to complete.

Your participation in this study is voluntary.

The research will take place online and may be completed at a place and time of your choosing.

If you wish to participate in this study, please complete the survey via the provided link in this email and click on 'submit' when you have finished it.

If you have any questions about the research, please contact us at nbenda@oakland.edu

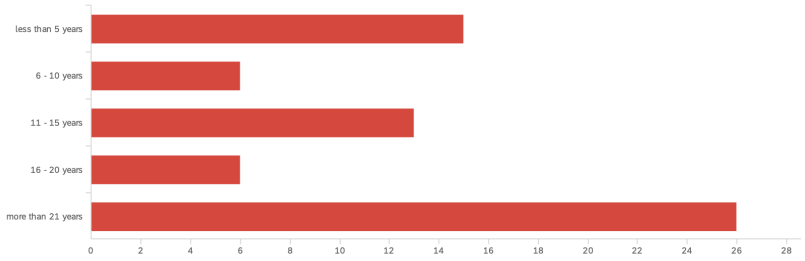
(Nicholas Benda), kvanthof@oakland.edu (Kathryn Van't Hof). You may also contact our faculty advisor Dr. Mary Golinski by email golinski@oakland.edu or phone (248) 364-8776.

Please complete the survey HERE.

(survey link: https://oakland.az1.qualtrics.com/jfe/form/SV_es1zXP0F3zXiliq?jfefe=new)

Appendix E. Survey Results

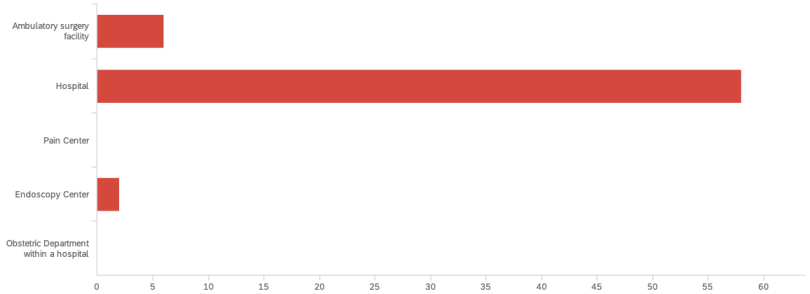
Q1 - How many years have you been practicing as a CRNA? Consider the length of time in years after passing the NBCRNA National Certification Examination. (select only one)



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	How many years have you been practicing as a CRNA? Consider the length of time in years after passing the NBCRNA National Certification Examination. (select only one)	1.00	5.00	3.33	1.60	2.56	66

#	Field	Choice Count	
1	Less than 5 years	22.7%	15
2	6 - 10 years	6.09%	6
3	11 - 15 years	19.70%	13
4	16 - 20 years	9.09%	6
5	More than 21 years	39.39%	26
			66

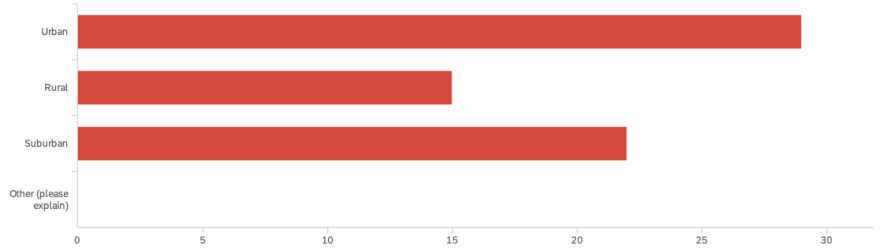
Q2 - Which best describes the setting where you spend the majority of your time administering anesthesia (for example, your clinical setting where you practice anesthesia)



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Which best describes the setting where you spend the majority of your time administering anesthesia (for example, your clinical setting where you practice anesthesia)	1.00	4.00	1.97	0.46	0.21	66

#	Field	Choice Count	
1	Ambulatory surgery facility	9.09%	6
2	Hospital	87.88%	58
3	Pain Center	0.00%	0
4	Endoscopy Center	3.03%	2
5	Obstetric Department within a hospital	0.00%	0
			66

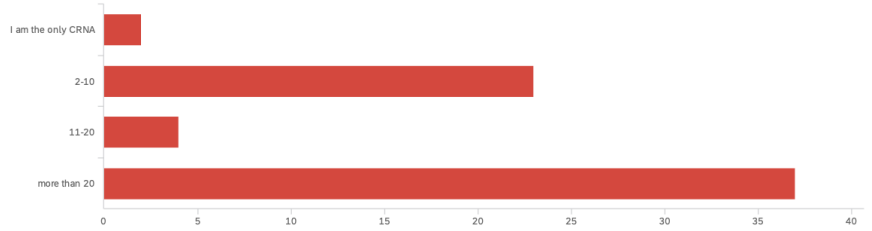
Q3 - What best describes the geographic of where you spend the majority of your time practicing anesthesia



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	What best describes the geographic of where you spend the majority of your time practicing anesthesia? - Selected Choice	1.00	3.00	1.89	0.87	0.76	66

#	Field	Choice Count	
1	Urban	43.9%	29
2	Rural	22.73%	15
3	Suburban	33.33%	22
4	Other (please explain)	0.00%	0
			66

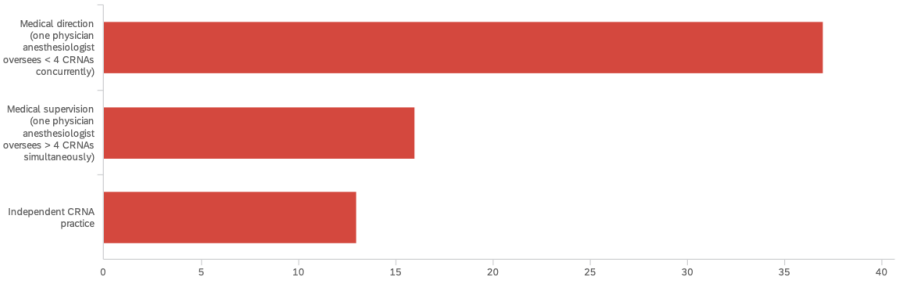
Q4 - Approximately how many CRNAs are in your primary practice setting? (select only one)



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Approximately how many CRNAs are in your primary setting? (select only one)	1.00	4.00	3.15	1.00	1.01	66

#	Field	Choice Count	
1	I am the only CRNA	3.03%	2
2	2-10	34.85%	23
3	11-20	6.06%	4
4	More than 20	56.06%	37
			66

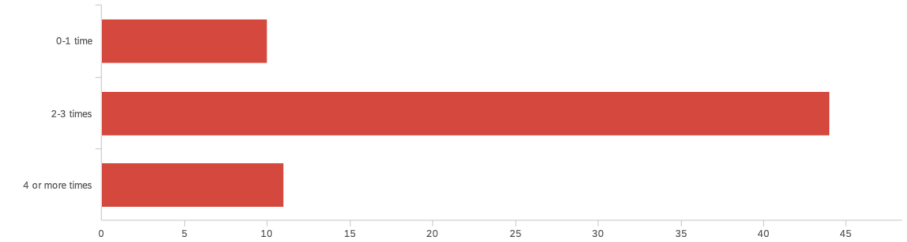
Q5 - Which anesthesia practice model best describes your primary practice setting?



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Which anesthesia practice model best describes your primary practice setting?	1.00	3.00	1.64	0.79	0.63	66

#	Field	Choice Count	
1	Medical direction (one physician anesthesiologist oversees < 4 CRNAs concurrently)	56.06%	37
2	Medical supervision (one physician anesthesiologist oversees > 4 CRNAs simultaneously)	24.24%	16
3	Independent CRNA practice	19.70%	13
			66

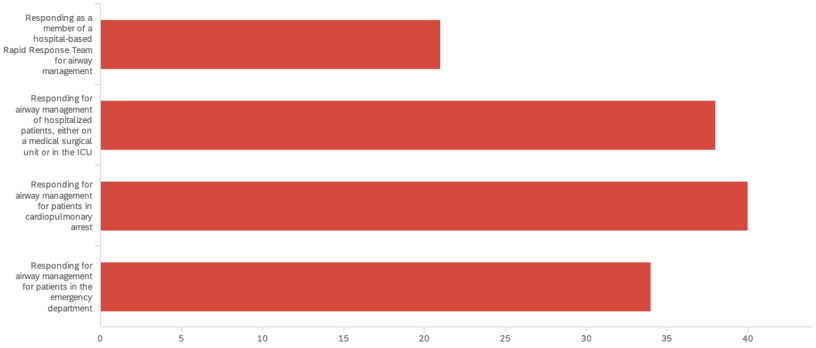
Q6 - Consider an average 8-hour shift: how often do you perform an endotracheal intubation in the operating room or in non-operating room areas?



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Consider an average 8-hour shift: how often do you perform an endotracheal intubation in the operating room or in non-operating room areas?	1.00	3.00	2.02	0.57	0.32	65

#	Field	Choice Count	
1	0-1 time	15.38%	10
2	2-3 times	67.69%	44
3	4 or more times	16.92%	11
			65

Q7 - In your primary clinical practice, indicate which of the following is part of your responsibility as a CRNA: (select all that apply)

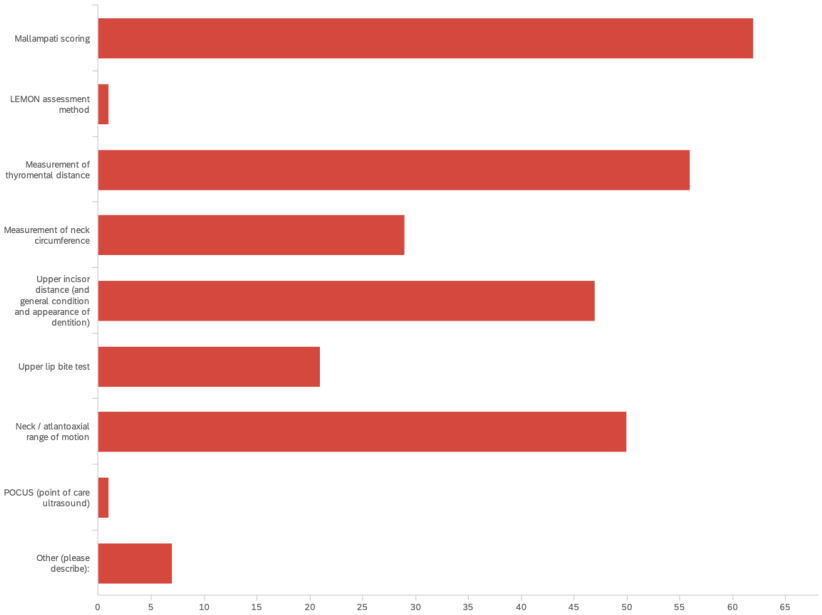


#	Field	Choice Count	
1	Responding as a member of a hospital-based Rapid Response Team for airway management	15.79%	21
2	Responding for airway management of hospitalized patients, either on a medical surgical unit or in the ICU	28.57%	38
3	Responding for airway management for patients in cardiopulmonary arrest	30.08%	40
4	Responding for airway management for patients in the emergency department	25.56%	34
			133

TEXT: Other (please list):

- Occasional response to the unit/ED for possible difficult intubations

Q8 - Considering the pre-anesthesia assessment, indicate all methods you use to assess the airway: (select all that apply)

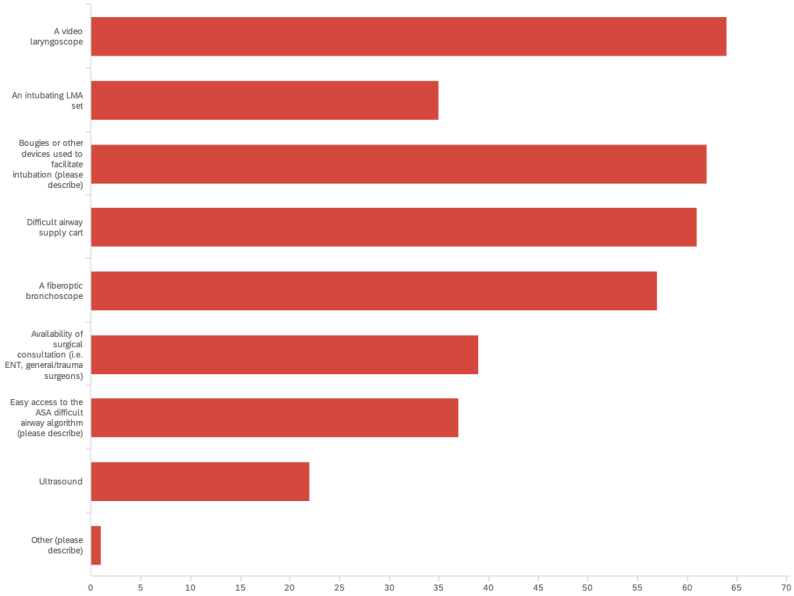


#	Field	Choice Count	
1	Mallampati scoring	22.63%	62
2	LEMON assessment method	0.36%	1
3	Measurement of thyromental distance	20.44%	56
4	Measurement of neck circumference	10.58%	29
5	Upper incisor distance (and general condition and appearance of dentition)	17.15%	47
6	Upper lip bite test	7.66%	21
7	Neck / atlantoaxial range of motion	18.25%	50
8	POCUS (point of care ultrasound)	0.36%	1
9	Other (please describe):	2.55%	7
			274

TEXT: Other (please describe):

- Not always able to make a physical evaluation of airway in emergency
- Hx
- Pediatrics - take what I can get…
- None
- Previous records
- Experience. Sometimes all the measurements above just confirm what you already know.
- Just look

Q9 - If the pre-anesthesia assessment indicates a potential or true difficult airway, what tools are available to you? (select all that apply)



#	Field	Choice Count	
1	A video laryngoscope	18.93%	64
2	An intubating LMA set	9.26%	35
3	Bougies or other devices used to facilitate intubation (please describe)	16.40%	62
4	Difficult airway supply cart	16.14%	61
5	A fiberoptic bronchoscope	15.08%	57
6	Availability of surgical consultation (i.e. ENT, general/trauma surgeons)	10.32%	39
7	Easy access to the ASA difficult airway algorithm (please describe)	9.79%	37
8	Ultrasound	5.82%	22
9	Other (please describe)	0.26%	1
			378

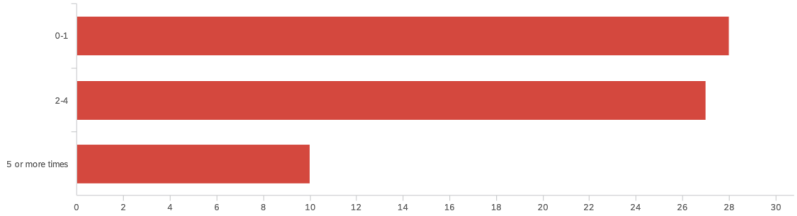
TEXT (3): Bougies or other devices used to facilitate intubation (please describe):

- Bougie
- Blue bougie
- Stylette
- Blue disposable bougie
- Bouvier
- The long blue one
- Blue plastic bougie

TEXT (9): Other (please describe):

- Airway algorithm is on every machine

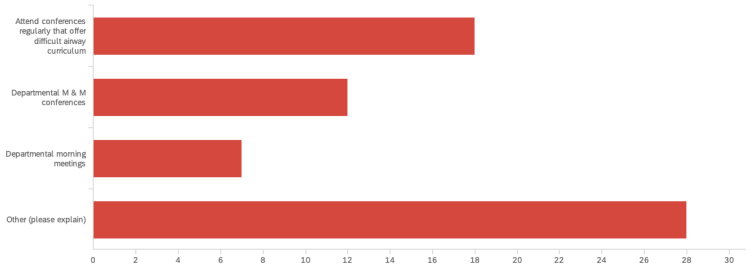
Q10 - Reflecting back on the past 2-3 years, how often did you review the ASA Difficult Airway Algorithm? (select only one)



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Reflecting back on the past 2-3 years, how often did you review the ASA Difficult Airway Algorithm? (select only one)	1.00	3.00	1.72	0.71	0.51	65

#	Field	Choice Count	
1	0-1	43.08%	28
2	2-4	41.54%	27
3	5 or more times	15.38%	10
			65

Q11 - How do you usually review the ASA Difficult Airway Algorithm?



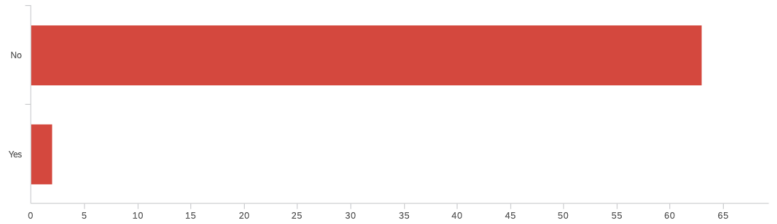
#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	How do you usually review the ASA Difficult Airway Algorithm? - Selected Choice	1.00	4.00	2.69	1.28	1.63	65

#	Field	Choice Count	
1	Attend conferences regularly that offer difficult airway curriculum	27.69%	18
2	Departmental M & M conferences	18.46%	12
3	Departmental morning meetings	10.77%	7
4	Other (please explain)	43.08%	28
			65

TEXT (4): Other (please explain):

- None
- Personally review ASA algorithm
- On my own
- On line
- Review with students during clinical day
- Chart
- Read
- We have cue cards in the anesthesia offices
- Teaching airway to students/staff
- Review it online before a case
- Self guided
- AlertWatch Emergency Reference
- Personal review
- Self review
- Alex modules
- On my own time, in school
- Self
- Not much education at my place.
- Internet
- I'm a curious person and this is one thing I'm curious about.
- Don't
- Continued education articles
- Read & discuss it.
- Individually

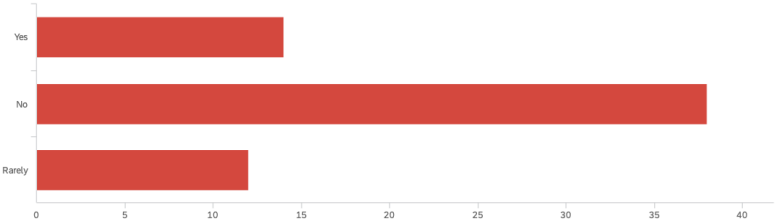
Q12 - Are you a member of the Difficult Airway Society? (select only one)



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Are you a member of the Difficult Airway Society? (select only one)	1.00	2.00	1.03	0.17	0.03	65

#	Field	Choice Count	
1	No	96.92%	63
2	Yes	3.08%	2
			65

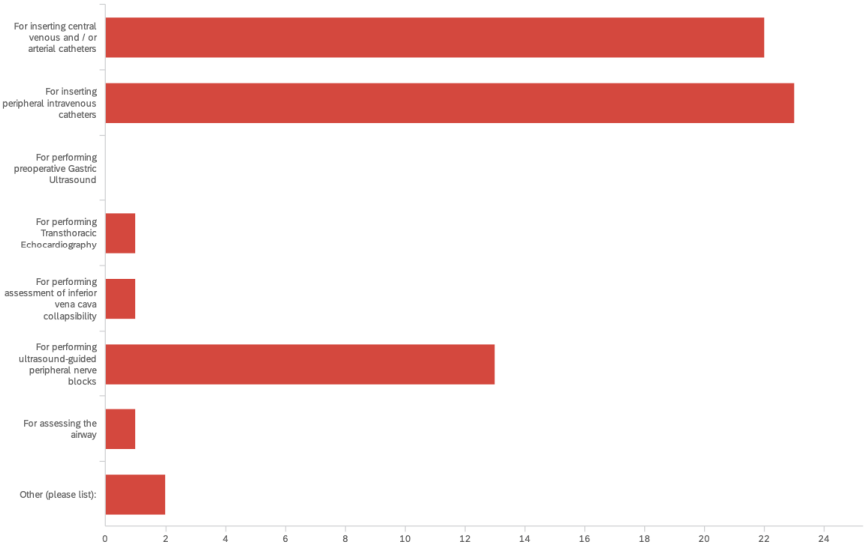
Q13 - Do you routinely use POCUS for any reason in your clinical practice? (select only one)



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Do you routinely use POCUS for any reason in your clinical practice? (select only one)	1.00	3.00	1.97	0.64	0.41	64

#	Field	Choice Count	
1	Yes	21.88%	14
2	No	59.38%	38
3	Rarely	18.75%	12
			64

Q14 - If you answered “yes” or “rarely” to the previous question, please indicate all the ways you incorporate POCUS into your clinical practice: (select all that apply)

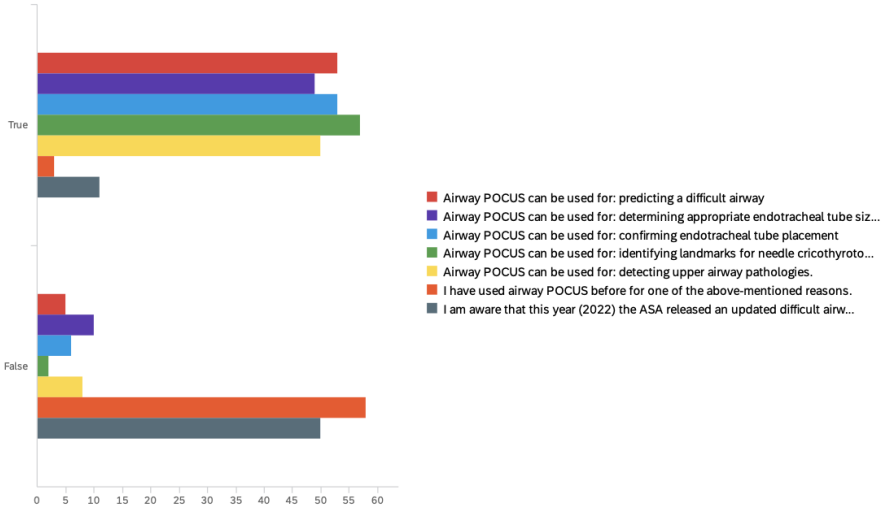


#	Field	Choice Count	
1	For inserting central venous and / or arterial catheters	34.92%	22
2	For inserting peripheral intravenous catheters	36.51%	23
3	For performing preoperative Gastric Ultrasound	0.00%	0
4	For performing Transthoracic Echocardiography	1.59%	1
5	For performing assessment of inferior vena cava collapsibility	1.59%	1
6	For performing ultrasound-guided peripheral nerve blocks	20.63%	13
7	For assessing the airway	1.59%	1
8	Other (please list):	3.17%	2
			63

TEXT (8): Other (please list):

- I don’t know what that is :(
- None

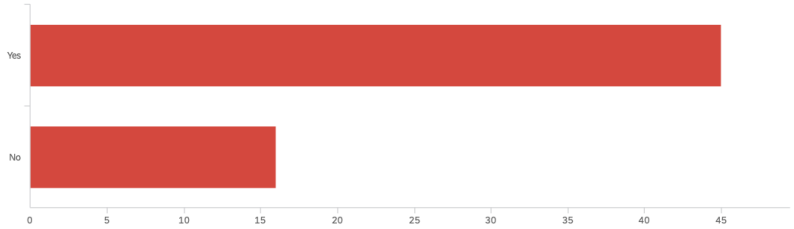
Q15 - Please answer with True or False for the following questions:



#	Field	Min	Max	Mean	Std Deviation	Variance	Count
1	Airway POCUS can be used for: predicting a difficult airway	1.00	2.00	1.09	0.28	0.08	58
2	Airway POCUS can be used for: determining appropriate endotracheal tube size	1.00	2.00	1.17	0.38	0.14	59
3	Airway POCUS can be used for: confirming endotracheal tube placement	1.00	2.00	1.10	0.30	0.09	59
4	Airway POCUS can be used for: identifying landmarks for needle cricothyrotomy	1.00	2.00	1.03	0.18	0.03	59
5	Airway POCUS can be used for: detecting upper airway pathologies.	1.00	2.00	1.14	0.34	0.12	58
6	I have used airway POCUS before for one of the above-mentioned reasons.	1.00	2.00	1.95	0.22	0.05	61
7	I am aware that this year (2022) the ASA released an updated difficult airway algorithm that specifically lists bedside ultrasound as a method for risk prediction for a difficult airway.	1.00	2.00	1.82	0.15	0.15	61

#	Field	True	False	Total
1	Airway POCUS can be used for: predicting a difficult airway	53 (91.38%)	5 (8.62%)	58
2	Airway POCUS can be used for: determining appropriate endotracheal tube size	49 (83.05%)	10 (16.95%)	69
3	Airway POCUS can be used for: confirming endotracheal tube placement	53 (89.93%)	6 (10.17%)	59
4	Airway POCUS can be used for: identifying landmarks for needle cricothyrotomy	57 (96.61%)	2 (3.39%)	59
5	Airway POCUS can be used for: detecting upper airway pathologies.	50 (86.21%)	8 (13.79%)	58
6	I have used airway POCUS before for one of the above-mentioned reasons.	3 (4.92%)	58 (95.08%)	61
7	I am aware that this year (2022) the ASA released an updated difficult airway algorithm that specifically lists bedside ultrasound as a method for risk prediction for a difficult airway.	11 (18.03%)	50 (81.97%)	61

Q16 - Would you be interested in receiving additional information to learn more about airway ultrasound?



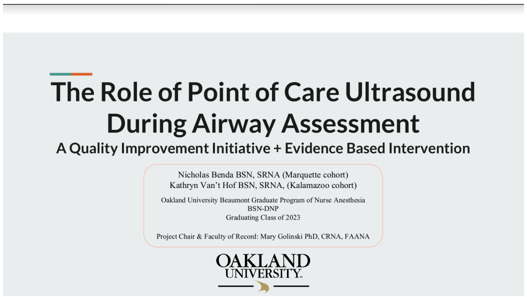
#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Would you be interested in receiving additional information to learn more about airway ultrasound?	1.00	2.00	1.26	0.44	0.19	61

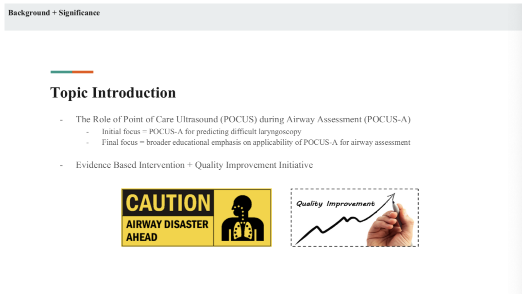
#	Field	Choice Count	
1	Yes	73.77%	45
2	No	26.23%	16
			61

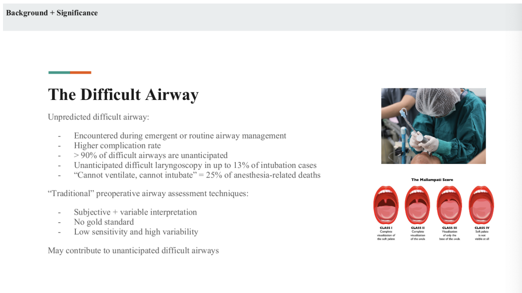
COMMENTS – Please add any additional comments you may have regarding POCUS of the airway and its applicability to your clinical nurse anesthesiology practice:

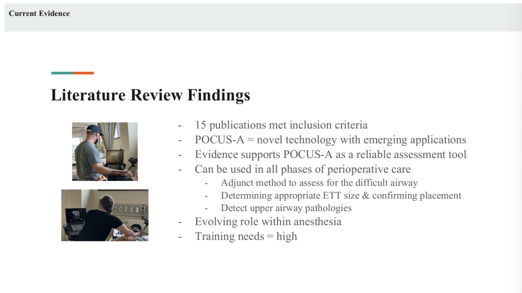
- I am not certain this is possible due to cost & also the restrictiveness of some hospitals
- POCUS is no doubt a valuable tool. However, when faced with an emergency airway why wouldn't the default intubation technique be the Glide Scope? 95% first pass success (FPS). If POCUS indicates a difficult airway what are you going to do? Answer: Use a Glide Scope. Working with students and discussing a possible difficult airway I often hear 'I will try a DVL. If that doesn't work I will use the Glide Scope.' Really? Why not just start with the Glide Scope…95% FPS. Which begs the argument…why aren't we using the Glide Scope for every intubation. If you are using disposable laryngoscopes the cost of Glide Scopes and blades will cost equalize very quickly. Remember 95% FPS. A large majority of lawsuits are because of failed intubation and hypoxic injury.
- This was the best survey I've participated in and I'm highly motivated to learn more about this.
- One of the questions in your survey asked if we were members of the Difficult Airway Society (a UK-based organization) but did not include the Society of Airway Management (SAM) wherein a lot of US-CRNAs are members.
- Would like to learn to use
- There are significant limitations to its use by CRNAs in a clinical setting. First is obtaining and maintaining competency. This is cost prohibitive for a department of 150 CRNAs in which I practice. Additionally, this would require a capital expenditure that many departments would be hesitant to provide, especially given the rarity of unanticipated difficult airway emergencies occurring in the OR.
- Great project idea for an educational module. I'm familiar with use for gastric volumes but not for airway assessment.
- Unsure of the pediatric applications; nonemergency situations depend on patient cooperation, emergency situations usually stem from respiratory issues so I would be worried about the time this would take.
- Seems a bit time consuming when most intubations are straightforward and if they are not the glidescope works every time.
- Sounds great guys! Id use it!
- Survey needs additional response options of "not applicable" or "unsure" for a few questions (such as the true/false for knowing if POCUS can be used for airway assessment"
- We don't use it frequently because of the culture at our hospital. I'd love to learn more and have hands on experience.
- In medical direction the Lazyiologist dictates practice and hence your ability to do POCUS
- I have never heard of pocus
- Glide scope makes everything so easy. It's extremely rare to encounter a true difficult airway in my personal experience.

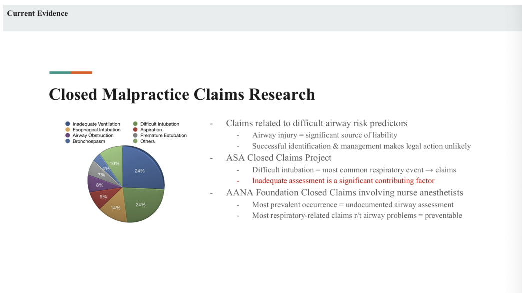
Appendix F. Scholarly Presentation Powerpoint

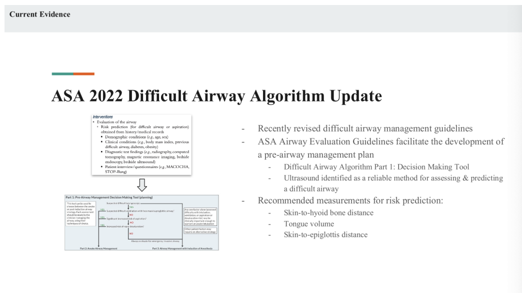


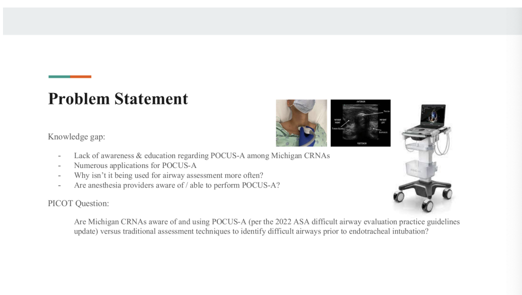


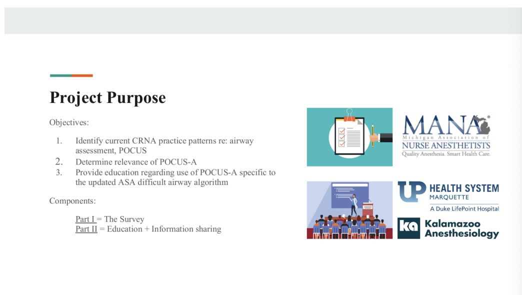












Methodology: Translational Research

Practice Theory

ACE Star Model of Knowledge Transformation – EBP framework

- Conceptualizes the cycle of transformation that knowledge must go through before it is "clinician ready"
- Provides tangible outcomes delineated as 5 steps:
  1) Discovery Research
  2) Evidence Summary
  3) Translation to Guidelines
  4) Practice Integration
  5) Process, Outcome Evaluation

Methodology: Translational Research

Project Timeline

OU Project Approval	January 31, 2022
OU IRB Approval	September 14, 2022
MANA Survey Opened	September 19, 2022
MANA Survey Closed	November 1, 2022
Educational Scholarly Presentation Completed	March 15, 2023
Collaboration & practical experience with FUJUFILM Sonosite Clinical Specialist	April 28, 2023
Presentations to Anesthesia Departments	May 4, 2023 (Kalamazoo) May 11, 2023 (Marquette)

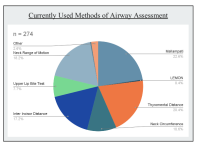
Meeting DNP Project Objective #1: Identify current CRNA practice patterns and awareness of POCUS-A

Part I: The Survey

- Assessed for current level of familiarity with POCUS-A among Michigan CRNAs
- Online Qualtrics survey – 16 questions
  - CRNA demographics & current employment arrangement
  - Clinical practice & approach to identifying the difficult airway
  - POCUS
  - POCUS-A
- Distributed via email to 2,200 participating CRNA MANA members
  - Voluntary
  - Completely anonymous
  - 74 responses (74/2200, 3% response rate)

Meeting DNP Project Objective #1: Identify current CRNA practice patterns and awareness of POCUS-A

Survey Results



CRNA demographics + employment arrangement

- Years of experience:
  - < 5 years – 15/66
  - > 21 years – 26/66
- Workplace setting:
  - Hospital setting – 58/66
  - Ambulatory surgery center – 6/66
- Geographic:
  - Urban – 29/66
  - Suburban – 22/66
  - Rural – 15/66
- Group size:
  - > 20 CRNAs – 37/66
  - < 10 CRNAs – 25/66
- Practice model:
  - CRNA independent – 13/66
  - Medical supervision - 16/66
  - Medical direction – 37/66

Meeting DNP Project Objective #1: Identify current CRNA practice patterns and awareness of POCUS-A

Survey Results

CRNA respondents:

- Were unaware of the ASA Difficult Airway Algorithm guidelines update – 50/61
- Answered "true" when asked "Airway POCUS can be used for:"
  - Predicting the difficult airway – 53/58
  - Determining appropriate ETT size – 49/59
  - Confirming ETT placement – 53/59
  - Identifying landmarks for needle cricothyrotomy – 57/59

Most respondents have NOT used POCUS for the above reasons (58/61)
Most respondents DO have an interest in learning more about POCUS-A (45/61)

Meeting DNP Project Objective #1: Identify current CRNA practice patterns and awareness of POCUS-A

Survey Results

Summary of Free Responses:

- Concerns for cost, time, hospital restrictions
- Many comments on Glidescope and rarity of true difficult airway
- Some eager to learn more

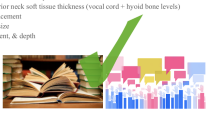
Identified barriers to POCUS-A use:

- Restriction in practice
- Difficult to obtain the technology + maintain competency
- Culture
- Cost
- Time constraints in emergencies
- Unsure of practicality due to VL availability

Meeting DNP Project Objective #2: Determine relevance of POCUS-A

POCUS-A Is Relevant

- Established via literature review + survey results
  - POCUS-A applications:
    1) Predicting difficult laryngoscopy
       - US better able to predict difficult airway than traditional airway assessment methods
       - Best predictors: distance skin to epiglottis, anterior neck soft tissue thickness (vocal cord + hyoid bone levels)
    1) Determining appropriate ETT size + confirming ETT placement
       - Height & weight are poor predictors of airway size
       - Measure airway diameter, confirm ETT placement, & depth
    1) Detecting upper airway pathologies
       - Subglottic stenosis
       - Vocal cord pathologies
       - Foreign body obstructions & airway masses
       - Paratracheal hematoma
- Opportunities for improving patient care



Meeting DNP Project Objective #3: Education + Performing POCUS-A

Part II: Education + Information Sharing

- Collaboration & practical experience with FUJIFILM Sonosite clinical specialist
- Scholarly presentation:
  - What is POCUS-A
  - Current evidence-based information regarding its use
  - ASA difficult airway algorithm update
- Practical skills + scanning technique video recordings:
  - Equipment + positioning
  - Performing POCUS-A
  - Identifying normal airway anatomy
  - Identifying abnormalities + clinical implications

- Disseminated at anesthesia department meetings in Kalamazoo (5/4/23) and Marquette (5/11/23)

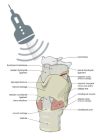
Meeting DNP Project Objective #3: Education + Performing POCUS-A

Part II: Education + Information Sharing

Educational POCUS-A Program Curriculum:

1. Equipment + Positioning
2. Identifying normal upper airway anatomy
   a. Systematic scan
3. Obtaining measurements for risk prediction:
   a. Skin-to-hyoid bone distance
   b. Tongue volume
   c. Skin-to-epiglottis distance
4. Identifying abnormalities + clinical implications
   a. ETT size + subglottic stenosis
   b. Confirm ETT placement + depth
   c. Cricothyrotomy preparation
   d. Vocal cord pathologies
   e. Foreign bodies
   f. Other upper airway pathologies (masses, lesions, hematomas)

Discussion



Project limitations:

- Survey: homogeneous sample + small response rate (74/2200, 3%)
- POCUS-A in its infancy
- Reported lack of access to equipment or training
- Requires knowledge of airway anatomy + ultrasound equipment & technique

Implications for future anesthesiology practice:

- Encourage POCUS-A integration into educational curriculums
- POCUS-A shows great potential as a diagnostic tool
- Need for future POCUS-A research
- Opportunity to refine pre-anesthetic assessment of airway
- Establish practice guidelines for clinical application

Conclusion

Achieving DNP Essentials

- Essential I: Scientific Underpinnings for Practice
- Essential II: Organizational & Systems Leadership for Quality Improvement + Systems Thinking
- Essential III: Clinical Scholarship & Analytical Methods for Evidence-Based Practice
- Essential VI: Interprofessional Collaboration for Improving Health Outcomes

Achieving personal goals:

- Dedication to maintain professional accountability + curious mind
- Opportunity to change professional practice – incorporate POCUS-A as much as possible
- Seek out learning & training opportunities
- Share knowledge with peers
- Exciting development for the future

Entire DNP project + Qualtrics survey

Questions?

References

Appendix G. Anesthesia Groups Presentation Powerpoint

The Role of Point of Care Ultrasound During Airway Assessment

A Quality Improvement Initiative + Evidence Based Intervention

Nicholas Benda SRNA, BSN (Marquette cohort)
Kathryn Van't Hof SRNA, BSN (Kalamazoo cohort)
–
Oakland University Beaumont Graduate Program of Nurse Anesthesia
BSN-DNP
Graduating Class of 2023
Project Chair & Faculty of Record: Mary Golinski PhD, CRNA, FAANA

Project Introduction

- Title: The Role of Point of Care Ultrasound (POCUS) during Airway Assessment (POCUS-A)
  - Initial focus = POCUS-A for predicting difficult laryngoscopy
  - Final focus = broader educational emphasis on uses of POCUS-A
- Form:
  - Evidence based intervention
  - Quality improvement initiative

Background + Significance

Unpredicted difficult airway:

- American Society of Anesthesiologists (ASA) difficult airway definition
- > 90% of difficult airways are unanticipated
- Unanticipated difficult laryngoscopy in up to 13% of intubation cases
- Emergent or routine
- Higher complication rate

"Cannot ventilate, cannot intubate"

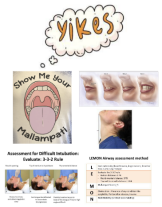
- 1:1000 elective cases
- 1:250 are RSI
- Account for 25% of anesthesia-related deaths

Background + Significance

"Traditional" preoperative airway assessment methods:

- Subjective
- Variable interpretation amongst providers
- No gold standard
- Low sensitivity and high variability (Roth et al., 2018)

May contribute to unanticipated difficult airways



Background + Significance

Video laryngoscopy (VL):

- First pass success rate for intubation NOT 100%
- False sense of security

Airway complications are not improved:

- VL has 15x higher risk of palatal injury
- #1 Glidescope complication = piercing tonsillar pillars & soft palate

Background + Significance

Literature review:

- 15 publications met inclusion criteria
- Findings
  - POCUS = novel technology with emerging uses
  - Evidence supports POCUS-A as an adjunct assessment tool for the difficult airway
  - Can be used in all phases of perioperative care
  - Emerging practice amongst anesthesia providers
  - Training needs – high

Background + Significance

Literature Review – Findings

POCUS-A applications:

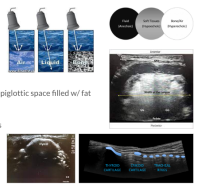
1) Predicting difficult laryngoscopy
   - US was better able to predict difficult laryngoscopy & intubation than traditional airway assessment methods
   - Best predictors:
     - Skin-to-epiglottis distance
     - Anterior neck soft tissue thickness (at vocal cords & hyoid bone levels)
2) Determining appropriate ETT size + confirming ETT placement
   - Height & weight are poor predictors of airway size
   - Measure airway diameter, confirm ETT placement, & depth
3) Detecting upper airway pathologies
   - Subglottic stenosis
   - Vocal cord pathologies
   - Foreign body obstructions & airway masses
   - Paratracheal hematoma

Background + Significance

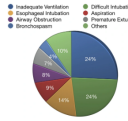
Literature Review – Findings

POCUS-A limitations:

- Ultrasound waves can't travel through air or bone
  - Can only visualize anterior laryngeal structures
  - Image distortion d/t soft tissue air, large epiglottis, pre-epiglottic space filled w/ fat
- Relatively novel technique that is still evolving
  - Guidelines or reference standards yet to be determined
  - No current evidence to suggest a difference in outcomes
  - Variability with race & gender
- Dependent on:
  - Operator experience + expertise
  - Technical skill & knowledge
  - Ability to accurately interpret results
  - Available equipment + technology



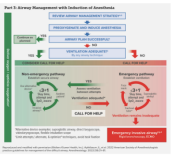
Background + Significance



Closed Malpractice Claims Research

- Claims related to difficult airway risk predictors
  - Airway injury = significant source of liability
  - Successful identification & management makes legal action unlikely
- ASA Closed Claims Project
  - Difficult intubation = most common respiratory event → claims
  - Inadequate assessment is a significant contributing factor
- AANA Foundation Closed Claims involving nurse anesthetists
  - Most prevalent occurrence = undocumented airway assessment
  - Most respiratory-related claims r/t airway problems = preventable

Background + Significance



ASA 2022 Difficult Airway Algorithm Update

- Recently revised difficult airway management guidelines
- Ultrasound identified as a reliable method for assessing & predicting a difficult airway
- Recommended measurements for risk prediction:
  - Skin-to-hyoid bone distance
  - Tongue volume
  - Skin-to-epiglottis distance

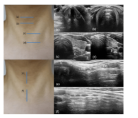
Updated ASA Difficult Airway Algorithm

The ASA Airway Evaluation Guidelines facilitate the development of a pre-airway management plan (Difficult Airway Algorithm Part 1: Decision Making Tool)

Interventions

- Evaluation of the airway
  - Risk prediction (for difficult airway or aspiration) obtained from history/medical records
    - Demographic conditions (*e.g.*, age, sex)
    - Clinical conditions (*e.g.*, body mass index, previous difficult airway, diabetes, obesity)
    - Diagnostic test findings (*e.g.*, radiography, computed tomography, magnetic resonance imaging, bedside endoscopy, bedside ultrasound)
    - Patient interview/questionnaires (*e.g.*, MACOCHA, STOP-Bang)

Project Problem Statement



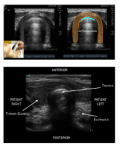
Knowledge gap:

- Lack of awareness & education regarding POCUS-A among Michigan CRNAs
- Numerous applications for POCUS-A
- Why isn't it being used for airway assessment more often?
- Are anesthesia providers aware of / able to perform POCUS-A?

PICOT Question:

Are Michigan CRNAs aware of and using POCUS-A per the 2022 ASA difficult airway evaluation practice guidelines versus traditional assessment techniques, or a combination of techniques, to more accurately identify difficult airways prior to establishing endotracheal intubation during the induction of anesthesia?

Project Purpose + Objectives



Purpose:

- Determine relevance of POCUS-A
- Explore applicability as an adjunct tool to predict the difficult airway

Objectives:

1) Identify current CRNA practice patterns

2) Determine relevance of POCUS-A

3) Provide education regarding use of POCUS-A specific to the updated ASA difficult airway algorithm

Practice Theory

ACE Star Model of Knowledge Transformation – EBP framework

- Conceptualizes the cycle of transformation that knowledge must go through before it is "clinician ready"
- Provides tangible outcomes delineated as 5 steps:
  1) Discovery Research
  2) Evidence Summary
  3) Translation to Guidelines
  4) Practice Integration
  5) Process, Outcome Evaluation

Project Timeline

- January 31, 2022 - OU Project Approval
- September 14, 2022 - OU IRB Approval
- September 19, 2022 - MANA Survey Opened
- November 1, 2022 - MANA Survey Closed
- March 15, 2023 - Educational Presentation Completed
- April 28, 2023 - Establishing competencies – Sonosite Representatives
- Spring / Summer 2023 – Presented at respective departments; hands on demonstration & practice

Methodology – Translational Research

- Translational Research = methodology used to meet project objectives
- Project components:
  - Part I = The Survey
  - Part II = Education + information sharing

Meeting DNP Project Objective #1:

Identify current CRNA practice patterns and awareness of POCUS-A

Project Part I: The Survey

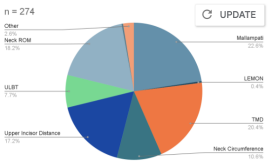
- Assess for Michigan CRNAs' level of familiarity with POCUS-A
- Online Qualtrics survey – 16 questions
  - CRNA demographics & current employment arrangement
  - Clinical practice & approach to identifying the difficult airway
  - POCUS
  - POCUS-A
- Distributed via email to 2,200 MANA members
  - Voluntary
  - Completely anonymous
  - Response rate = 74 / 2200

The Survey Results

- CRNA demographics + employment arrangement
  - Years of experience:
    - < 5 years – 15/66
    - > 21 years – 26/66
  - Workplace setting:
    - Hospital setting – 58/66
    - Ambulatory surgery center – 6/66
  - Geographic:
    - Urban – 29/66
    - Suburban – 22/66
    - Rural – 15/66
  - Group size:
    - > 20 CRNAs – 37/66
    - < 10 CRNAs – 25/66
  - Practice model:
    - CRNA independent – 13/66
    - Medical supervision - 16/66
    - Medical direction – 37/66

The Survey Results

Currently Used Methods of Airway Assessment



The Survey Results

CRNA respondents are:

- Unaware of the ASA Difficult Airway Algorithm update: 50/61
- Aware that POCUS can be used for:
  - Predicting the difficult airway – 53/58
  - Determining appropriate ETT size – 49/59
  - Confirming ETT placement – 53/59
  - Identifying landmarks for needle cricothyrotomy – 57/59

Most respondents have NOT used POCUS for the above reasons (58/61)

Most respondents DO have an interest in learning more about POCUS-A (45/61)

The Survey Results

Summary of Free Responses:

- Concerns for:
  - Cost
  - Time
  - Hospital restrictions
- Many comments on Glidescope and rarity of true difficult airway
- Some eager to learn more

Identified barriers to POCUS-A use:

- Restriction in practice
- Difficult to obtain the technology + maintain competency
- Culture
- Cost
- Time constraints in emergencies
- Unsure of practicality due to VL availability

Meeting DNP Project Objective #2:

Determine relevance of POCUS-A

- Established via literature review + survey responses
- POCUS-A remains relevant
- Opportunities for improving patient care

Meeting DNP Project Objective #3:

Education + Performing POCUS-A

Project Part II: Education + Information sharing

- Blended curriculum
  - Scholarly presentation:
    - What is POCUS-A
    - Current evidence-based information regarding its use
    - ASA difficult airway algorithm update
  - Hands-on competency demonstration – how to perform POCUS-A:
    - Meeting with Sonosite Representatives
    - Equipment
    - Identifying normal airway anatomy
    - Identifying abnormalities + clinical implications
- Disseminated at anesthesia group meetings in Marquette and Kalamazoo

UP HEALTH SYSTEM MARQUETTE
A Duke LifePoint Hospital

Kalamazoo Anesthesiology

Performing POCUS-A

1. Equipment + Positioning
2. Normal upper airway anatomy
3. Obtaining measurements for risk prediction:
   a. Skin-to-hyoid bone distance
   b. Tongue volume
   c. Skin-to-epiglottis distance

Meeting DNP Project Objective #3: Education + Performing POCUS-A

Performing POCUS-A


1. Equipment + Positioning
   - Transducer types:
     - High frequency linear (5 - 15 MHz)
       - Superficial structures
       - Hyoid bone
       - Trachea
     - Curved/curvilinear convex low frequency (2 - 5 MHz)
       - Non-linear structures
       - Tongue

Meeting DNP Project Objective #3: Education + Performing POCUS-A

Performing POCUS-A


1. Equipment + Positioning
   - **Positioning for Optimal Views – Setting up for Success!**

THE PATIENT

- Position for intended airway manipulation
- Supine
- Sniffing
- Head & neck neutral position?
- Pillow


THE OPERATOR

- Probe in dominant hand
- Hold close to imaging surface
- Longitudinal or transverse orientation
- Anchor hand on the patient
- Match probe indicator with image screen

Meeting DNP Project Objective #3: Education + Performing POCUS-A

Performing POCUS-A

2. Normal upper airway anatomy

Becoming Proficient Requires Practice, Practice, & more Practice!

Meeting DNP Project Objective #3: Education + Performing POCUS-A

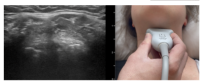
Normal Upper Airway Anatomy

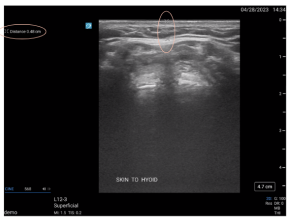
Meeting DNP Project Objective #3: Education + Performing POCUS-A

Measurements for difficult laryngoscopy risk prediction (ASA update)
(1) Skin-to-hyoid bone
(2) Tongue volume
(3) Skin-to-epiglottis

Skin-to-Hyoid Bone

- Assesses for anterior neck soft tissue thickness
- Linear probe + transverse orientation
- Place probe midline in submandibular region under jaw
- Move probe caudally
- Identify anterior border of hyoid bone
  - Appears hyperechoic



- Measure minimal distance from hyoid to skin surface
- Inc risk difficult laryngoscopy if > 1.28 cm

*All values taken from articles from our literature review (see references)

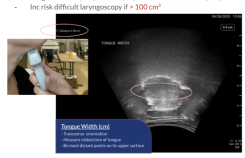
Meeting DNP Project Objective #3: Education + Performing POCUS-A

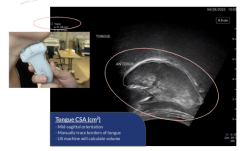
Measurements for difficult laryngoscopy risk prediction (ASA update)
(1) Skin-to-hyoid bone
(2) Tongue volume
(3) Skin-to-epiglottis

Tongue Volume

- Assesses for macroglossia
- Curvilinear probe + transverse & mid-sagittal orientations
- Place probe on submandibular region under jaw
- Tongue volume (cm^3) = width (cm) x cross sectional area (cm^2)
- Inc risk difficult laryngoscopy if > 100 cm^3

Kate's tongue volume: 3.9 cm x 21.08 cm^2 = 82.2 cm^3





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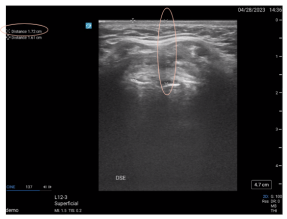
Meeting DNP Project Objective #3: Education + Performing POCUS-A

Measurements for difficult laryngoscopy risk prediction (ASA update)
(1) Skin-to-hyoid bone
(2) Tongue volume
(3) Skin-to-epiglottis

Skin-to-Epiglottis

- Assesses for anterior neck soft tissue thickness
- Linear probe + transverse orientation
- Place probe midline at floor of mouth
- Move caudally toward suprasternal notch of neck
- Epiglottis is visible bn hyoid bone & thyroid cartilage
  - Curvilinear + hyperechoic
  - Discretely mobile structure
  - Swallowing +/- angling the probe helps identify



- Measure distance from epiglottis to skin
  - Studies used a single measurement or an average of 3 measurements
- Inc risk difficult laryngoscopy if > 1.42 - 2.9 cm

*All values taken from articles from our literature review (see references)

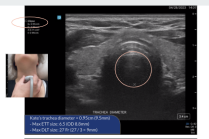
Meeting DNP Project Objective #3: Education + Performing POCUS-A

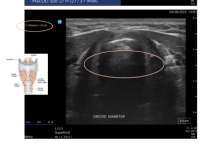
Other POCUS-A Uses

ETT Size + Subglottic Stenosis

- Linear probe + transverse orientation
- Place probe midline just above suprasternal notch
- Measure diameter of trachea
- ETT Size:
  - Choose ETT 0.5mm less than trachea diameter
  - **ETT size refers to its inner (not outer) diameter

  - ETT wall thickness varies by manufacturer
  - Pediatrics – more accurate than sizing by height / weight
  - DLT size – correlates with CT measurements
    - Outer tracheal diameter just above sternoclavicular joint
    - French unit corresponds to ⅓ mm
    - Example – 38 Fr DLT → 39 / 3 = 13 mm
    - **DLT size refers to its outer (not inner) diameter!!
- Subglottic stenosis:
  - Measure subglottic diameter
  - Place probe at lowest edge of cricoid cartilage
  - Identify level of stenosis or narrowest point
  - Can also measure length of stenosis



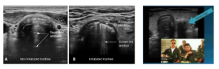


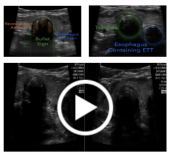
Meeting DNP Project Objective #3: Education + Performing POCUS-A

Other POCUS-A Uses

Confirm ETT Placement + Depth

- Linear probe + transverse orientation
- Place probe midline just above suprasternal notch
- Identify trachea & esophagus (anatomically to the left)
- Tracheal vs Esophageal intubation:
  - ETT in trachea = "bullet sign" + comet-tail artifact
  - ETT in esophagus = "2nd trachea" or "goose" or "double tract" sign





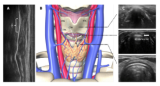
- Confirm ETT depth:
  - Visualize ETT cuff balloon at level of sternal notch → correlates w/ appropriate depth
  - Filling ETT cuff balloon w/ saline provides recognizable acoustic window

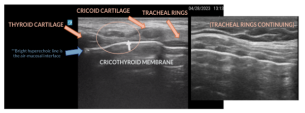
Meeting DNP Project Objective #3: Education + Performing POCUS-A

Other POCUS-A Uses

Cricothyrotomy Preparation

- High risk for difficult airway? Preemptively plan safest needle approach for emergent surgical airway placement
- Linear probe + midsagittal & transverse orientations
- Transverse orientation:
  - Identify nearby blood vessels and vulnerable structures
  - Measure depth from skin to trachea
- Midsagittal orientation:
  - Visualize CTM (bn thyroid & cricoid cartilages)
  - Visualize needle path during placement
  - Avoid inadvertently injuring vessels → potential hematoma formation
  - Confirm tracheal cannulation real-time





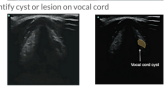
Meeting DNP Project Objective #3: Education + Performing POCUS-A

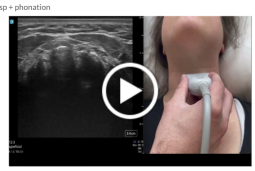
Other POCUS-A Uses

Vocal Cord Pathologies

- Linear probe + transverse orientation → level of thyroid cartilage
- Noninvasive assessment of vocal cords & muscles
- Observe for symmetrical movement during spont resp + phonation
- Vocal cord palsy? Confirm side of paralysis

- Identify cyst or lesion on vocal cord



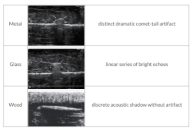


Meeting DNP Project Objective #3: Education + Performing POCUS-A

Other POCUS-A Uses

Foreign Bodies

- Tracheal vs esophageal foreign body
- Possible source of airway obstruction or difficult intubation?

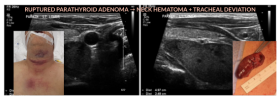


Meeting DNP Project Objective #3: Education + Performing POCUS-A

Other POCUS-A Uses

Other Upper Airway Pathologies

- Airway masses or lesions
- Paratracheal hematoma
- Tracheal compression or deviation?
- POCUS-A enables for a quick assessment + immediate results
  - Guides further diagnostics
  - Facilitates developing an informed plan to establish safe airway securement



Project Limitations + Discussion

- Limitations:
  - Small survey response rate (74 / 2200)
  - Narrow range of practice setting – demographic mainly CRNAs who work in a large urban hospital
  - Limited to Michigan CRNAs
  - Lack of access to ultrasound or restrictions to CRNA use
  - Basic airway ultrasound knowledge
- Discussion:
  - Remains relevant despite video laryngoscope availability
  - Opportunity to develop guidelines for pre-anesthetic assessment of airway
  - Need for future research
  - Establish practice guidelines for clinical application to improve airway assessment

Conclusion

POCUS-A: non-invasive, efficient, non-radiating, efficacious, & readily available

- Wide applicability → improve assessment quality
- A good technique to have in your tool kit
- Offers potential for positive care outcomes
- Exciting development for the future

Opportunity to change professional practice

- Provide global education
- Need for more teaching + hands-on workshops
- Seek out learning & training opportunities
- Incorporate POCUS-A into practice as much as possible

Questions?

References