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Spring 5-19-2023

Development of a Nurse Anesthesia Program Point-of-Care Ultrasound Airway Examination Curriculum

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Recommended Citation

Butler, Sarah Elyse Sandheinrich and Butler, Colton Phillip, "Development of a Nurse Anesthesia Program Point-of-Care Ultrasound Airway Examination Curriculum" (2023). *Doctor of Nursing Practice Projects*. 282.

<https://spark.siu.edu/dnpprojects/282>

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Executive Summary

Introduction of the Problem

Airway management is one of the most fundamental and critical skills in the anesthesia provider's repertoire, and the Certified Registered Nurse Anesthesiologist (CRNA) should become proficient at using every tool available to evaluate and manage the airway efficiently and effectively. Increasing evidence shows improved airway management techniques and assessment approaches through Point-of-Care Ultrasound (POCUS), benefitting both patients and providers (Li et al., 2020; You-Ten et al., 2018). The airway POCUS examination can illuminate crucial information about a patient's airway anatomy, as hypoxia caused by airway obstruction, esophageal or endobronchial intubation, or generalized airway mismanagement can lead to severe and devastating neurological damage and death (Naji et al., 2021; You-Ten et al., 2018). Therefore, determining the precise POCUS equipment, techniques, findings, and clinical implications for appropriate and efficient airway examination is essential for safe and effective anesthesia practice.

The American Association of Nurse Anesthesiologists (AANA) and the American Society of Anesthesiologists (ASA) have recently recognized the lack of standardized practice guidelines for POCUS application for anesthesia providers. As a result, the ASA and AANA released recommendations that anesthesia providers become proficient in using POCUS for standard diagnostic requirements, including airway assessment (AANA, 2020; Bronshteyn et al., 2021).

Despite the host Nurse Anesthesia program at Southern Illinois University Edwardsville (SIUE) having integrated ultrasound-guided regional anesthesia material into its coursework, a distinct POCUS-centered curriculum was needed to align with the most recent AANA and ASA

recommendations for POCUS curriculum inclusion. Therefore, this project created a clinical airway POCUS examination curriculum that could be incorporated into the host Nurse Anesthesia program and utilized in future anesthesia practice.

Literature Review

The literature review analyzed 32 primary and six secondary research articles discussing airway POCUS techniques. Many authors described techniques for POCUS performance that are easily mastered with minimal education and training. Additionally, eight primary and two secondary research articles related to peer teaching for ultrasound instruction were reviewed, which highlighted the success of peer teaching as an evidence-based instructional method for ultrasound education.

Endotracheal tube (ETT) placement confirmation is a crucial aspect of airway management as incorrect positioning can result in significant morbidity and mortality (Das et al., 2015; Kristensen, 2011; Li et al., 2020). Researchers have discovered a variety of ultrasonographic techniques for ETT placement confirmation and correct positioning that have higher or equivalent diagnostic sensitivity, specificity, and accuracy compared to traditional ETT placement assessments (Abdelrahman et al., 2020; Chen et al., 2018; Chou et al., 2015; Das et al., 2015; Gottlieb et al., 2018; Hoffmann et al., 2014; Lahham et al., 2017; Merlin & Kamukutti, 2021; Ramsingh et al., 2016; Thomas et al., 2017). The studies were divided into three categories: ultrasound examination to differentiate between tracheal or esophageal intubation, determine endobronchial intubation, or ascertain general appropriate ETT depth of insertion inside the trachea.

Unanticipated difficult laryngoscopy (UDL) and intubation remain significant sources of increased morbidity and mortality in the surgical population (Adhikari et al., 2011; Chan et al.,

2018; Kasinath et al., 2021; Ni et al., 2020; Rana et al., 2018; Wu et al., 2014; Yao & Wang, 2017). Several studies have shown that ultrasonographic evaluation of the airway can predict UDL and difficult intubation with high accuracy, potentially allowing for proactive management and avoiding adverse outcomes (Adhikari et al., 2011; Agarwal et al., 2020; Wu et al., 2014; Yadav et al., 2019). The studies also highlighted that POCUS examination is a rapid, non-invasive bedside tool used for airway assessment in the perioperative period.

As identification of the cricothyroid membrane (CTM) is a crucial component of the “cannot intubate, cannot ventilate scenario,” several researchers have studied the effectiveness of ultrasonography for the identification of the CTM compared to the commonly practiced palpation technique, which has been shown to have a lower success rate than ultrasound (Kristensen et al., 2015; Siddiqui et al., 2018). These findings align with other observational studies of the accuracy of CTM localization by palpation, wherein ultrasound was utilized as the confirmatory marker for CTM identification due to its superiority over palpation (Aslani et al., 2012). Additionally, researchers found that only one e-learning module, a 20-minute lecture, and a 20-minute hands-on experience granted the anesthetists the ability to perform the ultrasound examination, making it an efficient learning process with high yield in the clinical setting (Kristensen et al., 2015).

Project Methods

This project was a non-experimental, instructional improvement project for the Nurse Anesthesia program at Southern Illinois University Edwardsville (SIUE). The setting for the project was the hands-on skills development lab at the SIUE campus in Edwardsville, IL. The project aimed to develop an airway POCUS curriculum that could be integrated into current Nurse Anesthesia course content and was submitted to the Institutional Review Board (IRB) at SIUE as a non-experimental study without the handling of proprietary or protected health

information. The project was determined to fall within quality improvement guidelines and was deemed exempt by the IRB.

Evaluation

Third-year Nurse Anesthesia students at SIUE were invited to participate in the airway POCUS lecture and skills lab through an email including a cover letter briefly explaining the purpose of the project and the content to be explored. Those students who volunteered to participate were asked to fill out an 11-question pre-lab survey utilizing the Likert scaling method to determine the baseline knowledge the Nurse Anesthesia students possessed regarding airway POCUS assessment. After collection of the pre-lab survey from each volunteer, a PowerPoint with voiceover lecture covering basics of ultrasonography and focused airway POCUS examination content was emailed to the third-year Nurse Anesthesia students to view prior to the skills lab. At the conclusion of the hands-on skills lab and review of the esophageal versus endotracheal intubation PowerPoint, the participants were asked to fill out another 11-question Likert scale post-lab survey for comparative analysis. The students were surveyed before and after the lab to assess their gain in knowledge of airway POCUS examination and technique.

The results of the pre-lab survey showed that the students had very little knowledge of the airway POCUS examination prior to the skills lab. None of the participants felt confident in their ability to identify key airway structures on ultrasound, including the hyoid bone, thyrohyoid membrane, epiglottis, cricoid cartilage, or tracheal rings. Similarly, no participants indicated that they knew the measurements used to identify potential difficult laryngoscopy, and over 95% of the students either strongly disagreed or disagreed that they could identify the thyroid cartilage and vocal ligaments on ultrasound.

After conducting the in-person skills lab and reviewing a second PowerPoint on tracheal versus esophageal intubation, the post-lab survey data showed that knowledge of the airway POCUS examination significantly increased. Additionally, over 85% of respondents either agreed or strongly agreed that they could identify the hyoid bone, cricoid cartilage, thyrohyoid membrane, and cricothyroid membrane for emergency airway management at the conclusion of the lab.

In addition, all participants reported that they had not seen the airway POCUS examination utilized in practice or in the clinical setting prior to the lab. After the lab, The combined curriculum approaches of independent study via voiceover lecture, hands-on training, and real-time feedback on ultrasound scanning technique appear to have successfully improved the third-year Nurse Anesthesia students' knowledge of airway POCUS examination. Confidence levels in performing essential airway POCUS assessment skills improved in every category, and all participants either strongly agreed or agreed that the peer-led curriculum was effective and that they would recommend these methods to learn other POCUS-related content.

Regarding limitations, although the PowerPoint with voiceover lecture was sent to each volunteer prior to the in-person skills lab, the authors cannot guarantee that the content was genuinely reviewed by each participant. The PowerPoint lecture gave essential airway POCUS examination information in greater detail for enhanced understanding. If some participants did not review the PowerPoint with voiceover lecture prior to the skills lab, the confidence levels reported in the post-lab survey could have been greater than actual results reported.

Additionally, the project has a limited number of participants (n=20), and the skills lab was conducted over just one hour due to space and time availability. Although hands-on

scanning time was adequate to allow each participant to perform a complete airway POCUS examination, additional lab time could further improve skills and increase confidence levels.

As a final consideration, the lack of ultrasound equipment and POCUS use in certain clinical settings may have limited the base knowledge of the third-year Nurse Anesthesia students; insufficient use of POCUS in anesthesia practice can become a barrier to students utilizing the skills learned during the airway POCUS curriculum.

Impact on Practice

In the context of anesthesia practice, the incorporation of an airway POCUS assessment curriculum into a Nurse Anesthesia program such as SIUE may have a significant impact on the safe management of the airway. The combined educational method of self-study PowerPoint lectures, hands-on training, and real-time ultrasound scanning feedback included in an airway POCUS examination curriculum can enhance Nurse Anesthesia students' knowledge of airway assessment and ultimately improve patient outcomes. By creating this airway POCUS curriculum and including it in the current coursework at SIUE, students gain valuable knowledge of airway evaluation that can be utilized in their future anesthesia practice.

Conclusion

The results of the pre-lab and post-lab survey analysis demonstrate that incorporating a comprehensive airway POCUS curriculum into a Nurse Anesthesia program can enhance students' knowledge of essential POCUS techniques and ultimately promote patient safety. Through the integration of this curriculum, students can acquire crucial skills in the examination of key airway anatomy, evaluation of predictors of difficult laryngoscopy, identification of the cricothyroid membrane for emergency airway management, and assessment of correct

endotracheal tube positioning. In addition, future students or instructors can utilize the structure of the curriculum provided by this project and build other POCUS-related course content.

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