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Gastric Point-of-Care Ultrasound Education for Certified Registered Nurse Anesthetists

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Abstract

Background: Pulmonary aspiration is a significant risk of general anesthesia and is related to increased perioperative morbidity and mortality. Gastric point-of-care ultrasound (POCUS) has been shown to be a reliable indicator of gastric contents and volume, and it can be used in the perioperative setting to detect gastric contents and make informed clinical decisions to prevent aspiration events.

Purpose: This project aimed to educate Certified Registered Nurse Anesthetists (CRNAs) at Washington University in the use of point-of-care ultrasound to assess gastric contents prior to surgery with the overall goal of improving knowledge, skills, and attitudes towards this practice among participants.

Methods: Participants were provided with written materials and a pre-recorded lecture detailing the current state of gastric POCUS research and how to perform and interpret a gastric POCUS assessment. They then attended a live session where each participant performed their own hands-on POCUS exams with various prandial states. A pre- and post-survey design was used to determine changes in knowledge and attitudes among participants in response to the education.

Results/Discussion: Ten CRNAs participated in the education. All participants successfully completed the modules and attended the live education. Post-survey responses showed
significant improvement in both knowledge, and attitudes at three separate time points following the education when compared to the pre-surveys. These results suggest brief hands-on education can significantly improve knowledge, and attitudes regarding gastric POCUS for CRNAs.

*Keywords:* Ultrasound, gastric POCUS, point-of-care ultrasound, pulmonary aspiration, gastric volume, gastric contents, perioperative pocus
Introduction

One of the most significant complications of general anesthesia is pulmonary aspiration (Nason, 2015). Several factors put perioperative patients at increased risk for aspiration, but perhaps the most significant is residual gastric contents. Fasting guidelines have been put in place to ensure patients have empty stomachs upon induction of anesthesia. However, these guidelines are unreliable and unable to guarantee an empty stomach prior to anesthesia, especially in populations with reduced gastric emptying (Zhou et al., 2019; Dupont et al., 2017). As a result, patients otherwise thought to have an empty stomach before undergoing surgery may have residual gastric contents that can lead to aspiration. For this reason, gastric point-of-care ultrasound (POCUS) may be a viable tool for anesthesia clinicians to learn and utilize in the perioperative environment.

Background

Pulmonary aspiration is the inhalation of oropharyngeal or gastric contents into the larynx and lower respiratory tract (Robinson & Davidson, 2014). Patients under general anesthesia and sedation are especially vulnerable due to reduced or absent airway reflexes and nausea caused by anesthetic agents (Van de Putte & Perlas, 2017). In addition, aspiration of gastric contents can lead to further complications such as pneumonitis or aspiration pneumonia (Nason, 2015). Although uncommon, aspiration of gastric contents is associated with high morbidity and mortality (Van de Putte & Perlas, 2014).

One of the key risk factors attributed to perioperative aspiration is the presence of gastric contents prior to induction of anesthesia (Van de Putte & Perlas, 2017). Therefore, patients are fasted according to specific guidelines to ensure gastric volume is minimal during
the perioperative period. These guidelines, however, are established based on normal physiology and may not be reliable for specific patient populations who may have delayed gastric emptying (American Society of Anesthesiologists, 2011). For this reason, traditional fasting guidelines may not be adequate to ensure the absence of gastric contents on induction of anesthesia.

Certified Registered Nurse Anesthetists (CRNAs) often anticipate the risk of aspiration when treating patients suspected of having significant gastric contents and take steps to prevent this complication. However, given the unreliable nature of preoperative fasting, it can be difficult to predict when patients are at increased risk due to high gastric volume. Ideally, clinicians would be able to assess gastric volume accurately and plan their anesthetic accordingly. One potential solution is the use of point-of-care ultrasound to determine gastric contents prior to induction of anesthesia. Recent studies have shown that POCUS can be used to assess gastric contents quickly and reliably (Johnson et al., 2021; Perlas et al., 2009; Kruisselbrink et al., 2019). Additionally, the American Association of Nurse Anesthetists (AANA) has identified POCUS as an increasingly important skill in the field of anesthesia, and they cite lack of knowledge and training as a significant barrier to the use of POCUS in CRNA practice (AANA, 2020). Even with brief education, anesthesia clinicians have been found to detect gastric volume after limited practice accurately (Arzola et al., 2013). As such, it may be a viable solution.

**PICOT Question**

Although POCUS is a viable method to determine the presence of gastric contents, many CRNAs lack training in its use. For this reason, the following PICOT question was developed: For
CRNAs practicing at a large academic center (P), does a one-time POCUS education session (I), compared to no formal education (C), improve knowledge, skills, and attitudes regarding POCUS for gastric volume assessment (O) immediately following education, two weeks, and four weeks after education (T)? An education project was conducted to answer this question.

**Significance**

The significance of such an education is ultimately in service of preventing perioperative aspiration. Pulmonary aspiration is associated with poor outcomes in perioperative patients. Nearly half of all patients who aspirate during surgery develop significant lung injury such as pneumonitis or aspiration pneumonia (Nason, 2015). These complications often require extended inpatient treatment and can even result in mortality. Perioperative aspiration has been found to have a mortality rate as high as 5%. Furthermore, it plays a role in up to 9% of anesthesia-related deaths, making it one of the highest causes of anesthesia-related deaths (Putte & Perlas, 2014). As such, the prevention of aspiration is paramount for anesthesia providers.

POCUS is a viable solution to help reduce aspiration risk in patients suspected of having consequential gastric contents prior to anesthesia. The lack of POCUS education is a significant barrier preventing CRNAs from practicing gastric ultrasound (AANA, 2020). As such, education and training in the use of gastric POCUS may reduce this barrier and facilitate the use of gastric POCUS to reduce the risk of perioperative aspiration. By preventing perioperative aspiration, this project may, in turn, lead to improved patient outcomes including reducing hospital length of stay, ICU admissions, pulmonary complications, and mortality.

**Literature Review**
A literature review was conducted to investigate the current research and clinical practice regarding perioperative aspiration and gastric POCUS. The literature review consisted of an in-depth search of two sizeable medical research databases and a review of several alternate literature sources. Pubmed and the Cumulative Index for Nursing and Allied Health Literature (CINAHL) were the two primary databases searched. Key search terms were initially broad. The initial primary search terms were point-of-care ultrasound, ultrasound, and gastric contents. This search was further narrowed with the MeSH terms ultrasonography and gastrointestinal contents. Additionally, education was also later included as a search term to identify literature specific to educating clinicians on the use of gastric ultrasound. Results were filtered to only show results published after the year 2000. The same search terms were used for other literature sources, including the websites for the Centers for Disease Control (CDC), the World Health Organization (WHO), the American Association of Nurse Anesthetists (AANA), and the American Society of Anesthesiologists (ASA).

Ten searches between two databases yielded 22 pieces of literature for review. The majority selected were original research related to the search terms. Review articles and case studies were also considered for inclusion. The focus was on literature related to the use of gastric ultrasound in the perioperative setting, educating clinicians in the use of point of care ultrasound (POCUS) for gastric assessment, and data about the perioperative risk of aspiration. Although the search included older literature, the majority of articles selected were from within the last five years. Several protocols and recommendations were also selected for review from the AANA and ASA. Lastly, numerous currently ongoing studies related to POCUS, and gastric contents in perioperative patients were found and reviewed.
Preoperative Fasting and Gastric Volume

One key insight gleaned from the literature was that preoperative fasting guidelines may not ensure a minimal gastric volume suitable for induction of anesthesia. Aside from apparent cases where gastric contents are uncertain, such as in trauma, patients may otherwise be unreliable in adhering to fasting guidelines or misunderstand preoperative instructions, leading to inconsistent compliance with fasting. Additionally, many disease pathologies may reduce gastric emptying and potentially lead to unanticipated residual gastric volume even with adequate fasting. Dupont et al. (2017) used ultrasound to measure gastric contents in 263 patients prior to undergoing unplanned surgery. Patients fasted for a minimum of 6 hours, and the median fasting time for the entire sample was 16 hours. They found that 35% of these patients had a gastric area exceeding 410 mm², a value determined to be a reasonable cut-off for “full stomach” prior to surgery. Additionally, they found that the measured gastric area correlated with morphine administered and elevated BMI, but it did not correlate with fasting time. This study was somewhat limited by its non-randomized design. But overall, the study is of good quality, and these results suggest that the duration of preoperative fasting is not a reliable surrogate for gastric volume.

Similar findings have also been demonstrated in elective surgery. Sharma et al. (2018) sought to correlate gastric volume measured via ultrasound with fasting times in elective surgery patients. All patients fasted a minimum of 6 hours. The study included 100 patients, and 16 had greater than 1.5ml/kg gastric volume, a minimum value found to be significant for aspiration risk. Similar to Dupont and colleagues, they found no correlation between gastric
volume and fasting time. The only correlating factors with the gastric volume being diabetes mellitus, chronic kidney disease, and obesity. Another study further highlights this risk in diabetic patients specifically. Zhou et al. (2019) compared preoperative gastric contents in patients with type II diabetes to a control group of non-diabetic patients. Both groups fasted for more than 6 hours. Out of 52 diabetic patients, 25 (48%) were found to have gastric contents significant for risk of aspiration compared to only four non-diabetic patients (8%). Sharma and colleagues’ results suggest preoperative fasting is unreliable across a wide range of patients. Zhou et al. (2019) further confirm these results with patients from both the control group of non-diabetic patients and diabetic patients having significant gastric volume despite fasting guidelines.

**Point-of-Care Ultrasound for Measurement of Gastric Contents**

Research indicates that gastric ultrasound is an accurate and reliable method to measure gastric contents prior to surgery. A study by Perlas et al. (2009) found that gastric antral cross-sectional area (CSA) measured via ultrasound directly correlates with gastric volume in a near-linear fashion, especially in volumes less than 300 ml. These results suggest CSA measurement of the gastric antrum is a reliable method of estimating gastric volume. A randomized controlled trial by Kruisselbrink et al. (2019) examined point-of-care ultrasound sensitivity, specificity, and likelihood ratios to detect gastric contents in a fasted control group compared to those who ingested a solid meal or liquids. Out of 80 tests, the examiner correctly identified all 40 positive results and 39 out of 40 negative results for a total sensitivity of 1.0 and a specificity of 0.975. Another similar study conducted by Johnson et al. (2021) used gastric ultrasound to identify gastric contents. Between three researchers, sensitivity and
specificity for detecting gastric liquids were high, 95-100% and 87.5-90%, respectively.

However, participants who consumed only a small solid meal with no liquid proved to be more difficult to accurately identify compared to liquid gastric contents. Bouvet et al. (2011) measured antral CSA via ultrasound in 180 subjects, calculated gastric volume, and compared it to actual gastric contents drained via Salem tube. They found antral CSA correlated in a linear fashion with aspirated gastric contents. Overall, this literature suggests ultrasound measurement of gastric antral CSA is a reliable method of determining gastric contents prior to surgery.

**Gastric Ultrasound Education for Anesthesia Clinicians**

Given the poor reliability of preoperative fasting and the high accuracy of gastric POCUS, key anesthesiology institutions and current research suggest anesthesia clinicians be educated in the use of POCUS to assess gastric contents in the perioperative setting. The American Association of Nurse Anesthetists (AANA) published an article in 2020 outlining the use and importance of POCUS for Certified Registered Nurse Anesthetists (CRNAs) and the future of anesthesia. This report, cited POCUS assessment specifically for gastric content and volume as an essential skill for CRNAs and highlighted numerous ways for CRNAs to develop POCUS skills. The official journal of the American Society of Anesthesiologists (ASA) has similarly cited POCUS as a vital tool in the practice of anesthesiology. It supports the further development of POCUS skills such as gastric assessment in anesthesia practice (Ramsingh et al., 2020).

The AANA has cited continuing education and workshops as one viable method for anesthesia providers to gain proficiency in gastric ultrasound (AANA, 2020). Research has shown brief education and practice can lead to proficiency. Arzola et al. (2013) conducted a
study to educate anesthesiologists in the use of POCUS to measure antral CSA and determine the number of examinations necessary to attain proficiency. The education consisted of a brief lecture, reading material, visual content, and a three-hour live hands-on workshop. All providers were familiar with using POCUS for procedures but unfamiliar with gastric ultrasound. Arzola and colleagues found that, in combination with the brief education session, only an average of 33 examinations were required for participants to gain a 95% proficiency in accurately diagnosing empty stomach, liquid gastric contents, and solid gastric contents via POCUS. This study suggests brief didactic and hands-on training may be an effective method to educate anesthesia clinicians in the use of POCUS to assess perioperative gastric contents.

Ultimately, current literature indicates that preoperative fasting alone is inadequate to ensure minimal gastric contents on induction of anesthesia. Point-of-care ultrasound is a more definitive and reliable indicator of gastric contents. As such, anesthesia providers should be proficient in POCUS to measure gastric contents and plan accordingly to prevent perioperative aspiration. In addition, given the current lack of standardized POCUS education, there is a significant need for POCUS training and education for CRNAs in the perioperative space.

Theoretical Framework

Conceptual and theoretical frameworks can be helpful to identify the scope and purpose of a QI project. The Donabedian model is a conceptual framework model that splits the different aspects of a project into three categories: structure, process, and outcome (Moran et al., 2020), and this framework was used to organize and provide focus to this project. Structure refers to the setting and who was involved. Process refers to what was done and how this was carried out, and the outcome is whatever was measured or assessed (Moran et al., 2020). The
setting for this project was a simulation room at a large teaching hospital. The people involved were a second-year nurse anesthesia student, two experienced nurse anesthetists, an anesthesiologist with extensive knowledge of POCUS, and the CRNAs that took part in the education. The process included a pre-recorded lecture and hands-on teaching. The outcome was pre and post-tests used to assess knowledge and attitudes, and a skills checkoff list to assess skill. A theoretical framework that was used for this project was the Dreyfus model of skill acquisition. This theory describes how individuals most easily learn and retain concepts and has commonly been used in clinical skill learning (Dreyfus, 2004). It explains how new learners move from novice to advanced beginner and eventually to competence and expertise. This was used when structuring education to ensure the use of tactics that were effective for the given stage of learners addressed during the teaching and to better understand the different stages of learning a new skill.

**Goals, Objectives, and Expected Outcomes**

The primary goal of this project was to educate CRNAs in the use of POCUS to assess gastric contents prior to surgery. The primary objective was to provide a live, one-time one-hour presentation and hands-on education session to CRNAs in the given setting. Additional objectives included: to assess CRNA knowledge and attitudes regarding gastric POCUS prior to the education session, to assess CRNA knowledge and attitudes immediately following the education session, and to reassess knowledge and attitudes two weeks and four weeks post-education. The expected primary outcome was to detect a statistically significant improvement in knowledge and attitudes regarding the use of gastric POCUS both immediately post-
education, two weeks, and four weeks following the education, as well as ensure adequate skill improvement via a one-time skills check-off list.

**Project Design**

**Design Overview**

This project was an educational intervention designed to improve knowledge, skills, and attitudes regarding gastric POCUS for CRNAs with the long-term goal of improving patient outcomes after surgery. The education session consisted of a formal lecture and a live ultrasound demonstration, followed by hands-on practice with all participants. Knowledge and attitudes regarding gastric POCUS were assessed at four different points, and skills were evaluated once following the education via a hands-on skills check-off list. The goal was for all CRNAs to show statistically significant improvement in knowledge and attitudes regarding gastric POCUS both immediately following the education, two weeks following, and one-month post-education. Regarding gastric POCUS skills, the goal was for each CRNA in attendance to complete the hands-on skills check-off list with an instructor prior to leaving after the education session to demonstrate their ability to obtain basic gastric views and evaluate gastric contents.

**Project Site and Population**

This education project took place at a level I trauma teaching hospital in an urban setting. The anesthesiology department was associated with both nurse anesthetist and anesthesiologist education through a nurse anesthesia program and an anesthesiologist residency program. The population of interest consisted of a smaller subsect of the over 100 CRNAs that staff the anesthesia department. CRNAs within the department provided anesthesia for every type of procedure and in every area where anesthetic services were needed. These
CRNAs served a large metropolitan community, and many of their patients were high acuity with multiple comorbidities increasing the risk of residual gastric contents. The CRNA staff encompassed a wide range of demographics, with clinicians of varying years of experience. CRNAs included in the education were those actively practicing in the perioperative setting and, thus, those for which gastric POCUS education may benefit. Ten CRNAs were recruited as participants on a volunteer basis. An email was sent out by the primary investigator to the department describing the project goals, plan, and date, and flyers were hung up in the anesthesia department lounge. Participants signed up via email and were confirmed for attendance by the primary investigator prior to the education session. Potential participants had two weeks to respond. All recruitment was strictly voluntary, and participants were able to opt out at any time and for any reason.

**Setting Facilitators and Barriers**

The selected setting offered unique benefits and opportunities for this specific project. The anesthesiology department provided an evidence-based, practice-focused and education-oriented environment to conduct the project. Continued education and training were highly valued by the department and expected of all of its clinical staff. Additionally, nearly all of the resources for the project were available within the department. Ultrasound machines and a suitable space within the facility were all available at no additional costs to the department, hospital, participants, or those conducting the study. Additionally, POCUS is a newly emerging and increasingly popular topic. Several influential leaders within the department were involved in the project, and many CRNAs within the department expressed interest in learning more about POCUS prior to the project taking place.
A substantial barrier to the success of this project was the relatively short timeframe. Given the participants' time constraints, each were scheduled to attend a single one-hour education session, which may have limited the education project in scope and efficacy. To overcome this barrier, focus was placed on simple skills that could be regularly practiced in the clinical setting following the education. There may have also been some resistance from CRNAs to learn gastric POCUS, as it may have been viewed as a waste of time or an unnecessary change in practice. However, by emphasizing the research supporting the use of gastric POCUS in the perioperative setting and the emerging importance of POCUS for anesthesia clinicians, ultimately participants were open and willing to learn gastric POCUS techniques. Project strengths, weaknesses, opportunities, and threats are detailed in Appendix F below.

Cost-Benefit Analysis/Budget

The resources needed for the project included personnel, physical materials, equipment, and software. Further breakdown of each category and individual costs are listed in Appendix G below. Personnel included the project leader, project chair, two additional project members, CRNA participants, three student volunteers acting as models, and a Washington University (WashU) statistician who assisted in the data analyses. Materials and equipment included the ultrasound machines used in the hands-on education and paper and printing supplies. Finally, software needed included an active Qualtrics subscription provided by the department for administering the surveys and SPSS software for data collection and analysis.

The majority of the cost of the project came from personnel. The project chair, both additional members of the team, and the CRNA participants were all Washington University Department of Anesthesiology employees, and the education was conducted during work
hours. With that considered, the education was scheduled during dedicated education hours before the start of anesthesia cases on Wednesday mornings, a time typically dedicated to department education. Thus, participating CRNAs did not generate any additional costs to the institution than was usually planned. Time outside of those hours served by the project chair and both additional team members, however, potentially resulted in additional use of resources.

Physical supplies and equipment were inexpensive for the project. The ultrasound machines needed were readily available at no additional cost to the institution, and paper/printing needs were limited given the online nature of the surveys. The software required posed and somewhat significant cost but was already licensed by the department.

Overall, the cost of the project was relatively low given the potential benefits. Some of the resources needed were already available within the department, and the project didn’t require prolonged time investment from participants. POCUS is becoming increasingly important in the perioperative space. This project allowed CRNAs the opportunity to expand their knowledge and incorporate gastric POCUS into their practice to improve patient outcomes.

**Timeline**

The entire project, from planning and implementation, to data collection and analysis, took approximately six months. The initial phase included finalizing the literature and written materials distributed to the CRNAs along with finalizing the knowledge test, Likert scale survey, and hands-on skills check-off list. Once complete, they were reviewed and approved by each member of the project team. Once approved by the team, the project was submitted for
Institution Review Board (IRB) approval. After IRB approval was obtained, CRNA volunteers were recruited for the project. The implementation itself took place over six weeks from pre-tests to final posts-tests. After the CRNA volunteers were selected, the written materials and pretests were sent to the CRNAs two weeks prior to the education. They then completed the skills check-off and the initial post-test the same day, with another round of post-tests at two weeks and four weeks. Finally, data analyses were performed, and conclusions drawn based on the results.

**Ethical Considerations/Human Rights**

Washington University Institutional Review Board (IRB) approval was obtained prior to data collection. The project proceeded once IRB approval was obtained and volunteers were recruited. Given that this was an education project for CRNAs, there was no direct contact with patients or risk to patient subjects. CRNA staff were recruited strictly voluntarily. An information sheet detailing the project and its requirements was provided to CRNAs interested in the project via email. Informed consent was obtained from those who participated as deemed necessary by the IRB. Data was collected securely through official survey tools. Once obtained, this data was also de-identified so as not to reveal the participants’ names or information. Otherwise, the IRB helped ensure risks were minimized, and potential benefits were maximized for the project, and any ethical concerns were addressed appropriately.

**Methods**

**Education Design**
Arzola et al. (2013) conducted a gastric POCUS education project for anesthesia clinicians. They found success in providing education through a combination of reading materials, pictures, a pre-recorded lecture, and a live hands-on demonstration. Similarly, this education consisted of multiple parts and was delivered via several different modes. First, two weeks prior to the live session, written materials and a prerecorded lecture were sent to participants via email. The written materials included several studies and articles highlighting the use of gastric POCUS and its reliability. The articles included were a literature review by Van de Putte & Perlas (2014), an expert opinion article also by Van de Putte & Perlas (2017), and a non-randomized experimental study by Dupont et al. (2017). The two articles by Putte & Perlas offered an overview of gastric POCUS and its utility in preventing perioperative aspiration. While the study by Dupont et al. was a high-level evidence example demonstrating that preoperative fasting is not a reliable surrogate for gastric volume. Additionally, an aspiration risk assessment tool developed by Gastricultrasound.org based on peer-reviewed data was distributed for easy reference following the education (See Appendix E).

The prerecorded lecture was split into two modules. The first summarized current evidence supporting the use of gastric POCUS. The points highlighted from the research in this lecture were as follows: perioperative aspiration poses a threat to patients resulting in significant morbidity and mortality; preoperative fasting does not consistently correlate with gastric content; patients may be at increased risk of aspiration due to residual gastric contents despite fasting; and gastric ultrasound is a reliable method to detect gastric contents to prevent aspiration. The final part of module one also briefly summarized the basic physics of ultrasound.
The second module focused on actually performing and interpreting a gastric POCUS exam. This included a discussion of the proper equipment, patient positioning, and a brief review of gastric anatomy as seen on ultrasound. Next, the appearance and qualities of the gastric antrum when empty, containing liquid contents, and containing solid contents were reviewed with multiple imaging examples. The final portion of the second module explained the use of antral CSA to calculate the gastric volume and the various cutoffs considered pertinent for clinical decision-making. Participants were required to read the written materials and watch the lecture prior to attending the education. The live education consisted of a brief review of gastric POCUS concepts covered in the modules followed by individual hands-on with each clinician.

Three students from the Goldfarb School of Nursing: Nurse Anesthesia Program were recruited as volunteers to be scanned for the project, and volunteering in this manner is a common practice in this educational program. Those eligible included any students currently enrolled in the nurse anesthesia program in the fall of 2022. No personal health information or demographic data was needed from these volunteers. Each volunteer was assigned to one of three groups. The first was instructed to fast for 8 hours prior to the education. The second was instructed to drink 500ml of water immediately before the education, and the third was provided a small meal one hour prior to the education consisting of a banana and a blueberry muffin. The volunteers represented empty stomach, clear fluid, or solid contents on gastric ultrasound, respectively. These volunteers were recruited by word of mouth, and an email was sent detailing the requirements of the project. Informed consent was obtained for each of these volunteers prior to participating in the project.
Measurement Instruments

Three dependent variables were measured: knowledge, skills, and attitudes. Knowledge was assessed pre-education, immediately post-education, and at two more time points following the education. This assessment was done via a 15 item online multiple-choice test designed by the project leader and verified by expert opinion (see Appendix A). The knowledge assessment test questions consisted of objective clinical multiple-choice questions related to gastric POCUS. Images of the gastric antrum were included, and participants were asked to identify the qualitative nature of gastric contents. Each of these questions was drawn from peer-reviewed literature sources. Participants were unaware of their score or the correct answers upon completion. The test was scored 1-15, with 15 being the highest possible score.

Attitudes were assessed via a 15 item, 5-point Likert scale survey designed by the project leader and verified by expert opinion (see Appendix B). It was administered online. Similar to the knowledge test, this Likert scale survey was administered four separate times. The survey consisted of questions regarding attitudes towards POCUS to assess gastric contents in the perioperative setting. Each question was scored 1-5 based on the response from negative to positive with the max possible score of 75 points.

The skills check-off required participants to obtain a view of the gastric antrum, correctly identify three different gastric states (empty, clear fluid present, solids present), and measure gastric volume (see Appendix D). This skills check-off was only assessed at one-time point immediately post-education. As such, it was not used to measure POCUS skills pre vs. post-education. Instead, this check-off was designed to ensure participants had adequate
understanding and hands-on practice with gastric POCUS to incorporate this skill into their clinical practice.

**Data Collection Procedures**

Both the knowledge test and attitudes Likert scale survey were administered electronically via the online tool Qualtrics (Qualtrics XM, 2022). This allowed for accessible data collection before and after the education without requiring participants to attend additional physical appointments outside of the education session. The knowledge test seen in Appendix A and the attitudes survey seen in Appendix B were constructed within Qualtrics.

These online surveys were administered to participants at a total of four time points. The first time point was one week prior to the education session. This survey set a baseline knowledge and attitudes measurement to later compare to the post-intervention results. The second time point was approximately 24 hours post-education. Thus, this survey served as the first post-education assessment. The following two time points were two weeks and four weeks following the education, respectively. These two-time points provided insight into how well participants retained the information detailed in the education and how attitudes toward gastric POCUS change over time. At each time point, both surveys were unchanged, with questions occurring in the same order with each administration to prevent bias and unintended deviations in data. The demographics survey seen in Appendix C was also administered via Qualtrics and was collected at a single time point one week prior to the education.

Email addresses for each participant were collected upon signing up to participate in the education session. Access to the surveys was granted to participants through a link sent via
email. The project leader was responsible for formatting Appendices A, B, and C into Qualtrics and sending participants access appropriately.

The hands-on skills check-off list seen in Appendix D was a physical sheet filled out by one of the project administrators as participants demonstrated said skills. One team member assisted the participant in performing the required skills, while another team member checked off each item on the list as it was completed. This assessment was only completed a single time for each participant.

There were several demographic and cultural considerations related to the data collection procedures. Firstly, the tests were only be provided in English. However, given the demographic makeup of the institution where the education took place, this was unlikely to skew the data towards a specific group unrepresentative of the general CRNA population of the United States. Second, the knowledge test and attitudes survey were administered electronically. Participants were required to have a level of technological competency to retrieve the email and complete the quiz. Each CRNA at the institution had a work-specific email they were expected to access regularly.

Data Analysis

Various data analyses were used to examine the results of the project. The independent variable was the study itself, more specifically the attendance of the education session by CRNAs. The primary dependent variables under study were knowledge and attitudes as measured by the objective quiz and the Likert scale survey, respectively. A paired t-test was used to compare the knowledge level of the group at each time point to determine the effect of
the education on knowledge over time. Paired t-test was also used to compare attitudes survey results at each time point to determine change in attitudes as a result of the education. Skills were included as a tertiary dependent variable presented as descriptive data at a single time point. Demographics detailed by the study included age, gender, number of cumulative years practicing as a CRNA, number of years practicing as a CRNA with Washington University Department of Anesthesia (WUDA), and highest degree obtained. Demographic variables were analyzed with Pearson’s correlation matrix or two sample t-test to determine if any correlations between demographic variables and the dependent variables under study were present. Data collection and analyses were conducted via IBM SPSS statistics software, and alpha was set at <0.05 with p values less than 0.05 being significant (IBM, 2022).

Results and Discussion

In total, ten CRNAs participated in the project. Each participant completed the required surveys prior to the education, attended the education itself, and completed the skills checkoff on the day of education (see Appendix D). Overall, the post-survey response rate was 85%, and all but one participant completed the first set of knowledge and attitudes post-surveys. Demographics are listed in Appendix C. The cohort consisted of six male and four female participants. Two sample t-tests showed no significant difference in scores between genders (see Table 1). Seven participants were masters prepared, and three were doctorate prepared CRNAs. No significant difference in results was found in relation to highest degree obtained (see Table 2). The median number of years in practice total and years in practice at Washington University was four years, and median age was 34. Similar to the other demographics observed,
no significant difference in results was seen in relation to these factors. Overall, no demographic variable tested was seen to affect knowledge, skills, or attitudes towards gastric POCUS in either pre- or post-survey results.

Significant improvement was seen in both knowledge and attitudes test scores across all three time points when compared to scores prior to the education. Each participants’ knowledge and attitudes test scores can be seen in Tables 3 and 4, respectively. For the knowledge test, the mean pre-test score was 6.9 out of 15. This compares to mean post-test scores of 12.7, 12.2, and 10.9 out of 15 for each time point, respectively, and this was found to be a significant improvement at each time point (see Table 5). For the attitudes survey, the mean pre-test score among participants was 39 out of 75. The mean post-test scores were 64.3, 64.1, and 55.3 out of 75, respectively, for each time point, and this was also found to be a statistically significant improvement for all three (see Table 6). Each participant practiced multiple times to obtain the required images and determine the qualitative and quantitative nature of the gastric contents for each model. All ten participants completed the skills check-off list.

The primary goal of this project was to educate CRNAs in the use of POCUS to assess gastric contents prior to surgery. The expected primary outcome was to detect a statistically significant improvement in knowledge and attitudes regarding the use of gastric POCUS both immediately post-education, two weeks, and four weeks following the education, as well as ensure adequate skill improvement via a one-time skills check-off list. From the pre- and post-survey results and analyses, it is clear that this brief gastric POCUS education resulted in
significant improvements in both knowledge and attitudes when compared to the initial pre-test. This result suggests brief education in gastric POCUS can significantly impact clinician knowledge and interest. Additionally, the relative lack of change in survey results over time suggests the effects of such an education may be long lasting and lead to long-term knowledge and continued interest in gastric POCUS concepts.

There are several limitations to this study. The first and most significant is the relatively small sample size of 10 CRNAs. Although significant improvements were seen on the post-surveys, a larger study with more participants could render higher power results. Another limitation is the relatively short duration of each participants’ hands-on practice had and the lack of measuring hands-on skills at multiple time-points. Ideally, participants would have had the opportunity to practice hands-on gastric POCUS and complete the skills checklist at multiple points to track changes in skill over time. However, given the time limitations and inability to schedule CRNAs for multiple hands-on sessions, only knowledge and attitudes were measured at multiple time-points. Potential future projects might benefit from a larger sample size, multiple hands-on sessions with more time overall dedicated to mastering gastric POCUS, and in-person clinical instruction during the routine care of patients. Also, measuring skill proficiency both before and after education could better determine if participants significantly improved in hands-on skills over time.

Conclusion

Pulmonary aspiration remains a significant risk to patients undergoing general anesthesia. Although preoperative fasting may be adequate in many patients to ensure minimal
gastric contents prior to anesthesia, some patients may still be at increased risk due to gastric residual. CRNAs can quickly assess gastric contents using gastric POCUS and make informed clinical decisions about each patient’s anesthetic care. This project has demonstrated that even brief hands-on gastric POCUS education can lead to an improvement in knowledge, skills, and attitudes towards gastric POCUS, which may potentially work to prevent perioperative aspiration.
References


Qualtrics XM - experience management software. Qualtrics. (2022, March 14).
https://www.qualtrics.com/

https://doi.org/10.1097/aln.0000000000003113


https://doi.org/10.4103/ija.ija_147_18


Table 1
*Two sample t-test to test for change of scores (post-pre) between genders*

<table>
<thead>
<tr>
<th>Test Comparison</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Knowledge Pre to Post 1</td>
<td>0.2006</td>
</tr>
<tr>
<td>2 Knowledge Pre to Post 2</td>
<td>0.0623</td>
</tr>
<tr>
<td>3 Knowledge Pre to Post 3</td>
<td>0.2982</td>
</tr>
<tr>
<td>4 Attitudes Pre to Post 1</td>
<td>0.7161</td>
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<tr>
<td>5 Attitudes Pre to Post 2</td>
<td>0.6284</td>
</tr>
<tr>
<td>6 Attitudes Pre to Post 3</td>
<td>0.6592</td>
</tr>
</tbody>
</table>

Table 2
*Two sample t-test to test for change of scores (post-pre) between highest degree (Doctorate/PhD vs. Masters)*

<table>
<thead>
<tr>
<th>Test Comparison</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Knowledge Pre to Post 1</td>
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</tr>
<tr>
<td>2 Knowledge Pre to Post 2</td>
<td>0.3168</td>
</tr>
<tr>
<td>3 Knowledge Pre to Post 3</td>
<td>0.3260</td>
</tr>
<tr>
<td>4 Attitudes Pre to Post 1</td>
<td>0.5351</td>
</tr>
<tr>
<td>5 Attitudes Pre to Post 2</td>
<td>0.1311</td>
</tr>
<tr>
<td>6 Attitudes Pre to Post 3</td>
<td>0.5525</td>
</tr>
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</table>

Table 3
*Knowledge test total score out of 15 for each participant at each time-point*

<table>
<thead>
<tr>
<th>Participant ID</th>
<th>Knowledge Pre</th>
<th>Knowledge Post 1</th>
<th>Knowledge Post 2</th>
<th>Knowledge Post 3</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>7</td>
<td>13</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>10</td>
<td>9</td>
<td>Incomplete</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td>14</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
<td>9</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>14</td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td>6</td>
<td>5</td>
<td>14</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>8</td>
<td>11</td>
<td>14</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>9</td>
<td>6</td>
<td>Incomplete</td>
<td>Incomplete</td>
<td>Incomplete</td>
</tr>
</tbody>
</table>
Table 4  
*Attitudes survey total score out of 75 for each participant at each time point*

<table>
<thead>
<tr>
<th>Participant ID</th>
<th>Attitudes Pre</th>
<th>Attitudes Post 1</th>
<th>Attitudes Post 2</th>
<th>Attitudes Post 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td>64</td>
<td>63</td>
<td>60</td>
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<td>2</td>
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<td>38</td>
<td>73</td>
<td>71</td>
<td>68</td>
</tr>
<tr>
<td>4</td>
<td>40</td>
<td>63</td>
<td>65</td>
<td>65</td>
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<tr>
<td>5</td>
<td>35</td>
<td>63</td>
<td>65</td>
<td>65</td>
</tr>
<tr>
<td>6</td>
<td>35</td>
<td>64</td>
<td>62</td>
<td>60</td>
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<td>8</td>
<td>43</td>
<td>68</td>
<td>64</td>
<td>64</td>
</tr>
<tr>
<td>9</td>
<td>39</td>
<td>62</td>
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<td>Incomplete</td>
</tr>
<tr>
<td>10</td>
<td>34</td>
<td>60</td>
<td>55</td>
<td>60</td>
</tr>
<tr>
<td>11</td>
<td>37</td>
<td>55</td>
<td>58</td>
<td>Incomplete</td>
</tr>
</tbody>
</table>

Table 5  
*Mean knowledge pre-test and post-test scores compared at each time-point*

![Mean Knowledge Quiz Scores](chart.png)

- Pre-post 1: Knowledge Pre-test = 6.9, Knowledge Post-test = 12.7  
  *p*-value = 0.0028
- Pre-post 2: Knowledge Pre-test = 6.9, Knowledge Post-test = 12.2  
  *p*-value = 0.0070
- Pre-post 3: Knowledge Pre-test = 6.9, Knowledge Post-test = 10.9  
  *p*-value = 0.0056
Table 6
Mean attitudes pre-test and post-test scores compared at each time-point

<table>
<thead>
<tr>
<th>Time-point</th>
<th>Mean Pre-test</th>
<th>Mean Post-test</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Post 1</td>
<td>39</td>
<td>64.3</td>
<td>(p&lt;0.0001)</td>
</tr>
<tr>
<td>Pre-Post 2</td>
<td>39</td>
<td>64.1</td>
<td>(p&lt;0.0001)</td>
</tr>
<tr>
<td>Pre-Post 3</td>
<td>39</td>
<td>55.3</td>
<td>(p&lt;0.0001)</td>
</tr>
</tbody>
</table>

Mean Attitudes Quiz Scores
Appendix A

Point-of-care gastric ultrasound knowledge assessment

1.) What transducer is most appropriate to evaluate gastric contents in adults and pediatric patients greater than 30kg?
   a. Linear array
   b. Phased array
   c. T-type linear array
   d. Curved linear array

2.) What transducer is most appropriate to evaluate gastric contents in the pediatric patient less than 30kg?
   a. Linear array
   b. Phased array
   c. T-type linear array
   d. Curved linear array

3.) What position is most optimal to assess gastric contents via ultrasound?
   a. Supine
   b. Right lateral decubitus
   c. Left lateral decubitus
   d. Reverse Trendelenburg

4.) Which portion of the stomach is most amenable to sonographic examination to determine the presence and volume of gastric contents?
   a. The fundus
   b. The body
   c. The pyloric antrum
   d. The pyloric canal

5.) Solid gastric contents on ultrasound typically appear ________
   a. Anechoic
   b. Hyperechoic and heterogenous
   c. Hypoechoic and homogenous
   d. Hyperechoic

6.) Liquid gastric contents on ultrasound typically appear
   a. Anechoic
   b. Hyperechoic and heterogenous
   c. Hypoechoic and homogenous
   d. Hyperechoic

7.) What measure is most ideal for calculating gastric volume?
   a. Antral diameter
   b. Fundus cross-sectional area (CSA)
   c. Antral cross-sectional area (CSA)
   d. Gastric body diameter
8.) The ultrasonographic view pictured would most likely indicate ______
   a. The presence of solid gastric contents
   b. The presence of liquid gastric contents
   c. No appreciable gastric contents
   d. Unable to determine

9.) The ultrasonographic view pictured would most likely indicate ______
   a. The presence of solid gastric contents
   b. The presence of liquid gastric contents
   c. No appreciable gastric contents
   d. Unable to determine

10. ) The ultrasonographic view pictured would most likely indicate ______
    a. The presence of solid gastric contents
    b. The presence of liquid gastric contents
    c. No appreciable gastric contents
    d. Unable to determine

11.) The correct formula to calculate gastric volume is ______
    a. $27.0 + (14.6 \times \text{Left lateral CSA}) - (1.28 \times \text{Age})$
b. 27.0 – (14.6 x Left lateral CSA) + (1.28 x Age)
c. 27.0 + (14.6 x Right lateral CSA) – (1.28 x Age)
d. 27.0 – (14.6 x Right lateral CSA) + (1.28 x Age)

12.) Referring to the previous question, this formula is accurate in ______

a. Pregnant and non-pregnant patients with greater than 500 ml of gastric volume
b. Non-pregnant patients with greater than 500 ml of gastric volume
c. Pregnant and non-pregnant patients with 500 ml or less of gastric volume
d. Non-pregnant patients with 500 ml or less of gastric volume

13.) A 40-year-old patient has clear fluid visible in supine position and a right lateral antral CSA measurement of 30 cm². What is his calculated gastric volume?

a. 242 ml
b. 414 ml
c. 128 ml
d. 66 ml

14.) Referring to the previous question, assuming the patient is 70kg, they would be categorized as ______.

a. Empty stomach
b. Grade 0
c. Grade 1
d. Grade 2

15.) Patients with greater than _____ of gastric volume are considered high risk for aspiration.

a. 1.0 ml/kg
b. 1.5 ml/kg
c. 2.0 ml/kg
d. 3.0 ml/kg
## Appendix B

### Point-of-care gastric ultrasound attitudes assessment

<table>
<thead>
<tr>
<th></th>
<th>Strongly disagree</th>
<th>Somewhat disagree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Gastric point-of-care ultrasound can provide me with valuable data that may influence my anesthetic plan.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>2. Overall, I am comfortable using point-of-care ultrasound to assess gastric contents.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>3. Gastric point-of-care ultrasound is a useful tool to determine if a patient is at risk for aspiration when undergoing anesthesia.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>4. I am comfortable using point-of-care ultrasound to obtain a view of the gastric antrum.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>5. I am confident in my ability to measure gastric volume via point-of-care ultrasound.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>6. I am confident in my ability to measure gastric antrum cross-sectional area (CSA)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>7. Gastric point-of-care ultrasound is an important skill for the future of CRNA practice.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>8. I am confident in my ability to determine the presence of solid gastric contents via point-of-care ultrasound.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>9. Gastric point-of-care ultrasound can be used to reliably measure gastric contents in perioperative patients.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
10. I am confident in my ability to determine the presence of liquid gastric contents via point-of-care ultrasound.

11. I often utilize point-of-care ultrasound to assess gastric contents.

12. Utilizing gastric point-of-care ultrasound can significantly reduce the risk of perioperative aspiration.

13. The presence of gastric contents poses a significant threat to patients during the perioperative period.


15. Using point-of-care ultrasound to assess gastric contents is convenient.

Appendix C

Demographic survey

Age: ______

Gender: ______

Number of cumulative years as a practicing nurse anesthetist: ________

Number of cumulative years as a practicing nurse anesthetist with Washington University in Saint Louis: ________

Highest degree obtained: ________
# Appendix D

## Gastric ultrasound hands-on skills check-off

<table>
<thead>
<tr>
<th>Skill Demonstrated</th>
<th>Satisfactory</th>
<th>Un satisfactory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positions the patient correctly</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Demonstrates correct probe placement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>successfully identifies empty stomach</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Successfully identifies the presence of solid gastric contents</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Successfully identifies the presence of clear liquid contents</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Successfully measures antral cross-sectional area</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Successfully calculates gastric volume based on antral CSA</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Participant Name (print)</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Instructure Signature</th>
<th>Date</th>
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</thead>
<tbody>
<tr>
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Appendix E

Gastric Ultrasound: A Point-of-care tool for aspiration risk assessment

[Diagram of Gastric Ultrasound protocol]

- **Qualitative Exam**
  - **Empty Grade 0**
    - Low Risk
  - **Clear Fluid**
    - **Volume?**
      - **Solid**
      - **Grade 1 OR Vol≤1.5 mL/kg**
        - Suggests Empty Stomach
        - Proceed with case
      - **Grade 2 OR Vol>1.5 mL/kg**
        - Suggests Full Stomach
          - **Urgent**
            - Proceed with aspiration prophylaxis e.g. RSI
          - **Elective**
            - Delay or cancel
Appendix F

DNP Project SWOT Analysis

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>• The selected hospital and anesthesiology department offer a supportive and EBP-focused environment for the project.</td>
<td>• The education project will be relatively short, consisting of only one live demonstration, and CRNAs may need more continuing education to encourage use of POCUS perioperatively.</td>
</tr>
<tr>
<td>• The project has support from an experienced Certified Registered Nurse Anesthetist (CRNA) and anesthesiologist within the department.</td>
<td>• Depending on the state of the Covid-19 pandemic, a hands-on session may not be possible, and only live demonstration via zoom will be conducted.</td>
</tr>
<tr>
<td>• The resources required for the project are readily available to CRNAs within the department (ultrasound machines).</td>
<td>• Using this education requires readily available ultrasound machines, which can be difficult to acquire in certain perioperative areas.</td>
</tr>
<tr>
<td>• The project will be fairly inexpensive, given the resources needed are already available in the department, and the staff signing on to the project are volunteering.</td>
<td>• This education will not be a comprehensive head-to-toe POCUS assessment program and will only focus on assessing gastric contents and lung fields.</td>
</tr>
<tr>
<td>• Project will be time-efficient, requiring relatively little time of clinicians and potential long-term benefit to their practice.</td>
<td>• Most likely, not all of the CRNAs in the department will receive the training, given their availability and time constraints.</td>
</tr>
<tr>
<td>• Given it is an education project, it poses no risks and only stands to benefit patients through the education of clinicians.</td>
<td>• POCUS relies on hands-on experience, and it will take commitment from clinicians following the education to make use of what they learned in the education project.</td>
</tr>
<tr>
<td>• POCUS for use in anesthesia is a newly emerging topic, and there is a lot of current research and evidence supporting POCUS education for anesthesia clinicians.</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Opportunities</strong></td>
</tr>
<tr>
<td></td>
<td>• POCUS education for CRNAs will expand their knowledge base, and it is essential for modern CRNA education.</td>
</tr>
<tr>
<td></td>
<td>• POCUS education has been shown to improve clinician acquisition and diagnostic interpretation of ultrasound images in the perioperative setting among anesthesia clinicians (Ramsingh et al., 2015)</td>
</tr>
<tr>
<td></td>
<td>• The American Association of Nurse Anesthetists (AANA) supports the use of POCUS for CRNAs and encourages CRNA POCUS education (AANA, 2020).</td>
</tr>
<tr>
<td></td>
<td>• Project may help expand CRNA practice and implementation within the department.</td>
</tr>
<tr>
<td></td>
<td><strong>Threats</strong></td>
</tr>
<tr>
<td></td>
<td>• Some clinicians may be hesitant to take part in POCUS training, as it has not traditionally been a part of their training in the past.</td>
</tr>
<tr>
<td></td>
<td>• Clinicians may be hesitant to utilize POCUS training due to added workload and need for an ultrasound machine.</td>
</tr>
<tr>
<td></td>
<td>• Some clinicians may be hesitant to receive education from a student-led project.</td>
</tr>
</tbody>
</table>
## Appendix G

### Budget Table

#### Table 1.

<table>
<thead>
<tr>
<th>Nature of Expenditure/Item</th>
<th>Cost per Unit (item)/Cost per hour (personnel)</th>
<th># Units</th>
<th>Total Estimated Cost</th>
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<tbody>
<tr>
<td><strong>Personnel</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project Leader</td>
<td>$0.00/ hour</td>
<td>100+ hours</td>
<td>$0.00</td>
</tr>
<tr>
<td>Project Chair</td>
<td>$91.00/hour</td>
<td>10-20 hours</td>
<td>$910.00-1820.00</td>
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<tr>
<td>Project Team Member #2</td>
<td>$191.00/hour</td>
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<td>$955.00</td>
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<tr>
<td>Project Team Member #3</td>
<td>$91.00/hour</td>
<td>5 hours</td>
<td>$455.00</td>
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<tr>
<td>CRNA Participants</td>
<td>$91.00/hour</td>
<td>30 participants (1 hour each)</td>
<td>$2730.00</td>
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<tr>
<td>Volunteers</td>
<td>$0.00/hour</td>
<td>3 volunteers (3 hours each)</td>
<td>$0</td>
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<tr>
<td><strong>Materials and Supplies</strong></td>
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<td></td>
</tr>
<tr>
<td>Ultrasound Machines</td>
<td>$0.00</td>
<td>2 units</td>
<td>$0.00</td>
</tr>
<tr>
<td>Paper and printing</td>
<td>$0.04</td>
<td>120-300 units</td>
<td>$4.80-12.00</td>
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<tr>
<td><strong>Technology Hardware/Software</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>SPSS software</td>
<td>$58.99</td>
<td>1 unit (12 months)</td>
<td>$58.99</td>
</tr>
<tr>
<td>Qualtrics</td>
<td>$99.00/month</td>
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<td>$297.00</td>
</tr>
<tr>
<td><strong>Other</strong></td>
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<td></td>
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<td></td>
<td></td>
</tr>
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<td><strong>TOTAL</strong></td>
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<td>$5410.79-6327.99</td>
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