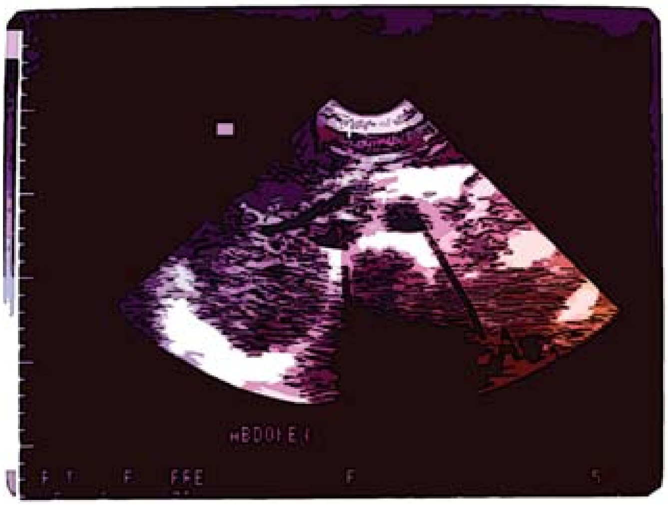
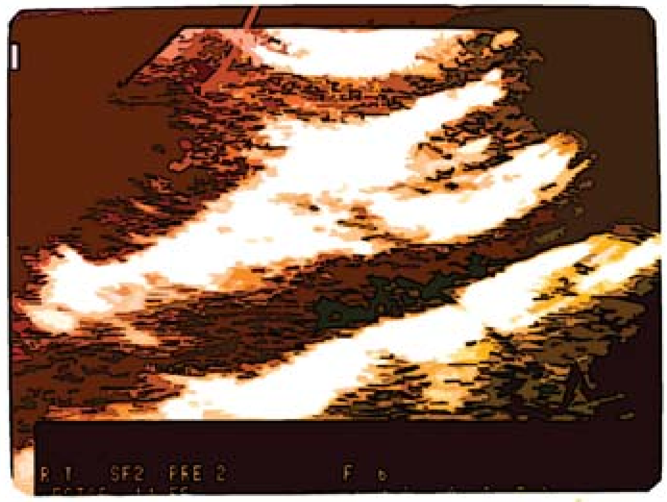
Accuracy in Evaluating Gastric Ultrasound Images Before and After Brief Training





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Authors Kline and Selai work for and are compensated by Twin Oaks Anesthesia Services, which provides AANA-approved courses on peripheral nerve blocks and ultrasound guidance. Authors Ardigo and Pugh reported no relevant financial disclosures.

An important preoperative evaluation is determining the presence of gastric contents. Here, student clinicians are taught how to use ultrasound to gauge aspiration risk.

Abstract

The objective assessment of gastric volume by ultrasound imaging can contribute valuable data for preoperative evaluation. Anesthesia providers can use the information to modify the plan of care as needed to reduce the risk for anesthesia-related pulmonary aspiration in surgical patients. We presented a 45-minute instructional activity to nurse anesthesia students (N=110) who had no prior experience with interpreting gastric ultrasound imaging. Initially, the students evaluated 8 sets of gastric images, demonstrating only

chance accuracy. Following instruction, the students accurately evaluated the gastric volume in 5 out of 8 sets of images. Additionally, students' confidence in their evaluations increased from "no confidence" before instruction to "fairly confident" or "completely confident" after instruction. This finding indicates that with even minimal training, anesthesia providers' use of an expedient, noninvasive procedure could improve their preoperative evaluation of patients.

Study purpose: To determine if, after exposure to a presentation about ultrasound evaluation of gastric contents, student nurse anesthetists were better able to recognize 3 different volumes of gastric contents accurately. These different volumes are categorized as full, empty, or moderate/normal.

Introduction

Evaluation of pulmonary aspiration risk is an important element of the surgical patient's preoperative interview.[1] Anesthesia providers must master the various risk assessment tools for hidden conditions that could increase patient risk, such as gastroparesis. This condition may arise from pain, opioid consumption, bowel obstruction, or patient noncompliance with NPO (nothing by mouth) guidelines. An objective evaluation of gastric contents could assist providers' identification of "at risk" patients for pulmonary aspiration.

An ideal technique for determining gastric contents should be noninvasive, relatively rapid, reproducible, and usable by even entry-level anesthesia providers. Ultrasound evaluation of gastric contents may represent an excellent diagnostic tool. Currently, anesthesia providers use ultrasound technology for the placement of regional blocks, vascular access, and rapid diagnosis of certain conditions.

The ultrasound evaluation of gastric contents for preoperative aspiration risk assessment is not a novel concept. One of its first applications was in a patient population that is known to develop gastroparesis—the parturient. Carp et al[2] performed ultrasound evaluation of gastric contents in a series of parturients and volunteers. These researchers concluded that ultrasound imaging was an effective means of determining gastric contents. Perlas[1,3] has published multiple works on this subject. Additional studies[4-10] also demonstrate the beneficial use of ultrasound evaluation of gastric contents.

Review of Literature

A literature review yielded 11 relevant articles. Initially, pioneering studies focused on methods to determine gastric content using ultrasound. In 1992, Carp et al[2] described the use of ultrasound to detect gastric contents in about 50 subjects. In late 1993, Fujigaki et al[4] published work targeting ultrasound gastric content detection specifically focused on the cross-sectional area of the stomach with patients in the sitting position. Fujigaki and colleagues then used the inclusion method of tracing the inner portion of the gastric antrum and applied a formula to determine gastric content.

With previous research in agreement on the efficacy of using ultrasound for detecting gastric content, newer studies focused on specific patient populations. In 1997, Jayaram et al[5] concluded that ultrasound reliably detected gastric contents in postpartum patients undergoing tubal ligation and in volunteers. Additionally, they observed a significantly greater incidence of delayed gastric emptying in the postpartum patients.

In 2003, Jacoby et al[6] reported the first ultrasound study of gastric contents in an emergency department. Their results yielded a sensitivity of 86% and a specificity of 70%. In 2009, Perlas et al[1] concluded that bedside ultrasound was useful for determining gastric contents in the fasted surgical patient. Bouvet et al[7] concluded that ultrasound images provided an accurate measurement of the antral area for indicating gastric contents in both fasting and nonfasting subjects. Sporea et al[8] presented a review of the use of ultrasound examination of the stomach and the entire GI tract.

More recent studies have focused on using ultrasound images to determine gastric volume and modification of patient care. In 2011, Koenig et al[9] demonstrated that accurate identification of the gastric contents could be made in less than 2 minutes for patients in urgent need of endotracheal intubation. About 25% of the patients had significant gastric contents; providers suctioned the contents prior to endotracheal tube placement. None of the 80 patients experienced pulmonary aspiration.

Perlas et al[3] established a 3-point grading system (0-2) for gastric scans, such that higher numbers indicated greater gastric contents. In 2012, Cubillos et al[10] established that different kinds of gastric contents could be identified in gastric ultrasound images. They successfully described 3 kinds of contents: clear liquid, milk, and solid food. Finally, in 2014, Van de Putte and Perlas[11] published a review of the available literature on the use of ultrasound to assess gastric contents.

Materials and Methods

The purpose of the present study was to determine if, after exposure to a presentation about ultrasound evaluation of gastric contents, student nurse anesthetists were better able to recognize 3 different volumes of gastric contents accurately.

Following Institutional Review Board approval, we collected 8 sets of gastric ultrasound images from the first author's private anesthesia practice. All images were obtained using a Terason 3300 (Teratec) ultrasound machine, in an abdominal setting, using a curvilinear probe. Each set consisted of one supine view and one right lateral decubitus view (for the same patient). Of the 8 sets, 3 showed an empty gastric antrum; 2 showed minimal food or fluid contents; and 3 showed antra with substantial food or fluid contents. We ordered the images using a random number table.

Next, we prepared a 20-item questionnaire beginning with 4 demographic items: age, gender, amount of prior experience with interpreting ultrasound images, and number of years' work experience as a critical care registered nurse (RN). The remaining items called for students to indicate their estimate of the volume of gastric contents depicted in each set of images, and their confidence in the accuracy of their estimates.

The volume estimate choices followed Perlas and colleagues' recommendations[3]: 0 = no volume, empty antrum; 1 = small fluid volume; and 2 = large fluid volume. The response choices for confidence included 0 = no confidence; 1 = fairly confident; and 2 = completely confident. The instructions advised students that the exercise was an ungraded voluntary activity to be used for research purposes and they were not expected to have any prior knowledge or experience with ultrasound interpretation, nor were they expected to be accurate or confident.

All members of the 2017 master's cohort attending Texas Wesleyan University, in Fort Worth, were invited to participate in the diagnostic gastric ultrasound assessment in conjunction with corresponding didactic instruction during a routine nurse anesthesia lecture. The diagnostic gastric ultrasound lecture itself is part of their didactic coursework. Participation in the assessment component (pre/post exposure) of the instruction was voluntary, anonymous, and ungraded, and students/participants were able to withdraw without penalty.

One week prior to the didactic lecture, all members of the 2017 cohort were offered the opportunity to participate in the diagnostic gastric ultrasound pretest. We embedded the questionnaire and the images into an anonymous survey format on Blackboard. Blackboard is an electronic educational platform used by the students of the graduate nurse anesthesia program at Texas Wesleyan University.

A week later, a guest speaker (the first author) presented a 45-minute lecture on the use of ultrasound imaging by anesthesia providers to determine the volume of gastric contents prior to induction of surgical patients. The association between gastric volume and pulmonary aspiration was reviewed. The speaker demonstrated how various amounts of gastric contents appear in ultrasound images. The speaker highlighted additional comparisons between the supine and right lateral decubitus positions, which would allow the anesthesia provider to evaluate patients' preoperative gastric volume with greater accuracy than can be attained with one or no images. The speaker used ultrasound images similar but not identical to the pretest images.

After the lecture, students completed the same questionnaire to evaluate 8 sets of ultrasound images and rate their confidence in their evaluations. The images were the same as those in the pretest, but the order in which they appeared was changed (again using a random number table). Finally, we collected and scored the data. Figures 1A and 1B are presentation images for a full stomach, and Figures 2A and 2B represent an empty stomach.

Results

Demographics

We discarded data from two participants whose questionnaire responses were unreadable. The remaining participants (N=110) reported an average age of 30 years and an average number of years' work experience as a critical care RN of 4. Most participants (95%) reported no prior experience or training in gathering or interpreting ultrasound images; 5 participants reported "minimal experience or training." There were 54 male participants and 55 female participants.

A

B

Figures 1A and 1B. These figures show an actual gastric ultrasound scan.

Figure 1A has been colored to emphasize important structures for recognition. These scans indicate a "full" gastric antrum. In the colored scan, the green area denotes the open gastric antrum, located immediately adjacent to the liver, which is presented in brown. Both images are in the right lateral position, the importance of which is described by Perlas (reference 3).

Accuracy

On the pretest, participants identified the gastric volume in the 8 sets of images with only chance accuracy, attaining an average score of 3.08 correct identifications out of a possible score of 8. The percentage of students who correctly identified each image ranged from a low of 21.6% for one of the “no volume, empty antrum” images to a high of 61.3% for one of the “large fluid volume” images.

On the post-test, students attained an average score of 5.03 correct identifications out of a possible score of 8. The post-test mean score was greater than the pretest score, and the difference was highly statistically significant [$t(110) = 15.84$; $P<0.001$]. The percentage of students who correctly identified each image ranged from a low of 36.9% for one of the “no volume, empty antrum” images to a high of 96.4% for one of the “large fluid volume” images. We noted that the inaccurate identification of an “empty” image meant that students erred on the side of caution, for which a “false alarm” is surely preferable to a “miss” of an actual risk factor.

Confidence

On the pretest, most students expressed no confidence in their image identifications. The percentage of students who indicated “fairly confident” hovered around 20% and never exceeded 29%. Only 4 participants indicated “complete confidence.” The sole student who indicated complete confidence on 3 items was incorrect each time; the other 3 students indicated complete confidence once or twice, and their answers were correct on those items.

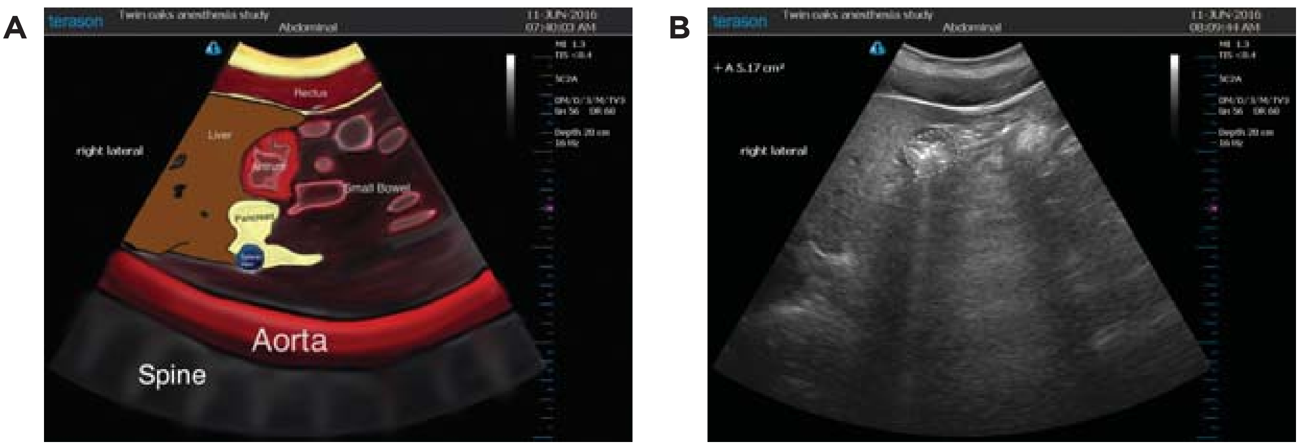
On the post-test, most students were far more confident. For 6 of the 8 sets of images, 80% or more of students indicated that they were “fairly confident” or “completely confident” in their assessments of gastric volume. About 70% of students were “fairly confident” or “completely confident” about their evaluations of the remaining 2 sets of images. Although students’ confidence increased more than their accuracy, confidence levels did not approach grandiosity.

Discussion

The implication of this study is that the skills taken from this effort can be used in the clinical arena. However, limitations exist to their incorporation. Some of the foreseeable challenges include resistance to change, the pressure to learn new skills, and the requirement of additional time to perform the scans in an already stressed and busy preoperative assessment area.

We recognize a few limitations to this study. One is that only student nurse anesthetists and not resident anesthesiologists were included in the data gathering. We recognize that many medical schools nationally have been incorporating a variety of ultrasound aspects into their curriculum and as such, may have given anesthesiologist residents a potential advantage based on prior exposure to the material. However, it is important that this study’s exclusion criteria deliberately omitted those with any prior exposure to the material.

In addition, there was some inconsistency in the wording of the labeled images between the presentation and the exams. The presentation included information that specified either full “solid” or full “liquid.” Due to this inconsistency, it is possible that some student RN anesthetists (RNAs) answered questions in a manner that might have been different if the nomenclature from the pre- and post-tests had been exactly the same as that used in the presentation. In retrospect,



Figures 2A and 2B. These figures show the images used to depict an empty stomach.

Figure 2A shows the empty gastric antrum in red adjacent to the liver, shown in brown. Figure 2B is the same image without color.

our presentation and exams should have used the same wording and descriptions.

A successful study of the recognition of gastric content patterns by entry-level anesthesia providers might imply that this teaching technique is viable to introduce into practice at any level of anesthesia expertise. We suggest that more experienced anesthesia providers may also be able to easily incorporate this technique into their practice following a similar presentation. This study represents evidence in support of our study goals. The study found that student RNAs are capable of correct identification of empty, but also normal and—more importantly—full gastric content ultrasound scans, following a brief presentation. The presentation consisted of a total of 33 slides and emphasized identification characteristics of the 3 scan types. A colored image was introduced that may have aided students in their ability to assess real gastric ultrasound images. This, in addition to the didactic presentation, led to an advancement in the skills required to identify patterns of gastric ultrasound contents. Tips and tricks for pattern recognition were included. This presentation helped establish an overall change in preoperative screening that should reduce the risk for pulmonary aspiration.

A gastric content screening program in the preoperative area may not only save patients from a potentially life-threatening aspiration of gastric contents but also prevent possible litigation. A simple scan, taking only minutes to perform, may be all that is required to implement this valuable aspect of anesthesia care. The patients most likely to benefit from this are those with questionable gastric or NPO status.

We believe that further study should be conducted to support the integration of this aspect of care into daily practice.

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Acknowledgement: The authors would like to formally acknowledge the students at Texas Wesleyan University for their participation in the study.