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Assessing the Learning Curve - Teaching Pediatric Emergency Physicians to Interpret Point-of-Care Ultrasound: A Multicenter Prospective Cohort Study

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To complement bedside learning of Point-of-Care Ultrasound (POCUS), we developed an online learning experience of the visual interpretation component of this skill. This study examined the amount and rate of skill acquisition in POCUS image interpretation n a cohort of Pediatric Emergency Medicine (PEM) physicians.

Design and Setting: This was a multicenter prospective cohort study.

Participants: This study included 172 PEM physicians that were POCUS learners and practiced as fellow-level trainees (n=65) or faculty (n=114) in Canada or the United States.

Interventions: PEM physicians learned using a computer-based image repository and learning system that allowed participants to deliberately practice image interpretation of 400 images from four pediatric POCUS applications (soft tissue, lung, cardiac and FAST). Participants completed at least one application (100 cases) over a four-week period.

Main Outcome Measures: The change in accuracy per application between the first and last 25 cases and the number of cases required to achieve the specific performance benchmarks for average (50th percentile) and least efficient (95th percentile) participants.

Results: The changes in accuracy were 11.6%, 9.8%, 7.4% and 8.6% for soft tissue, lung, cardiac and FAST, respectively. For all applications, the average learners required 0-45, 25-97, 66-175, and 141-290 cases to reach 80%, 85%, 90%, and 95% accuracy respectively, while the least efficient learners required 60-288, 109-456, 160-666, and 243-1040 cases to reach these same accuracy benchmarks. Generally, to reach a given performance benchmark, participants completed the lowest number of cases for the soft tissue application and the highest number of cases for the cardiac application.

Dedicated practice of POCUS image interpretation using an online tool leads to skill improvement, with a variable rate of achievement across learners. These data inform our understanding of POCUS image interpretation skill development and could complement bedside learning and performance assessments.

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Systematic Review of Point of Care Ultrasound Curricula in Primary Care Residency Ambulatory Education

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Point of care ultrasound (POCUS) has well established value in obstetrics, emergency medicine, and hospital-based procedures. However, utilization of POCUS in the outpatient setting by primary-care practitioners is not commonplace. With primary care residencies (internal medicine, family medicine, and pediatrics) increasingly implementing structured ultrasound curricula, we wanted to determine 1) what POCUS competencies can enhance the diagnostic and therapeutic ability of primary care residency graduates in ambulatory practice, 2) what POCUS curricula are available for primary care residency, and 3) if primary care residency alumni trained with POCUS curricula utilize POCUS routinely after graduation.

Following search strategies outlined by an inpatient POCUS review (http://www.crd.york.ac.uk/PROSPEROFILES/38302_STRATEGY_20160326.pdf) we performed a literature search with keywords “point of care ultrasound” and “internal medicine” “family medicine” “pediatrics” “primary care” and “residency” in combination with apply and replace thesaurus terms using the following databases: MEDLINE via PubMed, EMBASE via OVID, CINAHL via Ebsco, Web of Science, and Cochrane Central Register of Controlled Trials (CENTRAL). Two independent researchers reviewed each article to determine it’s inclusion in our review using the following criteria: (1) A published full-text paper must be available. (2) The paper must contain original data. (3) The paper must describe curricular training in use of POCUS among primary care residents (family medicine, pediatrics, and internal medicine). (4) The POCUS curricula must be completed by primary care residents in training. (5) The paper must describe ultrasound with an image for the clinician to view. Excluded were: (1) Papers regarding referral for ultrasound examination (2) Papers describing ultrasound as thermal therapeutic ultrasound (3) Papers describing ultrasound without production of an image for the clinician. (4) Papers not based on a medical education study of primary care residents. (5) Papers not published in English. (6) Papers focused solely on inpatient/hospital medicine. We analyzed the resultant articles using a standard template.

The defined search criteria resulted in 391 articles. By applying the inclusion and exclusion criteria, we selected 33 of the 391 articles for further review. The resultant articles overall have low quality methodology but provide some take away points for our adoption of an ambulatory POCUS curriculum.

POCUS in the ambulatory/outpatient setting appears to be in its infancy. Standardization in research surrounding outpatient POCUS utility, financial viability, and outcome review process for POCUS curriculum trials is limited.

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#POCUSart - How “App-Smashing” Can Influence #Ultrasound #MedEd

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Increasing numbers of physicians and student learners are utilizing social media to augment their education on a regular basis. Social media platforms, such as Twitter, have disrupted the classic paradigm of “classroom” and “bedside” teaching by enabling medical educators to easily distribute educational material to learners they previously would not be able to connect with. In an effort to enhance the ultrasound education of learners around the world a unique combination of “app-smashing” was implemented to create #POCUSart. The goal of the #POCUSart educational series is to create unique drawings and animations which simplify anatomy, highlight common applications of ultrasound, and add labels and color to augment the standard black, white, and gray colors present on ultrasound. “App-smashing” refers to the process of using multiple apps to create a single richer and enhanced final product. The apps used to create #POCUSart drawings are Doceri, Keynote, ScreenFlow, and GIF Brewery in combination an iPad and Twitter. The POCUSart is then posted on Twitter and accompanied by links to peer-reviewed ultrasound educational content.

Observation of “Tweet Activity” analysis completed by Twitter As of May 2019, the six tweet series of #POCUSart educational content had resulted in a cumulative total of 376 “retweets”, 379 “likes”, 2,113 “engagements”, and 40,150 “impressions”. “#POCUSart educational material lead to a large number of retweets, likes, impressions, and engagements around the world suggesting the educational content was of interest to educators and learners.The method of “app smashing” used to create #POCUSart facilitates the creation of a virtual whiteboard that is easily posted on social media. #POCUSart content is always available to learners as opposed to content which is eventually erased from physical whiteboards. Medical educators who utilize social media to enhance the education of their learners should be aware of this form of “app smashing” used to create “#POCUSart given it is highly generalizable to many medial topics outside of ultrasound.

PLEASE NOTE: This abstract was submitted and accepted for an oral abstract presentation at WCUME 2018, however, was not presented given the conference was cancelled. I am open to presenting the above in any way the planning committee would like during the conference as I appreciate this is not a typical “”study”” (it may be more appropriately viewed as an educational innovation/concept) and may not be appropriate for “”abstract presentation””.”

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Fundamental Breast Ultrasound with Simulated Pathology in Cadavers

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Ultrasound has long been a mainstay of breast imaging as a diagnostic tool. It is commonly used in diagnosing breast abnormalities and for characterizing potential abnormalities seen on mammography or breast magnetic resonance imaging (MRI). Ultrasound imaging can help to determine if an abnormality is solid, fluid-filled or both cystic and solid. This concept is a key objective of the ultrasound curriculum for the first year medical students at Eastern Virginia Medical School. However, it is difficult to find enough patients with pathologies willing to be scanned. Breast simulators can be used, but they very costly. Therefore, to expose students to a variety of breast pathologies, we fabricated solid and cystic lesions and then embedded them in female cadavers. This created a hands-on, inexpensive lab for students to visualize the female breast and to detect and differentiate pathologies in cadaver breasts using sonography.

Simulated cystic and calcified lesions were fabricated and embedded in the breasts prior to the lab and validated by expert sonographers. The lesions were made by heating and hand-forming clear ballistics gel into round and ovoid shapes, ranging between one and two centimeters in diameter. The cadaver left breast was pathologic and right breast was non-pathologic. students were expected to select the appropriate transducers and machine settings to acquire images of breast tissue and chest wall, recognize and acquire an image of breast pathology, measure that lesion with the ultrasound machine calipers, and describe the consistency and location of the abnormal finding within the breast.

One hundred thirty-two, second semester medical students completed the lab during the General Mechanisms of Disease module. Most students agreed that the cadaver was suitable for imaging normal (91%) and pathologic (99%) breast structures. The majority of students thought the pathologies were similar to real pathologies (87%) and easy to identify (95%). Students also agreed the lab was an appropriate complement to their in-class pathology coursework. Overall students felt the lab provided an enjoyable learning experience and wanted to see similar labs in the future.

In conclusion, pathology identification under ultrasound imaging was feasible using cadaver breast tissue with embedding simulated lesions. The surveyed students generally agreed that cadavers were an adequate tool for learning this procedure. Future plans are to add a clinical breast examination with standardized patients to the simulated breast lesions lab for better integration of clinical skills and facilitated learning.

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Brief Ultrasound Sessions are Highly Effective in Teaching Anatomical Structures and Basic Ultrasound Skills to First-Year Medical Students

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Ultrasound has become increasingly incorporated into medical school curricula across the country. In an effort to expand ultrasound education at the Brody School of Medicine, 6 optional ultrasound sessions were hosted for M1 students. Each session lasted less than 60 minutes. The sessions were designed to correspond with the Gross Anatomy and Physiology courses and consisted of a didactic portion followed by hands-on scanning. The purpose of this study was to evaluate the effectiveness of these sessions as well as the students' perception of the usefulness of including ultrasound as an adjunct to current Gross Anatomy and Physiology courses.

M1 students participated in 6 voluntary systems-based ultrasound sessions: ocular (n=11), abdominal (gallbladder, kidney, and spleen) (n=25), aorta (n=15), cardiac (n=19), pelvic (n=12), and renal (n=11). At each session, students were given a pre-test and post-test. Average percentile scores from each test were compared with a paired t-test using SAS 9.4 with statistical significance indicated by a p-value <0.05. Students were also given a post-session 5-point Likert scale survey to assess attitudes toward the course and ultrasound training as part of the educational curriculum.

Students showed a significant increase in basic ultrasound anatomical knowledge in all sessions. Means of the basic ultrasound pre- and post-test scores improved dramatically for all sessions ($p<.01$) [ocular: 15.91% correct to 100% correct, abdominal: 35% correct to 85% correct, aorta: 50% correct to 96.67% correct, cardiac: 15.79% correct to 89.47%, pelvic: 65.91% correct to 100% correct, renal: 32.95% correct to 90.9% correct]. In addition, students demonstrated significant improvement on the image based anatomical questions when comparing pre-test and post-test means ($p<.01$) [ocular: 68.18% correct to 95.45% correct, abdominal session: 7.2% correct to 94.4% correct, aorta session: 40% correct to 95% correct, cardiac: 30% correct to 94.74%, pelvic: 39.77% correct to 98.7% correct, renal: 33% correct to 82.83% correct]. Survey data indicated that students believed sessions helped with preparation for their exam and long term retention and believed it should be incorporated into the M1 curriculum.

Brief ultrasound sessions that correlate with the M1 curriculum are highly effective in increasing medical students' knowledge of basic ultrasound imaging and interpretation of anatomically relevant ultrasound images. First-year medical students feel that ultrasound sessions are relevant to their medical training, helped with long term retention and preparation for anatomy examinations, and should be integrated into their M1 curriculum.

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Point-of-Care Ultrasound for General Practitioners: A Systematic Needs Assessment

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The aim of the study was to achieve consensus among a group of ultrasound proficient GPs from Denmark, Norway, Sweden, and Finland on which ultrasound scanning modalities and ultrasound-guided procedures are essential to GPs in their daily work for the purpose of including them in a basic ultrasound curriculum.

Sixty Scandinavian GPs with more than two years of POCUS experience were invited to join a Delphi expert panel. In the first Delphi round each member of the panel was asked to produce a list of scanning modalities and procedures which they found relevant to include in a basic ultrasound curriculum. In Delphi round two, these suggestions were presented to the entire panel who assessed whether or not they found them essential in their daily work. Items not reaching consensus in round two, were presented to the panel in a third and final round. Items reaching more than 67 percent agreement were included.

Forty-five GPs were included in the study and 41 GPs completed all rounds. Agreement was obtained on 30 scanning modalities and procedures primarily within the musculoskeletal (8), abdominal (5), obstetric (5), and soft tissue (3) diagnostic areas. Four ultrasound-guided procedures were also agreed upon.

A prioritized list of 30 scanning modalities and procedures were agreed upon by a group of ultrasound proficient GPs. This list could serve as a guideline when planning future POCUS educational activities for GPs.

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Effectiveness of Simulation-Based Ultrasound Education In Supplementing Medical Physiology Education

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Ultrasound is an increasingly common diagnostic-imaging modality that is used in a variety of clinical settings. Accordingly, medical schools have begun integrating ultrasound education into medical school curriculums. As such, understanding how to most effectively do so is important to ensure that medical students learn the large volume of pre-clinical content in a manner that promotes retention and clinical competence. We aim to assess the effectiveness of simulation-based ultrasound education in improving medical student competence in physiology in comparison to a traditional didactic ultrasound curriculum.

After administering a pre-test of systems-based physiology questions, we gave 7 hours of lectures over two days to teach various ultrasound techniques. The control group received 2 additional hours of practice time during which instructors allowed students to obtain images and discuss associated physiology concepts. The experimental group instead received 2 hours of case-based simulations. A physiology post-test was administered to all students to complete the two day course.

The simulation group showed statistically significant improvement on the physiology exam, going from a pre-test average of 54.12% to a post-test average of 75.32%, ($P < .01$). The didactic group also showed statistically significant improvement on the physiology exam, going from a pre-test average of 59.30% to a post-test average of 70.00%, ($P < .01$). These improvements correspond to an average improvement of +21.20% and +10.70% for the simulation and didactic group respectively. The magnitude of improvement of the simulation group was significantly greater than that of the didactic group, ($P < .01$). Our results suggest that simulation-based ultrasound education improves retention in physiology to a greater degree than didactic ultrasound education.

Our findings are implicated in the integration of ultrasound education into medical school curriculum. Modalities of education that indirectly augment concepts from other medical school courses (physiology, pathophysiology, diagnostic reasoning, etc.) are of great value in building an efficient curriculum and in promoting long-term understanding.

Mariela Skendi

What is the diagnostic and therapeutic impact of the use of point-of-care ultrasound in general practice? An observational, transverse study.

Author(s): Mariela Skendi, Vincent Miramont, Quentin Delannoy, Mariela Skendi

Institution: Sorbonne University

The aim of this study was to determine the diagnostic and therapeutic impact of the daily use of point-of-care (POCUS) by general practitioners in France. Focused point-of-care ultrasound is defined as the use of an ultrasound machine at the bedside, during the physical examen in the office or home visits, in order to answer to a simple clinical question.

An observational, transverse study took place from August 2017 to August 2018 in France. Volunteer general practitioners that practice POCUS daily during the physical exam were included in the study. Every general practitioner filled a form after each POCUS use during the physical exam.

Ten general practitioners participated in the study and performed 164 focused POCUS exams. There were 69 types of patient complaints and 61 different diagnoses were initially suspected. There were 10 main anatomical regions explored by echoscopy: musculoskeletal (26%), vascular (20%), urinary (15%), digestive (13%), hepatobiliary (12%), pulmonary (12%), obstetrics and gynaecology (8%), cardiac (7%), soft tissue (5%) and thyroid (1%). The four ultrasound probes used were: phased-array, curvilinear, linear and endocavitary. The median duration of POCUS was between 5 to 9 minutes.

An impact on the diagnosis (confirmation, elimination or modification) was present in 98% of the cases. The diagnosis was confirmed for 113 patients, it was modified for 13 patients and ruled out without confirming another diagnosis for 35 patients. In 94% of the cases, the use of POCUS had a therapeutic impact. It reduced emergency department referral, reduced or modified medical treatment and modified the order of additional tests.

POCUS use in general practice has a wide range of indications. Its use during the physical exam is compatible with the exercise of general practitioners in France. We observed a diagnostic and therapeutic impact in more than ninety percent of patients after POCUS use.

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Point-of-Care Ultrasonography in a Weight Lifter with Suspected Rupture of Pectoralis Major Insertion

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With only 365 cases documented as of 2017 (Cordasco et al), rupture of the pectoralis major muscle is an uncommon injury. However, there has been an increasing trend in incidence of this injury with advancement of strenuous physical activities and weight lifting.

Our patient is a 50 year old male who initially presented to ER with complaints of left upper extremity pain after feeling a sudden spasm while bench pressing 2 days prior. He was discharged from ER after negative x-ray finding was confirmed. Subsequently, he was seen by his primary care physician. On examination he was noted to have a 4-5 cm area of ecchymosis to his left bicep and mild deformity of his pectoral muscle. He was subsequently sent for to the sports medicine department at our clinic, where he was evaluated by point-of-care ultrasound exam.

Via ultrasound exam, the diagnosis of a pectoralis major insertion site rupture and retraction was made promptly. The ultrasound was also notable for an anechoic and compressible defect within the rupture suggestive of a hematoma within. These findings were further confirmed by follow up MRI imaging. The patient was urgently referred to a orthopedic surgeon for evaluation. He underwent a surgical repair of his left pectoralis major tendon 6 weeks after initial injury without complications. He recovered well with post op physical therapy.

Detailed research on diagnostic guidelines, interventions, and return to function for pectoralis major injuries have been limited. Our case study provided further supporting evidence that the point-of-care ultrasound modality is an effective and easy way to identify a pectoralis major rupture (Provencher et al). Furthermore, its identification of where a fluid collection is located anatomically can help distinguish whether there is tendon avulsion versus myotendinous injury (Lee et al), thus becoming critical evidence to help avoid delaying of surgery. Musculoskeletal ultrasound is not only a comparable imaging modality to MRI for detecting pectoralis major injuries, but it is also more time-efficient and cost-effective. Still, not many emergency physicians and primary care physicians are proficient with basic musculoskeletal ultrasound skills to be able to detect an obvious pectoralis major tendon rupture. Improved training and Education on ultrasound diagnosis of the pectoralis major rupture for clinicians in the emergency medicine and primary care settings will be beneficial for making more accurate and timely diagnosis, and for improving patient outcome going forward.

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Penn 5Ps: A Framework for Hands-On Ultrasound Teaching in Undergraduate Medical Education (UME)

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Point of care ultrasound is growing rapidly in UME. In 2015, our institution introduced ultrasound into the pre-clerkship curriculum through didactic and small-group learning. Since then, we have led dozens of hands-on sessions that cumulatively includes over 90 instructors from 9 specialties. Our pool of instructors is represented by clinicians from: radiology, physical medicine & rehabilitation, anesthesia, nephrology, internal medicine, emergency medicine and intensivists, among others. Instructors include senior medical students, sonographers, nurses, residents, fellows and faculty. However, finding skilled instructors remains challenging due to variability of instructors' teaching ability, technical and clinical experience. Students report inconsistent teaching methods despite having shared and explicit hands-on learning objectives. This issue is further exacerbated as learners are expected to emerge with a specific set of technical and cognitive skills that nonetheless, require resource-intensive teaching. To address this problem, we propose the "Penn 5Ps," a teaching framework for hands-on ultrasound instructors, with the objective being to standardize a framework for hands-on ultrasound teaching with the goal of providing a consistent learning experience for students in undergraduate medical education.

Participation: instructors should maximize hands-on time for learners; minimize the experience of learners as spectators or instructors as primary scanners.

Professionalism: instructors should role model positive patient interactions with clear communication, proper draping and ways to scan in a respectful manner.

Preparation: instructors should review the content and objectives of the topic before a hands-on session and gauge his/her own level of knowledge or comfort regarding the topic; clarify inconsistencies prior to instruction.

Perspective: instructors should teach to the level of the learner (MS1 vs. MS4) because needs and expectations are different; offer a clinical perspective but re frame if the learner is not ready.

Protocol: instructors should lead discussions in a predictable and repeatable format to explain clinical presentations, knobs and probes, anatomy and pathology; consider using "5Ps for Learners."

We expect that the 5Ps for Hands-on Ultrasound Teaching will provide a framework that promotes a consistent, value-rich learning experience for students in UME. This construct provides instructors with a tool for communicating technical and cognitive ultrasound skills regardless of their clinical specialty or experience level. Ultimately, hands-on ultrasound instructors will have a reproducible and objective way to teach ultrasound across multiple topics and settings.

Our simple instructional mnemonic can serve as the framework for delivering more consistent hands-on teaching from a largely variable group of ultrasound instructors. Further studies will determine if the use of this framework leads to an improved hands-on learning experience from UME students and an improved teaching experience from hands-on ultrasound instructors.

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Impact of a 4-hr Introductory eFAST Training Intervention among Ultrasound-naive U.S. Military Medics

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US Army Combat Medics' diagnostic and therapeutic capabilities are often limited to what can be carried in a backpack or wearable medical kit, leading to increased interest in the value of battlefield point-of-care ultrasound (POCUS) as a diagnostic/procedural adjunct among military medicine clinicians. A growing body of evidence suggests that non-physician clinicians such as prehospital medical personnel can effectively employ POCUS, however there is limited data which demonstrates the amount of training required to impart basic proficiency on novice non-physician learners. This prospective observational study's primary objective was to assess the impact of a 4-hr introductory training intervention on ultrasound-naïve military medic volunteer participants' knowledge/performance of the eFAST ultrasound application, and compare the performance of learners receiving asynchronously- (online) vs traditional in-person/classroom-delivered didactic content. The overall aim of this study was the development and evaluation of a standardized eFAST ultrasound training protocol for medics that well-considers the resource constraints (availability of instructors, the availability of ultrasound systems, limited training time, the ability to demonstrate an adequate range of normal sonographic anatomy and pathologic findings) common to the Military Health System.

Ultrasound-naïve medic participants were recruited to participate. Baseline eFAST knowledge of medic participants was assessed via a pre-course written exam. Medic participants were then randomized to either a conventional classroom-based didactic training cohort or an asynchronously delivered (online) didactic training cohort (SonoSim®). Following 90 minutes of didactic training covering eFAST principles, anatomy, image interpretation, and clinical integration, both medic cohorts underwent 150 minutes of small group hands on-instruction and practice using live and phantom models. Medic participants were then individually assessed via OSCE using a validated task-specific checklist, for adequacy of eFAST exam performance on both a live and simulated phantom torso model (Blue Phantom®), followed by a post-course written exam to assess eFAST exam knowledge principles. Concurrently, emergency medicine resident volunteers, serving as standard criterion for trained personnel, underwent the same OSCE assessments, followed by a written exam to assess their baseline eFAST knowledge. Primary outcome measure was medic post-course eFAST knowledge improvement. Secondary outcome measures include 1) a comparison of post-course medic eFAST knowledge to baseline eFAST knowledge of EM resident cohort, 2) a comparison of eFAST exam technical adequacy rate, OSCE scores, and diagnostic accuracy rate between medic and EM resident cohorts and 3) a comparison of military medic eFAST knowledge and exam performance between those receiving traditional classroom-based didactic training and those receiving online didactic training.

A total of 34 medic and 20 EM Resident volunteer participants were recruited for this study. Overall eFAST knowledge among medics improved from a baseline mean of 27% to 83% post-course, comparatively inferior to EM residents' eFAST knowledge mean score of 92% (95% CI, $p = 0.002$). There was no statistically significant difference in mean eFAST knowledge scores ($p=1.00$), exam technical adequacy rate ($p=0.172$), mean OSCE score ($p=0.328$), or diagnostic accuracy rate ($p=0.306$) between the two medic cohorts. Though, the EM resident cohort demonstrated a higher mean OSCE score, there was no statistically significant difference between medic and resident cohorts' exam technical adequacy rates ($p=0.097$), or diagnostic accuracy rates ($p=0.118$). Mean total time to eFAST exam completion was significantly longer among the medic cohort (532 seconds vs 227 seconds).

A 4-hr training intervention significantly improved eFAST knowledge among a US military medic cohort. Medics performed the eFAST exam with similar technical adequacy and diagnostic accuracy rates compared to EM resident physicians. There was no statistically significant post-course difference in knowledge, exam performance, or diagnostic accuracy between cohorts receiving didactic instruction via traditional classroom setting vs an asynchronously-available platform.

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Evaluation of Phantoms using Cadaver Thyroid to Train Undergraduate Medical Students in Ultrasound Guided Fine Needle Aspiration

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Institution: Eastern Virginia Medical School

Due to the growing importance of ultrasound (US) in healthcare, training for US has been introduced into undergraduate medical curricula. Eastern Virginia Medical School has switched to a systems-based curriculum, allowing US to be taught according to the current system. During the second year module, Hormones and Reproductive Health, students scan transvaginal, obstetric, breast, testicle and thyroid trainers. However, available phantoms for practicing clinically-relevant procedures are limited and costly. This study created and assessed cadaver tissue thyroid phantoms that are affordable, realistic, and clinically relevant for training students in fine needle aspirations (FNAs).

Hemisected tracheas with thyroid glands were dissected from cadavers. Anechoic hydrogel cysts were placed posterior to the gland for US visualization and targeting. The entire cadaver structure was embedded in Zerdine(TM). A phantom carotid artery was included for orientation. 146 students in their second year tested six phantoms over two days. Using a linear probe, students scanned the fixed tissue thyroid phantom to locate and measure the target cyst. Students captured a split-screen view of the thyroid with a needle inserted into the cystic structure to practice US-guided FNAs. Following this exercise, students completed a three question Likert survey with one open ended question. Their printed images were evaluated via rubric by both peers and instructors who assessed the scan plane, image alignment, depth and gain as being clinically appropriate, marginal or clinically inappropriate.

The majority of students rated the trainers as effective (4.67 of 5) and found the phantoms to be anatomically accurate (4.53 of 5). They also indicated an interest in performing more US-guided procedures in their curriculum (4.68 of 5). Cumulatively, students were successful at creating a clinically relevant split screen shot and needling the target object with average scores of 14.55 of 15. However, with a flexible time limit for completing all 5 stations in 50 minutes, many students spent more time due to multiple needle repositioning efforts. Most recommendations for improvement from graders involved depth adjustments and alignment. Peers tended to provide less critical feedback than graders. Over 65% of the open-ended feedback responses from students were positive and this result did not differ across the two testing days. Recommended improvements included trainer durability across several sessions and users.

A durable version of the trainer will be created with a protective thermal polyethylene (TPE) cover and will use a 3D printed trachea with a full donor thyroid to improve orientation. Cystic structures suspended in Zerdine(TM) will be included and placed in a neck-shaped mold to improve fidelity. Students will attempt the FNA procedure using the phantom during the fall term of their second year and a stricter time limit will be imposed.

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The extent of regional and procedural ultrasound experiences of medical students during their junior clerkship rotations in the absence of a formalized ultrasound curriculum

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Introduction: The University of Arkansas for Medical Sciences just finished its fourth year of a preclinical ultrasound (US) curriculum though we have not yet established any formalized US curriculum in the clerkship rotations. For the past two years, we assessed the extent to which students are being exposed to US in the junior year through end-of-year surveys. The present data augment and expand upon the initial data reported in abstract form at the 2018 WCUME annual meeting.

Methods: Students were asked to complete an anonymous online survey at the end of their M3 year. The survey consisted of demographic information related to their gender, elective clerkship rotations and likely choice of residency field as well as LIKERT type and open-ended response questions. We asked students to identify US related experiences in each of their required and selective clerkship rotations and to comment on specifics of their US experiences in their rotations. The required rotations in our curriculum include: family medicine, internal medicine, neurology/ophthalmology, OB/GYN, pediatrics, and surgery. The selective rotations include: anesthesiology, emergency medicine, ENT, orthopedics, PMR, pathology, radiology and urology. The survey response rates for the past two years were 50.6% (88/174) and 29.7% (51/172, ongoing), respectively.

Results: Over a third of the students (37%) reported discussing archival ultrasound scans during one or more of their required/selective rotations. More students reported observing ultrasound scans being performed on patients in their required (98%) versus their selective (74%) rotations. A similar percentage of students (34%) reported having the opportunity to perform an ultrasound scan on patients in their required and selective rotations. Students were able to observe a wide range of ultrasound scanning in their rotations including scanning of targets in the head (thyroid gland, 25%; ocular, 7%; parotid gland, 2%), thorax (heart, 56%; lung, 18%; diaphragm, 11%), abdomen (liver, 65%; gall bladder, 44%; kidney, 41%, spleen, 35%; intestines, 19%), pelvis (uterus/transabdominal, 82%; fetus, 77%; bladder, 53%; uterus/vaginal, 40%), and various musculoskeletal targets in the upper (shoulder, 14%; wrist/hand, 5%; elbow, 2%) and lower (knee, 12%, hip, 8%; foot/ankle, 8%) limbs. More than half of the students (60%) observed ultrasound being used in a FAST/eFAST exam. The clerkship rotations also provided students with opportunities to observe a variety of US guided procedures including: CVL placement (internal jugular, 46%; subclavian, 40%; femoral, 22%), nerve injections (38%), biopsy (32%), bone marrow aspiration/biopsy (24%), joint injection (18%), joint aspiration (9%), pleurocentesis (12%), and pericardiocentesis (5%).

Discussion: The specifics of regional and procedural ultrasound training reported in the present study augments data reported last year regarding the extent of ultrasound experiences in specific rotations. Our combined two-year survey indicates that even in the absence of a formalized ultrasound curriculum in the junior year, a significant percentage of students are gaining a broad range of sonographic imaging experiences including hands-on opportunities. The broad exposure to regional and procedural ultrasound scanning revealed by our surveys documents the existence of an informal ultrasound curriculum that likely reflects the increasing adoption of US by clinicians in a variety of clinical specialties.

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Beginner's Ultrasound (BUS), Implementation and Evaluation of Near-Peer Teaching in Point of Care Ultrasound

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Nearly 1/3 of medical schools do not offer ultrasound education to matriculating medical students. The lack of trained ultrasound faculty remains a challenge for medical student and resident trainee's. Medical students at The Ohio State University College of Medicine (OSUCOM) have begun to bridge the gap in scaling this experience through the implementation of near-peer ultrasound education where students from all 4 years can enter ultrasound training regardless of previous ultrasound experience.

A robust Ultrasound Interest Group (USIG) executive decided to alter ultrasound education by combining ultrasound exposures into a Beginner, Intermediate and Advanced ultrasound experience. This program was developed by medical student leaders for medical students with supervision from Emergency Medicine faculty with the Division of Ultrasound. Recruitment for the BUS program began each academic year and scanning sessions were held in the Clinical Skills Educational and Assessment Center (CSEAC) throughout the academic year 2018-2019. The 2019 BUS experience has a current roster of 129 medical students. The curriculum consists of four scans: physics and knobology, musculoskeletal ultrasound, cardiac ultrasound, and head and neck ultrasound. The session is proctored by a senior medical student who previously completed the BUS curriculum. A statistically significant difference ($p<0.05$) was found between the global mean of the pre-scan ($\bar{x}=2.526$, $\sigma 2=0.857$) and global mean of the post-scan ($\bar{x}=3.938$, $\sigma 2=0.367$) comfort levels.

As point-of-care ultrasound becomes more prevalent in medical education, trainee's will be expected to utilize this skill in patient care. This program serves as proof of concept for the logistics involved of near-peer teaching in POCUS. As more formalized approaches evolve in undergraduate medical education and POCUS, more research is needed to validate the effectiveness of near peer medical student teachers.

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Medical Student Perceptions Towards an Emergency Department Point-of-Care Ultrasound Pilot Program

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Medical schools have increasingly incorporated didactic and hands-on ultrasound education into their pre-clinical curricula. Research shows that students respond positively to these experiences and express interest in continued training. The Emergency Ultrasound Scanning Pilot Program was established to allow first-year students the opportunity to perform clinically indicated point-of-care ultrasound (POCUS) scans in the Emergency Department under the direct supervision of Emergency Ultrasound Fellowship-trained faculty. Complimenting an expansion of ultrasound in the pre-clinical curriculum, POCUS scanning shifts provide a multimodal and interactive approach to the visualization of real-life pathologies and positive physical exam findings not regularly available in conventional hands-on teaching sessions. Students' perceived attitudes toward ultrasound were examined with respect to their own pre-clinical curriculum, ultrasound's clinical importance and utility, and the experiences' effect on their future practice.

Students' perceived attitudes were assessed using a post-experience survey administered through Microsoft Forms. The survey consisted of 6 demographics questions and 14 Likert-scaled questions. 95% confidence intervals were computed where appropriate.

Preliminary results were obtained from 22 first-year medical students who participated in the pilot program. Mean age was 23.5 (range 21-32), with students most often having no prior hands-on POCUS experiences (mean 0.68) and most often participating once (mean 1.32). Among respondents, 72.73% [51.85%, 86.85%] strongly agreed that the experience was helpful in their integration of anatomy, 72.73% [0.5185%, 86.85%] strongly agreed that they would consider using POCUS in their future patient management, and 86.36% [66.66%, 95.25%] expressed a strong desire for further hands-on training. Most respondents either agreed or strongly agreed that the experience was helpful for their integration of physiology (90.91% [72.19%, 97.47%]), pathophysiology (95.45% [78.20%, 99.19%]), and patient interaction and assessment skills (77.27% [56.56%, 89.88%]). All respondents [85.13%, 100%] either agreed or strongly agreed to a basic understanding of ultrasound's use in the clinical setting and 72.73% [51.85%, 86.85%] strongly felt that ultrasound is important for diagnostics and clinical decision making.

Research shows that students respond positively to conventional didactic and hands-on ultrasound education. Few studies, however, have explored student attitudes toward pre-clinical ultrasound training in the setting of direct patient care. Our findings demonstrate that a POCUS scanning program with strong emphasis on clinical experience and patient interaction is received well by students, facilitates integration of anatomy, physiology, and pathophysiology, and can be a useful tool in undergraduate medical education. Future work will include larger cohorts of students as the pilot program develops.

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Ocular Point of Care Ultrasound: Efficacy and Knowledge Retention of a New Teaching Workshop for Medical Students

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Ultrasonography is being widely incorporated into multiple medical disciplines and has evidence of improved patient outcomes1. Therefore, it is becoming more important to introduce ultrasound in undergraduate medical education. In the literature, medical students' feedback in regard to the utility of early ultrasound education has been overwhelmingly positive2,3. However, few studies have evaluated medical students' retention of point-of-care ultrasound (PoCUS) knowledge objectively.

We designed a one-hour teaching workshop of ocular ultrasound. Teaching objectives included a review of ocular anatomy, technique of ocular POCUS scanning, and review of major ocular pathology including the assessment of retinal detachment, posterior vitreous detachment, vitreous hemorrhage, and optic nerve sheath diameter. This was followed by bedside ocular scanning of normal volunteers. Scanning was done under the direct supervision of the authors (PB, NA, JT).

Immediately prior to the session, we evaluated the medical student's prior knowledge in general ocular anatomy, general principles of ocular ultrasound and sonographic findings in ocular pathology. Students were also asked to rate their perceived confidence in performing these various scans on a 10-point Likert scale.

Immediately following the session, the same test was provided to the students to assess their short-term knowledge gain

Data were analyzed using paired T-test and statistical significance was set at 0.006 with adjustment of multiple comparisons.

A total of 17 students participated in the workshop. There were 2 first-year, 10 second-year, and 5 third-year students.

Self-reported students' confidence in assessing traumatic and non-traumatic visual complaints when reported on a 10-point Likert scale increased from 4.1 to 6.5 ($p<0.006$). Perceived knowledge about ocular anatomy increased from 5.7 to 6.9 ($p<0.006$) and perceived knowledge of ocular PoCUS increased from 2.1 to 4.5 ($p<0.0001$).

Prior to the session, the mean final score measuring their knowledge of anatomy, PoCUS techniques, and ocular pathology was 43.7%; Immediately following the session, this increased to 65.6% ($p<0.0001$).

Students were overwhelmingly in favor of the session and felt that the best time for this type of workshop was during second or third year of medical school.

A one-hour workshop of ocular ultrasound was offered to McGill medical students. Students' self-reported confidence of ocular complaints and ocular PoCUS skills increased after the workshop. Importantly, students objectively improved in knowledge level regarding ocular anatomy, ocular PoCUS techniques, and recognizing ocular pathology on ultrasound. Results from the three-month post-workshop will be intriguing as they will have implications for retention of this knowledge long-term and thus utility of such workshop as an adjunct to undergraduate medical education.

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Introducing Point of Care Ultrasound into the Medicine Clerkship Through an Augmentation of Pre-existing Physical Exam Rounds

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Introduction:
Teaching of point of care ultrasound (POCUS) is becoming more common in undergraduate medical education (UME). In 2015, our institution integrated ultrasound into the pre-clerkship curriculum through didactic and small-group learning. Opportunities for hands-on scanning in the Internal Medicine (IM) Clerkship, however, were limited compared to the Emergency Medicine and Obstetrics-Gynecology Clerkships. In January 2019, the ultrasound curriculum was introduced into the IM Clerkship in conjunction with pre-existing physical exam rounds (PER). Because identifying jugular venous distension (JVD) on physical exam has both evidence-based utility and is a challenging technique for new learners, we implemented a PER session to teach ultrasound as an adjunct to traditional physical exam. We tracked student evaluations to determine if this change improved learners' perceptions of PER.

Objective/Aim:
To introduce point of care ultrasound vertically into the medical school clinical clerkship curriculum through an augmentation of a pre-existing PER.

Methods/Process:
Within a 12-week IM Clerkship, all students rotated 4 consecutive weeks through one tertiary referral hospital. During this 4-week period, students were scheduled for 3 PER sessions, 1 of which included ultrasound. Sessions were typically 1-hour long with 3-4 students. Clinician-instructors trained in ultrasound taught alone; clinician-instructors that were ultrasound novices were paired with our sonographer educator (CM).

A focus group of clerkship directors and POCUS experts identified learning objectives for the ultrasound-augmented PER sessions. JVD was chosen due to an evidence base for clinical utility, accessibility to the novice learner, and the potential for improving physical exam skills through real-time correlation with ultrasound. Two pilot sessions were held with volunteer medical students to refine the quantity and content of material covered. A handout outlined the use of JVD and physical exam maneuvers to assess patient intravascular volume. The handout also highlighted sonographic techniques to assess JVD and common pearls and pitfalls.

If students received an ultrasound-augmented PER session, they provided an overall rating of the session (on a 1-4 Likert scale; 1 least effective to 4 most effective and additional comments about the ultrasound-augmented PER session.

Preliminary data were gathered from the first group of IM Clerkship students (January 2019-March 2019). Thirty-two of 43 students in our first group of Medicine Clerkship students (January-March 2019) completed clerkship evaluations rating the ultrasound-augmented PER. Ratings were positive, with a mean of 3.56 (SD=0.5). Previously, the mean for non-augmented PER sessions was 3.45 (SD = 0.73). Written comments included a preference for ultrasound teaching in the ward setting over the classroom, a request for more PER sessions with POCUS, and identified a benefit of these sessions because students were able to teach the skill to their fellow team members.

Our pilot study demonstrates the feasibility and value of ultrasound-augmented PER. Further studies will determine if an ultrasound-augmented PER session leads to an improved learning experience and clinical competence for UME students during their IM Clerkship. We expect that the early integration of ultrasound curriculum into the IM Clerkship should be accessible and translational, driven by high-yield and evidence based PER topics. These characteristics are particularly important in the context of clinical faculty who may be ultrasound novices. We anticipate that future PER topics may be introduced in a stepwise fashion to include cardiac and lung ultrasound in correlation to physical exam findings.

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Seeing Double: Benefits of a Case-based, Augmented Reality Guided Approach to Teach Ultrasonography

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Ultrasound (US) instruction in undergraduate medical education has been shown to be an engaging and effective longitudinal teaching tool that enhances student learning of physical exam and other basic procedural skills, gross anatomy, and physiology throughout medical education. However, interactive and integrated small group teaching modalities used in foundational sessions and clerkship rotations demand increased faculty and technology resources. Furthermore, students want to integrate basic science concepts while they are learning new skills and maneuvers in small group sessions. Various studies have looked at the educational benefits of incorporating novel teaching techniques to scaffold and enhance US teaching and to provide solutions in resource-challenged settings. We proposed that using augmented reality (AR) technology with US instruction for medical students would: 1) increase the faculty to student ratio and reduce the probe to student ratio needed to facilitate the sessions, 2) facilitate integration of foundational knowledge with clinical skills, and 3) improve students' application of US skills to clinical diagnosis.

MS1s rotated in small groups through multiple stations to demonstrate how US can be used to help assess patients presenting with right upper quadrant pain. Student preparation for the session required watching 2 relevant 5 Min Sono videos online. At the first station, an EM resident taught the use of US to visualize the gallbladder using peers as models of normal anatomy. At the next station, clinical vignettes of suspected cholecystitis were presented and students were able to use the HP Reveal AR application on their mobile devices to scan images that revealed dynamic US images of normal gallbladder anatomy and cholecystitis–allowing them time to recognize subtle differences between them. A debriefing discussion concluded the session.

The technique allowed a 50% reduction in the number of students per rotating group and required recruitment of fewer faculty for 110 students per 3 hour sessions. Qualitative data will be presented on the self-reported perception of the module by a random selection of the class, showing a preference for this method of learning US. Student evaluation Likert style ratings of the session were higher in 2019 than in the prior year without AR. Data will also be presented on student performance on selected relevant questions on the summative end-of-unit exams.

This innovation alone decreased the resources needed to execute an engaging and relevant ultrasound session for first-year medical students with improved student feedback. It is our hope that it will inform and guide educators who are seeking engaging, low-cost solutions to facilitate ultrasound learning. Future application in other aspects of ultrasound instruction in undergraduate medical education and further evaluation of the effectiveness of this learning, as evaluated by exam score improvements, is necessary.

Kevin Piro

Overload! Restructuring a POCUS curriculum to meet the needs of the novice learner's cognitive load.

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Point-of-care ultrasound (POCUS) enthusiasm has outpaced rigorous curriculum development within internal medicine (IM), with nearly half of all IM programs reporting that they had formal or were imminently adding POCUS curricula. Graduate medical education trainees often receive POCUS training in a broad-based bolus (BBB) training session, where numerous different POCUS applications (eg. 8-10) are covered over one to several days. While BBB sessions have data suggesting decay in knowledge, it is unknown how this training model affects POCUS use patterns and whether the model itself leads to decay. Cognitive load theory (CLT) posits that when learning complex cognitive and psychomotor skills, novice learners experience high intrinsic load which can contribute to overloading working memory and thus reduce the amount of learning that occurs. Thus, our group at Oregon Health & Science University (OHSU) refined our own BBB POCUS curriculum to a focused bolus (FB) curriculum, covering only US basics and cardiopulmonary applications. We specifically worked on task deconstruction. We sought to reduce intrinsic load and optimize new learning (germane load). We hypothesized that a FB curriculum would result in increased monthly use of POCUS, reduced barriers to POCUS use, and improved confidence in the use and application of POCUS to clinical care in comparison to the BBB curriculum.

From 2014-2017, OHSU IM interns participated in a BBB POCUS course (1.5 days, 12 hours) that covered 10 ultrasound applications. In September 2018, we redesigned the curriculum to a FB curriculum course spanning the same duration and covered the most frequently used POCUS applications by IM residents: POCUS basics/physics, lung, cardiac, and volume assessment.

Immediately after the 2018 FB curriculum, surveys were distributed to IM PGY-1s who participated in the curriculum, in addition to PGY-2 and PGY-3 residents who had participated in the BBB curriculum. The survey focused on use patterns (frequency and clinical rotation used on), resident attitudes toward POCUS (value, perceived POCUS competence), and barriers to implementation of POCUS in clinical practice. The survey is being administered every 3 months to all IM residents track use residents longitudinally.

Chi-squared tests and Fisher's exact tests will be used to compare the effects between the FB and BBB in August 2019.

Our results are still being tabulated. Preliminary results suggest that PGY-1 residents used POCUS 1.2 times per month prior to the FB POCUS curriculum, compared to 4.7 times per month after the curriculum. Residents participating in the FB curriculum felt POCUS was of more value to their clinical care in comparison to their BBB curriculum counterparts. POCUS competence and barriers to the use of POCUS appear to be stable between the groups. A FB POCUS curriculum holds significant potential to improve new learning for novice POCUS users. By engaging the educational POCUS community in a discussion about POCUS bolus training and introducing CLT, our group hopes to stimulate discussion and challenge accepted constructs of POCUS training.

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Development of an online-based tutorial to teach transthoracic echocardiogram (TTE) image acquisition and interpretation skills in medical training

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Point of care transthoracic ultrasonography (POCUS) is emerging as an important diagnostic modality for multiple subspecialties. Teaching a new complex skill and developing tools for assessment of competency can be challenging for many training programs. Key elements of transthoracic ultrasonography include: understanding relevant anatomy, ability to acquire key images to demonstrate relevant anatomy and function, and ability to interpret the ultrasound images. Because the ability to interpret ultrasound images is a critical POCUS subskill, the aim of this project was to develop self-guided educational modules to teach this subskill accompanied by a competency assessment. The first objective was to help learners identify which view a TTE image was obtained from. The second objective was to help learners identify the key anatomical structures in each view.

Prior work at our institution had developed an online module to teach how each of the 11 core transthoracic echocardiographic (TTE) views are obtained and optimized. Thus, the first stage of this project was to develop a self-guided web-based educational module to teach recognition of the 11 different core TTE views. To accomplish the objectives, we utilized Articulate Storyline to develop an online module divided into three activities: Tutorials on the core TTE views, Practice identifying anatomical structures in the core TEE views, and Practice identifying which core TEE view an ultrasound image came from. Videos of the standard cardiac ultrasound views were obtained. “Readings” of the views were provided by cardiologists or anesthesiologists with expertise in POCUS.

In the Tutorial module, learners were presented with each of the standard views. The clips were annotated with labels and an audio “reading” describing the view and its diagnostic utility. In the Anatomy Practice module learners were presented with an ultrasound clip and asked to identify key anatomical structures by pinning a marker directly on the structure. In the TEE View Practice module, learners were presented with 15 unknowns and asked to identify the view. Feedback on the answer includes what structures can be seen or the diagnostic utility for certain medical conditions.

This TTE module is designed to aide learners further their medical education by providing a foundation in understanding key points of TTE to aide in creating more confident assessments and plans supported by the diagnostic tool of ultrasound. This can be achieved through these modules involving tutorials that are followed by assessments to better solidify their knowledge.

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Changing perceptions: Applying interprofessional, near-peer teaching strategies to point-of-care ultrasound education

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As point-of-care ultrasound (POCUS) education becomes more common in medical education, many programs struggle with a shortage of POCUS-trained faculty. Interprofessional education (IPE) may offer a solution by expanding the number of available teachers and leveraging expertise from other professions. Prior studies have found that IPE is valued by learners and mitigates biases towards other health professions, although medical trainees tend to have less positive attitudes than other professions. The purpose of this study was to evaluate the impact of an IPE POCUS workshop on participants' perceptions towards interprofessional education, collaboration, and stereotypes.

The study took place at a Midwestern academic health sciences university. Students in the Diagnostic Medical Sonography (DMS) program served as coaches for first-year internal medicine (IM) residents. Residents had received prior training in cardiopulmonary POCUS, but not abdominal scanning. Prior to the workshops, DMS students participated in a 2-hour train-the-trainer session in which they learned teaching strategies via case-based simulation with peer and faculty feedback.

In the POCUS workshops, DMS students coached IM residents to acquire images of the kidneys, bladder, gallbladder, and aorta. The course utilized a flipped-classroom approach to maximize scanning time. Residents scanned live models at 4 stations, each lasting 30 minutes and facilitated by a different DMS coach. Faculty were available for technical problems, but otherwise did not participate.

The workshops were conducted in 2 consecutive years with 2 different groups of DMS students and IM residents. Participants completed pre/post online surveys and participated in post-intervention interviews. The 24-item survey was adapted from validated instruments for assessing interprofessional attitudes. Paired survey results were analyzed via Wilcoxon signed-rank test. DMS students and IM residents participated in semi-structured focus group interviews, which were recorded and transcribed. Two coders analyzed interview data using a qualitative descriptive approach to generate major themes, which were validated by member checking.

Forty-nine of 49 (100%) IM residents completed the pre- and post-intervention surveys over the 2-year study period. There was statistically significant improvement ($p<.05$) for 10 of 14 questions addressing perceptions towards IPE (e.g.

Learning with other health professionals will help me become a more effective member of a health care team") and 10 of 10 questions regarding interprofessional stereotypes/biases (e.g. leadership abilities of other health professionals). Course evaluations were globally positive from both DMS students and IM residents.

Forty-eight of 49 residents (98%) and 12/13 DMS students (92%) participated in focus group interviews. Final qualitative analysis is in process and will be available for presentation at the conference. Preliminary analysis demonstrates that IM residents felt the IPE workshop provided a more relaxed learning environment than traditional training sessions and DMS students felt the experience encouraged deliberate consideration of their scanning technique, which could improve future performance. Working together led both groups to better appreciate the other's profession. IM residents had misconceptions corrected and gained new respect for the DMS coaches. Residents also expressed interest in seeking additional IPE opportunities not related to POCUS, including with nursing.

This study found that interprofessional POCUS education can improve participants' perceptions towards interprofessional education, dispel stereotypes amongst health professionals, and motivate interest in future interprofessional collaboration. Interprofessional, near-peer teaching may be a viable option for training IM residents in POCUS.

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Initial Student Perceptions of Ultrasound after Incorporation into Medical School Curriculum

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INTRODUCTION: Incorporation of ultrasound into medical school curricula is increasing, but not all schools have complete four year ultrasound curriculums. This study examined the opinions of a unique group of first year medical students. Students were unaware they would be receiving a full four-year ultrasound curriculum until they started their first year, as this was in development at the time they selected their medical school. Our study examined these students' opinions of ultrasound after their first hands-on ultrasound education session and discovering they would have a four-year ultrasound curriculum.

METHODS: Following their ultrasound education session, students were surveyed and answered questions on a Likert scale from 1-5. Results were analyzed using descriptive statistics. There were 40 respondents.

RESULTS: 97.5% of respondents agreed that learning ultrasound would enhance their ability to learn anatomy and would help connect surface anatomy with deeper anatomic structures. 77.5% agreed that learning ultrasound would enhance their ability to learn physiology, and 95% felt ultrasound would strengthen their physical exam skills.

100% also agreed that ultrasound enhanced their medical education; 92.5% wanted to learn more about point of care ultrasound after their experience; 97.5% felt ultrasound should be more integrated into the medical school curriculum.

CONCLUSION: Students who previously were unaware they would be receiving a four-year ultrasound curriculum responded positively to this news after their first teaching session. They felt ultrasound would enhance their education and was an important addition to the curriculum. Overall, first-year medical students who may not have placed much importance on ultrasound in their selection of medical school still enjoyed learning ultrasound and after exposure felt positively about its integration into the curriculum.

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Student perspectives on point of care ultrasound (POCUS) training in the internal medicine clerkship curriculum

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Over past decade, there has been a rapid integration of point-of-care ultrasound (POCUS) in undergraduate medical education. More specifically, the establishment of a POCUS curriculum during the internal medicine (IM) clerkship varies greatly amongst institutions. Here we describe the POCUS experience at the internal medicine clerkship (Spokane) at the University of Washington School of Medicine and students' reception of an integrated-POCUS clerkship.

POCUS was introduced into the 3rd year IM clerkship through hands-on learning supplemented with focused didactic sessions. Students received 4-6 hours of formal POCUS training. The educational scope included fundamentals/ appropriateness of POCUS, basic cardiac/pulmonary views and evaluation of free fluid. Additional exposure came from wards and ICU rotation. An anonymous survey was distributed to students after the completion of the IM clerkship. Answers were ranked on 1-5 Likert scale (1 = strongly disagree to 5 = strongly agree).

62% of students responded to the survey. 75% of the respondents had never used POCUS before the IM clerkship. After completion of IM clerkship 100% of the students strongly agreed that POCUS training was a valuable use of their educational time. 79% strongly agreed that POCUS advanced their understanding of anatomy and anatomic relationships. >65% of students scored 4 or 5 (1-5 Likert scale) on self-perceived confidence using POCUS to detect various pathology relevant to internal medicine. (identifying pleural effusion, ascites and etc).

Looking at students who successfully matched into an Internal Medicine programs, 80% agreed that an established POCUS curriculum an important factor in program ranking. Very similar data was seen in prospective students thinking about internal medicine residency. Finally, 92% of students felt very strongly that POCUS should be incorporated in all 4-years of medical school curriculum.

Medical students in this study had very little exposure POCUS prior to their Internal Medicine clerkship. The reception to POCUS was universally positive with most students looking for more experiences in the future and feeling that ultrasound should be incorporated into all four years of the medical school curriculum. As portable ultrasound units become more affordable it will become easier to incorporate POCUS into additional aspects of the medical school curriculum.

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University of Utah Ultrasound Probe Check-Out: Perceptions from the 2023 Class

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Many medical schools are now implementing point-of-care ultrasound in their curricula. This is in part due to ultrasound's increasing importance in clinical medicine. We have considered creating a check out system for several new hand-held probes. Medical students could then independently improve their ultrasound skills and benefit their overall medical education. The aim of our study was to evaluate perceptions of this new probe check out program with the incoming class of medical students.

A survey assessing student's perceptions of this new program was sent out to the incoming class of medical students. Subjects' responses were analyzed and reported using descriptive statistics.

All respondents reported that they would check out an ultrasound probe during their first semester and indicated they would use them at home (67%), school (87%), in clinics (67%), or in the anatomy lab (60%). 100% agreed that ultrasound enhanced their anatomy knowledge and physical exam skills. A minority thought an ultrasound check out program would enhance basic medical sciences and physiology. 64% also agreed that knowing about the ultrasound check out program at positively affected students' decision to attend a medical school. Only 27% students have had previous ultrasound exposure.

Incoming medical students are a unique population, as they have not started their medical school journey and have little ultrasound exposure. Yet the incoming class overall felt they would benefit from this program and would take advantage of an ultrasound check out program. Their opinions on its benefits varied by subject, but overall they viewed such a program positively. The possibility of this program even influenced many students' decision to attend their chosen medical school. Given ultrasound's benefits for medical education, it seems an ultrasound check out system would benefit students and medical schools.

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Practical evaluation of two teaching methods in cardiac POCUS with 1st year medical students

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Ultrasound is a growing part of undergraduate medical education and is one of the most expanding modalities across medical specialties. POCUS (Point of Care Ultrasound) has also increased in popularity within the medical community. Some medical schools have 100% student driven programs to integrate POCUS into their medical curriculum. The objective of this study was to determine the most effective method of teaching 1st year medical students cardiac anatomy and clinical skills through POCUS. We hypothesized that the best way of learning cardiac POCUS is by live demonstration by an experienced instructor, when compared to watching online modules.

The participants of the study were 1st year medical students from the California University of Science and Medicine - School of Medicine (CUSM - SOM).

All participants were divided in 2 groups: A and B (10 students in each group). The participants had no previous experience with POCUS. Group A watched cardiac-ultrasound modules provided by the Society of Ultrasound in Medical Education (SUSME), a reputable online resource for medical education. Group B was given an in-person cardiac POCUS demonstration by an experienced instructor. Afterwards, the participants from each group were asked to obtain 3 specified cardiac ultrasound views on a simulated patient with a phased array probe. They were asked to verbally identify particular anatomy of the heart to the blinded trained sonographer in the room. A 3-point grading scale was used by the trained sonographer to evaluate each participant's ability. Statistical analysis was done using Student's t-test, and a p-value < 0.05 was taken as significant.

Group B (in-person demonstration) was able to better identify the correct anatomical location for probe placement when compared to group A ($p < 0.05$). Additionally, group B was able to better identify the heart chambers in a short axis view of the heart ($p < 0.05$). There was no statistically significant difference between the groups when asked to identify the heart chambers in long axis view, aortic valve in the short axis view, mitral valve in the short axis view, and pericardium. A more effective method of teaching 1st year medical students cardiac POCUS is through in-person demonstrations, rather than watching online modules. The results of this study will help develop the ultrasound curriculum for the preclinical years at CUSM - SOM. Further studies can expand to other organ systems as students go through their undergraduate medical education.

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A comparison of two instructional methodologies in teaching first year medical students cardiac POCUS

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Recently, there has been an increasing effort among medical schools to integrate ultrasound technology into preclinical medical education. Many medical schools are even developing POCUS (Point of Care Ultrasound) based ultrasound curriculums, and these curricula are mostly driven by the medical students. POCUS of the heart is a growing modality for early identification of patients for echocardiography referral. The objective of this study was to compare the effectiveness of two common instructional techniques to teach cardiac POCUS: in-person demonstration and video demonstration. We hypothesized that the in-person demonstration is the more effective method of teaching cardiac POCUS when compared with the video demonstration.

This study was conducted with first year medical students at the California University of Science and Medicine - School of Medicine (CUSM – SOM). There were a total of 20 students and they were divided into two intervention groups: Group 1 participants were placed in a classroom and watched 3 projected videos from the Society of Ultrasound in Medical Education (SUSME). Group 2 was taken to an ultrasound room and was given an in-person demonstration of cardiac ultrasound by a trained instructor. Both groups had to complete a 15 question quiz before and after the intervention. Each group was given 20 minutes to complete each quiz.

A repeated measures ANOVA with a Greenhouse-Geisser correction determined the mean overall scores for both groups differed from pre- to post-test ($F(1,17) = 110.47$, $p < .05$); however, there were no significant interaction effect between groups ($F(1,17) = 2.754$, $p = .115$). The same analysis was performed to determine mean differences for each question asked. When asked to identify the four levels of a short axis view of the heart, the pre-test to post-test change in group A was 9% to 0% correct whereas correct answers in group B improved from 25% to 88% correct ($F(1,17) = 8.435$ $p = 0.01$). When asked to recognize the level of Mercedes-Benz sign, the pre-test to post-test change in group A was 9% to 64% correct, and in group B was 0% to 100% correct ($F(1,17) = 5.965$, $p = 0.03$).

Despite there being no statistically significant difference between groups 1 and 2 from pre-test to post-test, group 1 did not perform significantly better on any question than group 2. However, group 2 outperformed group 1 on two specific questions. Thus, we believe the in-person teaching method to be the superior ultrasound teaching method. The results of this study will serve as evidence to create future ultrasound learning sessions as a part of the ultrasound curriculum at CUSM - SOM. Further studies can include an analysis of two teaching modalities in hands-on applications.

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Barriers to Student Participation in Ultrasound Education

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Medical schools are increasingly incorporating point of care ultrasound into their curriculums. The University of Utah recently initiated an Ultrasound Interest Group (USIG). This provided all students the opportunity to learn ultrasound skills and engage in near peer teaching. Participation in group events was variable over its first year. We sought to assess what barriers existed and to what extent these barriers prevented participation for USIG members.

A survey was distributed to USIG members. Answers were primarily multiple choice or a Likert scale rating from 1-5. The survey concluded with an open-ended question where members could list any additional barriers or suggestions not addressed in the survey. Data was analyzed using descriptive statistics. All respondents felt USIG enhanced their medical education. 55% of students felt they missed opportunities to attend USIG events due to poor communication through the Facebook group or not having enough advanced notice before events. 36% missed events because there were not enough ultrasound machines available relative to the number of students. 18% felt behind because they had missed other teaching sessions, so they missed future events. 64% of students indicated that USIG events conflicted with other higher priority or required school obligations (such as class).

Based on the results of this survey, it appears that the barriers to participation in a new USIG are multifactorial. The most common barriers related to adequate notification for events and timing to not conflict with other required medical school events. New USIGs should be aware of this to ensure the timing of and communication for events are well planned to ensure maximal student participation. Ensuring sufficient machine to student ratios and a plan for members to catch up from missed events would also enhance student participation in USIGs. Overall students feel USIGs enhance their education, but addressing the common barriers to participation will allow students to maximize their benefit from new USIGs.

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Utilization of Ultrasound in Diagnosis of Pediatric Pneumonia: A Case Report CPT

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Community-acquired pneumonia (CAP) represents a significant cause of morbidity in children, with up to 35% of patients under the age of 5 requiring hospitalization. Chest radiograph is currently the gold standard for imaging in suspected CAP, though it does come with limitations, including delay in diagnosis and exposure to ionizing radiation. Point-of-care ultrasound (POCUS) has been shown to be highly sensitive and specific in diagnosing pediatric pneumonia.

A 2-year-old female was brought into the emergency department (ED) by her mother due to persistent fever and respiratory distress. Portable chest radiographs and point-of-care lung ultrasound were performed immediately, with the diagnosis of pneumonia with parapneumonic effusion made using ultrasound prior to radiologist interpretation of the radiographs.

This case illustrates how the speed of point-of-care ultrasound can lead to a rapid diagnosis, treatment and disposition of pediatric pneumonia. “It is a valid diagnostic alternative to chest radiograph in pediatric patients suspected of having pneumonia, and could be useful to primary care clinics as an aid in making this diagnosis.

(poster case presentation; accepted to WCU 2018, however, not presented due to conference cancellation.)”

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A Survey of Emergency Medicine Resident Knowledge, Attitudes and Barriers to Point-of-Care Ultrasound Utilization during Cardiac Arrest in the Emergency Department

Short Title: CUBED (Cardiac Arrest Ultrasound Barriers in the Emergency Department)

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Objectives
Point-of-care ultrasound (POCUS) is increasingly recognized as essential in the management of cardiac arrests in the emergency department (ED). However, several studies have identified sub-optimal POCUS performance as a factor which may negatively impact patient survival. The purpose of this study was for emergency medicine (EM) residents to identify significant barriers which may exist to prevent their performance of high-quality POCUS during cardiac arrests in the ED.

Methods
A 20-item survey instrument was distributed to EM residents at three academic centers (Center A= 46 residents, Center B=21 residents, and Center C=29 residents) in the South Florida Emergency Medicine Residency Consortium. The survey encompassed resident demographics, POCUS experience and proficiency, and attitudes and barriers to the performance of POCUS in cardiac arrest.

Descriptive and inferential statistics were used to profile residents' POCUS experience. The Item Response Theory Logistic Models were used to rank barriers to high quality POCUS performance in cardiac arrest.

Our return rate was 97% (93/96). In combination, there were 32 PGY1 residents, 32 PGY2 residents, and 29 PGY3 residents who returned the survey.

75% of residents (69/92) rated their proficiency as high (ACGME levels 4-5), while 4 residents rated their proficiency as low (ACGME Level 1). 67% (62/92) residents stated they had been specifically trained in POCUS in cardiac arrest.

At least 35% (15/43) of Center A residents, 57% (12/21) of Center B residents, and 52% (15/29) of Center C residents managed 1-5 cardiac arrests per rotation. 56% (24/43) of Center A residents, 52% (11/21) of Center B residents and 21% (6/29) of Center C residents perform POCUS in 100% of their cardiac arrests.

49% (46/93) of all residents are "encouraged (to perform POCUS) each and every time." 57% (53/93) of all residents reported that their POCUS in cardiac arrest was supervised by faculty 100% of time and 31% (29/93) rated their faculty supervision as excellent.

The top two barriers (of nine surveyed barriers) at each academic center were "chaotic milieu", "time to retrieve and operate the US machine" or "availability of functional US machine". The least significant barrier was "pushback from consultants" or "I believe that POCUS has a negative impact on efficiency and patient outcomes.

Conclusion
While POCUS is performed in a majority of resident assisted cardiac arrests at three academic centers in South Florida, multiple barriers to high-quality implementation exist. Specific interventions to address these barriers may lead to an increased rate of high-quality POCUS-guided resuscitation.

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Leadership USIG Barriers

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Creation of an Ultrasound Student Interest Group (USIG) provides opportunities for ultrasound education, practice, and leadership outside of the standard curriculum. However, USIG leaders establishing a new group are faced with many challenges in its first year. In our study we assessed USIG leadership to determine what challenges they felt created the greatest barriers to the group's success. Our aim is to provide guidance for new USIGs being established, so that they may address potential problems before they occur.

A survey was sent out to student leaders and their faculty advisor. Questions were both multiple choice and Likert scale ratings from 1-5. A final open ended question for comments was included for barriers not addressed by the survey. Data was analyzed using descriptive statistics.

All leaders strongly agreed that they enjoyed being a part of USIG leadership. Communication was a significant issue with 100% feeling events were not announced far enough in advance and that students missed Facebook announcements for these events. Resources were also an issue. 75% felt there weren't enough machines to support the groups size and 100% agreed there was not enough leaders to support USIG's desired activities. Goal setting was another perceived issue with 100% feeling goals were not thoroughly planned out for the year. 75% agreed that there was not sufficient follow up on progress towards goals that were set.

Most challenges with establishing a new USIG centered around difficulty with communication, inadequate resources, and planning/follow up for goals. New USIG leaders should establish efficient means of communication that provide sufficient notice for events. They should be sure to have sufficient numbers of leaders with designed roles to perform essential tasks and try to secure additional machines when possible. Lastly, they should set specific goals and create a follow up plan for assessing progress. Knowing these primary challenges encountered by leadership in a USIG's first year can help new USIGs address these issues early and reduce their impact.

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Medical Education with Meme Excellence (MEME) to Enhance Image Acquisition Skills

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Improving less exciting aspects of ultrasound education for residents can be a challenge. A specific challenge in the resident education is teaching residents to consistently optimize image depth. Repeatedly correcting this skill can be boring and feel nagging for resident learners. We attempted to address this challenge by teaching with humor, specifically with a funny meme addressing the problem of poor depth. In our study, we sought to determine if humor through a meme was a viable tool for improving resident's image depth. In our study, we compared renal ultrasound images from residents exposed to the educational intervention (experimental group) and residents from the year prior (control group). We collected data on the average depth of the exam and distance from the posterior wall of the kidney to the far field edge of the screen. Datasets consisted of four month periods of renal ultrasounds for both control and experimental groups. We also compared depth and distance values for the first month following the educational intervention and four months after to assess learning fatigue. Data was analyzed using student T-test statistics.

Residents taught depth optimization using humor as a tool had significantly better depths on renal images. Their average depth was 15.6 cm, compared to 16.8 cm for the control group. This was significant with a p value of 0.002. Additionally, learning did not significantly fatigue. This is evidenced by a p value of 0.49 when comparing the average distance to the far field edge of the screen between the first and four months after intervention. Overall, residents taught depth optimization through a humor-based educational intervention were significantly better at consistently saving images with an appropriate depth.

Teaching the less exciting aspects of ultrasound image acquisition can be difficult. However, this can be enhanced using humor-based education to make topics like appropriate depth more memorable. Residents taught about appropriate depth using a funny meme had significantly better image depth skills than control residents form the previous year. Learning did not fatigue significantly with this method of education, so less effort is required from faculty to teach this skill and the need for repeated feedback for depth is reduced. Overall, humor-based education through memes is an educational tool that may be effective in teaching ultrasound image acquisition skills.

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Advanced Clinical Training Does Not Influence Clinician-Performed Ultrasound Fund-of-Knowledge

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When teaching clinician-performed ultrasound (CPU) it is common to group learners by academic rank with the assumption that increased clinical experience yields greater CPU fund-of-knowledge. We assessed the pre- and post-ultrasound rotation test results of learners at different academic ranks to determine if there was a difference in ultrasound knowledge.

A retrospective analysis was conducted on pre- and post-test results of trainees who completed a 4-week CPU rotation of a US EM residency program and medical school from 01/2011 to 11/2016. Study subjects included third and fourth year medical students, first and second year EM residents, and first year PEM fellows.

The pre-test (17 questions) and post-test (85 questions) consisted of closed-book, web-based exams with multiple choice, true/false, and open ended questions about physics, knobology, and CPU core imaging modalities (www.emergencyultrasoundteaching.com). Tests were graded by a fellowship-trained emergency sonologist and regraded by a research coordinator blinded to the rotators using a master key. Pre/post-rotation differences in knowledge were examined by converting scores to percentages and paired t-test tests were performed. To determine differences by training level, an analysis of variance in repeated measures with posthoc pairwise t-tests were employed.

Of 39 rotators, 20 were medical students, 14 were EM residents, and 5 were PEM fellows. Baseline ultrasound fund-of-knowledge was moderate across all groups (PEM 63.1% vs medical student 70.6%, EM resident 73.4%, $p>0.08$ for all pairwise comparisons). Post-test scores significantly improved for all 3 groups (mean score 92.3%, increase from baseline 23.2%, 95% CI: 17.3 -29.1%, $p<.0001$).

Physics, echo, and FAST were the domain topics with enough questions for comparison. On the pre-test, physics was the most challenging for all learners, followed by FAST (mean 56.7%, 62.5% respectively); the easiest was echo (mean 75.4%). Post-test scores were much improved (95.9% physics, 93.4% FAST, 94.5% echo).

Pre-ultrasound rotation fund-of-knowledge was moderate across learners of different academic rank and improved greatly after a 4-week CPU rotation. Medical students seem to grasp CPU concepts as well as those with advanced clinical experience. CPU knowledge appears to be a skillset independent of clinical experience.

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Using Ultrasound Technology in a High School Outreach Exposure Program to Provide A Positive Hands-On Classroom Science Experience

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INTRODUCTION: Arkansas has one of the lowest per capita income and education levels in the country and faces the same challenges as other rural states in trying to prepare for the demands of a properly educated and diverse science, technology, engineering and mathematics (STEM) workforce. The ArkanSONO program was established in 2017 as a partnership between University of Arkansas for Medical Sciences (UAMS) faculty and the Little Rock School District (LRSD). The outreach program is designed to provide students with an opportunity to peer inside the human body in real time and experience first-hand the transformative power of ultrasound. Last year at the World Congress on Ultrasound in Medical Education (WCUME) we reported our pilot outreach efforts and this year we report on year 1 of outreach efforts now funded by a 5-year, $1.27 million dollar Science Education Partnership Award (SEPA) educational research grant from the National Institute of General Medical Sciences at NIH.

METHODS: In the 2019 academic calendar year, the ArkanSONO team visited 50 different 9th grade physical science classrooms in three LRSD high schools and presented two separate 90-minute STEM focused sessions in each classroom. We also piloted a third ultrasound focused outreach session in 8 classrooms. In each session, ultrasound scanning was included as part of a coordinated cardiovascular STEM focused effort that included discussions of college and STEM careers. We assessed student learning of various ultrasound and heart related concepts in each session using a pre/post survey design. Students also completed an 8-question survey that measured their level of engagement and a 7-question survey on their beliefs about the value and usefulness of each session.

RESULTS: In the first classroom outreach session, we brought hand-held portable Dual Probe GE Vscan Extend devices to allow students to work in groups of 6-9 students to gain hands on experience scanning the neck and forearms of program faculty and classroom teachers. Students identified the thyroid gland and major blood vessels in the neck and observed difference in responses of these vessels to external pressure and the effect of the Valsalva maneuver. Students also scanned the median nerve and the flexor muscles and tendons in the forearm as well as the metacarpal bones and flexor pollicis longus tendon in the palm of the hand. They used the Doppler mode to monitor the flow of blood in arteries and veins. In the second classroom outreach session, we brought a NextGen LOGIQe laptop device equipped with EKG and a thermal printer and allowed students to scan the heart of a male standardized patient in the parasternal long axis view. Students were asked to pretend they were the health care provider and interact with the SP as if they were a real patient (e.g., introduce themselves and provide patient feedback). Staff pointed out how the mitral valve opens and closes out of synchrony with the aortic valve. Students also rotated through two other stations that included handling dissected sheep hearts and visualizing 3D reconstructions CT data from normal and pathological human hearts. In a pilot of a third classroom outreach session, we brought 16 separate Intelametrix ultrasound science kits and Dell Inspiron laptop computers so students could work in teams of 2-3 to directly measure the speed of sound in various media (e.g, Lucite, tongue depressor, rubber stopper, water and salt water) using the A-mode of the devices. Students then used the B-mode of the device to scan themselves to identify the radius (as it coursed from the wrist to the elbow and its relationship to the extensor muscles at the elbow), the changing shape of the superficial flexor tendons just proximal to the wrist (as they clenched and unclenched their fingers into a fist), and the appearance of the metacarpal bones and intervening hand tissues (as they moved the probe along the dorsum of the hand from medial to lateral).

The average level of student engagement was high in each session (1st=3.1, n=880; 2nd=3.2, n=803; 3rd=3.0, n=124) [4 point Likert scale with 1=NO!, 2=no, 3=yes, 4=YES!]. Student evaluations of the three sessions was also very positive with an average task value/usefulness rating of 4.9, 5.0 and 4.4, respectively [7 point Likert scale with 1=not at all true and 7=very true]. Our pre/post surveys revealed only modest increases in student learning of basic concepts related to ultrasound and heart structure and function. For example, 35% of students in the 1st pre-survey correctly indicated that the "brighter regions on an ultrasound image represent areas of increased echo" and this only increased to 45% in the post-survey (N=880). Similarly, 18% of students in the 2nd pre-survey correctly indicated that the statement "All four valves in the heart open and close simultaneously during a heartbeat" was FALSE, and this only increased to 27.4% of students in the post-survey (N=804).

DISCUSSION: The first year of our NIH SEPA funded ArkanSONO program was a tremendous success with students providing very positive feedback to the use of clinical hand held and laptop ultrasound devices coupled with commercially available ultrasound technology in the classroom. The high level of student engagement provided students with a positive hands-on science experience. The ArkanSONO program is strategically positioned to potentially serve as the spark that potentially ignites student interest in pursuing STEM careers.

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Creating an ultrasoundable specimen library using cadaver materials encapsulated in a low sound-attenuating medium

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While commercial ultrasound phantoms are available, they are expensive and often of low fidelity. In addition, the number of phantoms needed to train a typical medical class of 150 can be inhibitory from both curricular time and financial investment. This study demonstrates how low cost, high fidelity phantoms can be constructed using readily available cadaver specimens embedded in an ultrasoundable medium.

Housing units for embedded specimens are created using a PVC pipe with a large scanning window cut out. A thin vinyl covering is placed onto the window adhered with glue, creating a water tight seal. An epoxy resin cap is placed on both sides, one prior to organ embedding and one after.

The organs are dissected and cleaned thoroughly preventing tissue fraying during encapsulation. Multiple washes are also administered to wash away excess embalming salts. Naturally occurring pathologies have been preserved and synthetically created pathologies have been placed in certain specimens. Organs are then suspended in the housing unit with positioning wire and filled with an ultrasoundable medium (Zirdine TM) and cured.

Multiple ultrasoundable kidney specimens have been created with varying pathologies either naturally occurring or synthetically created. Normal kidney anatomy can be visualized through ultrasound imaging as well as the different pathologies. A lipid interface as accumulated at the apex between the organ and the hydrogel but has not influenced the ultrasound quality. Tissue preservatives have also leached out of the tissue creating discoloration in the Zirdine (TM) due to diffusion, however, the organ appears to remain well preserved.

Encapsulating cadaver materials in a low sound-attenuating material is a viable method for creating ultrasound phantoms with real anatomy and naturally occurring or synthetically created pathologies.

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Ultrasound Checkout: Assessing Student Perceptions on Independent use of Ultrasound Equipment for improved study of core sciences and Ultrasound Techniques

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The use of ultrasound (US) has increased across many medical specialties. As US use increases so does the need for physicians to be adequately trained in US. This can be difficult as cost often limit medical students' access to machines. However by implementing a portable ultrasound check-out program (PUCP) independent learning can occur and machines can be checked out intermittently to accompany students in clinical learning environments. In our study we evaluate students opinions on introducing a PUCP to second year medical students who've completed their first year of ultrasound curriculum.

Second year medical students were surveyed and answered questions on a Likert scale from 1-5. Collected data was analyzed using descriptive statistics from twenty respondents.

Students felt positive about having a PUCP. 90% of students said they would use the PUCP if it were available. All students felt a PUCP would enhance their ability to learn clinical ultrasound skills. In order of decreased perceived value, students felt the program would help them learn ultrasound skills, anatomy, physical exam skills, physiology, and pathology. Students also agree that they would use ultrasounds from the PUCP in variety of locations, including home, campus, and the clinical environment. Lastly, 45% agreed such a program would have influenced their choice of medical school. The majority of surveyed medical students had positive opinions on implementing a PUCP to enhance their medical training. The majority believed it improved both core medical curriculum and ultrasound skills. Almost half of students also felt a PUCP would have influenced their selection of a medical school. Overall it appears that students with integrated ultrasound curriculums feel a PUCP would positive influence their medical education.

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The Ultrasound Digital Badging Curriculum of Eastern Virginia Medical School: A Competency Based, Self-Directed Roadmap to RDMS – Results after first year of implementation

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The inclusion of ultrasound training within Undergraduate medical education (UGME) continues to grow. However, lack of institutional resources, faculty expertise, and curriculum time are great limitations to its inclusion. Digital badging platforms have demonstrated that knowledge and skills training can be validated asynchronously via gamification. By marrying these methods together EVMS has developed A Competency Based Digital Badging Ultrasound Curriculum with intra-curricular and (self-directed) extra-curricular components that allows students to build a digital badge portfolio assessing their skills and competencies. By completing the badging curriculum students can become eligible to challenge both the nationally recognized SPI (Sonographic Principles and Instrumentation) and the RDMS (Registered Diagnostic Medical Sonographer) Abdomen exams.

The curriculum is based on dividing the SPI and RDMS (abdomen) requirements into three badging blocks each with approximately 30 requirements per level. The Bronze block is composed of ultrasound sessions contained within the first two years of the integrated Care Forward EVMS curriculum while Silver and Gold badging blocks are extracurricular and require students to be self-directed and intrinsically motivated for completion. Each badging block combines sono-savvy components (knowledge and attitudes) using SonoSim® video modules and integrated quizzing prior to completing intra- or extra-curricular and virtual scanning labs for badge requirements. Some completed badge requirements are controlled automatically while other badges will require students to submit components for review by qualified faculty as a means of quality control. Each badge block will include a final “review badge” that incorporates a review of the block’s materials, a 50 question quiz and a final OSCE examination that will ensure students are sono-skilled and sono-savvy. It is intended that the EVMS Digital Ultrasound Badging Curriculum may serve as an option for those institutions struggling with the heavy demands of incorporating ultrasound into an already packed undergraduate medical education curriculum. Quantitative analysis and satisfaction will be derived by following the metrics of students who complete badges, skills assessments, and SPI and RDMS eligibility and completion rates. Qualitative data will be obtained through evaluations measuring attitudes, responses, and overall student satisfaction with the curriculum at set intervals throughout the implementation. Competency and skills degradation will also be monitored via the review badges at each level.

The curriculum components have each been trialed at different times and the curriculum was implemented in August 2018. The presentation will lay out the components of the curriculum with examples of the modules, badges and badge blocks as well as the formats of assessment and mastery levels for each stage. After the first year of implementation, we have received valuable feedback as well as data to suggest an improvement in not only the competency of our student physicians but also in the motivation to pursue ultrasound certifications throughout their medical training. This program is motivational, engaging, and progressive while meeting the LCME mandate for including self-directed learning, narrative feedback, and competency-based skills as well as inter-professionalism into the existing curriculum.

By coupling the strengths of digital badging technologies and the difficulties of delivering a competency-based ultrasound curriculum we feel there is great promise for the EVMS Ultrasound Digital Badging Curriculum as an effective pedagogical tool to provide the fundamental knowledge of ultrasound for achieving RDMS eligibility and competency. This model also has great promise for expanding ultrasound skills with other national accreditation standards in the future. As ultrasound continues to struggle with logistical difficulties of curricular inclusion, we feel that a digital and independently paced program will be of interest to the institutional communities mandated to include ultrasound in their curriculum.

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Gauging the interest of Ultrasound in today's newest medical students

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Ultrasound training is becoming more common in both preclinical and clinical curricula in medical schools. This is in part to its growing use in the clinical environment, leading to a growing importance for ultrasound in medical training. Because of this we sought to assess the value incoming medical students place on ultrasound curriculums for their decision to matriculate into their chosen medical school.

The incoming class for a medical school with a new ultrasound curriculum were surveyed. Questions were answered on a Likert Scale from 1-5. Data was analyzed using descriptive statistics.

Incoming students viewed ultrasound curriculums as a positive feature of a potential medical school. 78% of students felt that the presence of an ultrasound curriculum positively impacted their decision to choose the medical school. Exposure to the ultrasound curriculum at a second look day also positively impacted 76% of incoming students' decision to attend their medical school. 84% of incoming students felt medical schools with ultrasound curriculums better prepared their students to be doctors. They also felt ultrasound skills were important for medical students (92%) and physicians (100%). Based on the results of this survey, it appears that prospective medical students value the presence of ultrasound in medical school curricula. They feel medical schools which provide an ultrasound curriculum better prepare them to be doctors. The also believe ultrasound skills are importance for both medical students and physicians. Highlighting this feature of a medical school's curriculum during second look days appears to positively influence students' opinions of that medical school. Medical schools with ultrasound curriculums should consider highlighting them to enhance student recruitment because students are taking notice of ultrasound in medical education.

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Integrating Competency Based US into the Physician Assistant Curriculum: Competent but for how long?

Author(s): Katherine Schaffer, Ciara Jenkins, Lane Fortney, Felicia Toreno, Bradford Boyette, Craig W. Goodmurphy

Institution: Eastern Virginia Medical School

Ultrasound education is expanding rapidly in Medicine It has been slower to grow in the intensely packed MPA (Masters of Physician Assistant) Programs. The same difficulties of integration exist for MPA programs as it would MD programs, but with the shorter timeline (27mo) and competing needs make meaningful integration extremely difficult. The current study aimed to integrate ultrasound competency training into the EVMS MPA curriculum across the first year of preclinical training and to assess the competency degradation curve over time in the program. This will be fundamental to assessing whether US can be meaningfully integrated in such a short period of time prior to entering clinical training phases.

The EVMS MPA program matriculated 82 students in 2018 and exposed students to three terms of Ultrasound training. Term 1 had an intro and three short events in anatomy. Term 2 had 6 scanning sessions and an OSCE, and Term 3 had 5 sessions and an OSCE with a final degradation OSCE at the end of Term 4 after a hiatus of 4 months without scanning. Each US session involved a prelab knowledge component and a proctored lab scanning session in which students acquired, labeled and printed a clinically relevant image for assessment and written feedback. For all knowledge quizzes and skills the competency standard of 75% needed to be met or it was repeated until the standard was met. In total, four OSCE type assessments and three knowledge quizzes were performed across the year to assess competency and skills degradation. Each was either multiple components of a FAST image. Following the first OSCE students were without ultrasound training for 2 months prior to being retested in groups with components of the FAST to measure the degradation of skills. In term 3 the scanning sessions inoculated student with ultrasound of the thorax but not the abdomen and was followed by a final FAST OSCE. Lastly, in their 4th term there was no ultrasound training sessions but right before their clinical rotations, the students were reevaluated with a final FAST OSCE. The degradation was assessed in multiple ways. Overall success rates and individual image acquisition success rates. In addition, they completed surveys in regards to subjective belief of clinical relevance, degradation and general course feedback. During the Anatomy portion of student training, they met standards in knowledge (73 students or 91% passing (7 students below standard) and skills components (71 students or 86% (11 students below standard) during the first attempt. When collecting individual images for cardiac, Morrison's Pouch (RUQ), and long-axis bladder, two students did not meet >3.6 (out of 5) grade point criteria while capturing bladder shot. The first OSCE was completed and out of 79 students, 62 (78%) met the criteria for the cardiac scan, 67 (85%) for RUQ, 58 (73%) for splenorenal, and 65 (82%) for bladder. The second OSCE was completed two months without practice, 21 students of 78 (27%) met minimum requirements for cardiac scan, 24 students of 40 students (60%) for bladder, 4 of 20 (20%) for splenorenal, and 8 of 18 (44%) for RUQ. After additional training, the third OSCE (6-month mark) was completed with of the 66 students (84%) met requirement in the cardiac scan, 76 students (96%) for RUQ, 64 students (81%) for splenorenal, and 78 students (99%) for bladder. After four months with no practice (10-month mark), the fourth OSCE was completed and of 76 students, 46 students (61%) met standard in the cardiac capture, 60 students (79%) in the RUQ capture, 51 students (67%) in splenorenal, and 37 students (49%) in the bladder capture.

The MPA program is a suitable avenue for bringing students a specific ultrasound skill set. There is however a need for a well sequenced and timed inoculation of skills to avoid a steep degradation curve as part of the planning process if students are to maintain proficiency standards. It also appears that some skills (cardiac) will need more innoculations that some relatively easier skills such as RUQ. More investigation is needed on how and what types and rhythms of training can serve as the most effective formats of reducing skill degradation. This will continue to be pursued as the MPA curriculum is rolled out at Eastern Virginia Medical School.

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Comparative study of the teaching of transfontanellar ultrasonography to undergraduate students and pediatricians. Are there differences?

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Transfontanellar ultrasonography (UTNF) is an imaging method of great importance in the evaluation of newborns and provides additional information regarding the physical examination. Objective: To evaluate if the UTNF can be taught to undergraduate students and pediatricians without previous ultrasonographic knowledge. Fifteen medical students and fifteen pediatricians underwent a multiple choice test before and after receiving four hours of theoretical and practical sessions on tuning of the ultrasound machine and UTNF. The hands-on sessions were carried out in human models (five healthy newborns with previous authorization of those responsible), aiming at the recognition of the main brain structures of newborns. The UTNF was performed in the anterior fontanelle with the individuals in dorsal decubitus, through images obtained in the coronal and longitudinal planes. Finally, three clinical cases were presented on hydrocephalus, peri-ventricular hemorrhage and a normal case, for a normal, abnormal or doubtful examination.

The cognitive evaluation of the theoretical subjects (total of 10 points) by students increased from 3.9 ± 1.3 (before) to 8.8 ± 1.01 points after the training ($p < 0.05$) and by pediatricians increased from 5.0 ± 2.0 (before) to 8.9 ± 1.0 points after the training ($p < 0.05$). An excellent result was observed in OSCE evaluation (9 theoretical-practical questions) with performance superior to 90% in 7 of the 9 questions (and 8 of the 9 by pediatricians). The score 5 on Likert Scale ("totally agree") was obtained in 97% by students and pediatricians for the sentence "The use of ultrasonography as well as the transfontanellar study should be included in undergraduate medical education"; in 96.7% (and 97% by pediatricians) for the sentence "After the course on transfontanellar ultrasonography the student added knowledge and believes he or she has more capacity to evaluate the cerebral part of a newborn"; and in 86.6% (and 80.0 % by pediatricians) for the sentence "Practical theoretical training using ultrasound allows the identification of cerebral structures". The ability to identify the completely normal exam was the situation that raised the highest index of answers with doubt by undergraduated students (60%) and pediatricians (10%).

These results demonstrate that medical students and pediatricians have the ability, after performing a short course, to adjust the ultrasound correctly to determine the main anatomical structures. The ability to rule out a normal UTNF was the parameter that students and pediatricians found most difficult to answer. The satisfaction assessment demonstrates that short theoretical-practical courses are well received.

Marcus Gomes Bastos

Teaching medical students ultrasound to assess intra-abdominal free fluid : comparison with physical examination.

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Intra-abdominal free fluid (IAFF) describes an accumulation of fluid in the peritoneal cavity. It has different etiology, but always constitutes an important clinical sign. In this study, the authors interrogate whether ultrasound (US) augments medical students ability in identifying IAFF.

Twelve medical students were subjected to a multiple choice test before and after to receiving a four hours of theoretical and hands-on sessions about physical examination (PE) and abdominal ultrasound in the diagnosis of IAFF. The hands-on sessions were done in human models (one medical student and a CAPD patient with two litter of peritoneal dialysis solution in his cavity) to document the absence or presence of IAFF, respectively. The abdominal ultrasound were done at upper right quadrant (RUQ), left upper quadrant (LUQ) and pelvic cavity (PC) in supine position. For the assessment of IAFF, three other CAPD patients with no liquid or one litter or 2 litters of peritoneal solution were used, with infusion controlled by a specialized nurse.

The cognitive assessment (total of 15 points) before and after the theoretical and hands-on training increased from 6.83±3.07 to 11.91±1.31 points ($p < 0.05$). It was noticed by one of the researchers (GC) that IAFF was detected by the US even in the patient with drained peritoneal cavity. The performance of the students using US was superior to their PE mainly when imaging the RUQ associated with LUQ and/or PC ($p < 0.05$). When the three situations of liquid in the peritoneal cavity (“empty”, one litter and 2 litters) are analyzed, the IAFF was misdiagnosed as negative or dubious using US in 44%, mainly due to the negative findings in the PC (88%). The students were able to detect IAFF in all patients in whom the assessment were negative by PE.

These results demonstrate that medical students’ ability to diagnose IAFF using abdominal US is superior when compared to PE only. The PC is the region where the student found more difficulties in identifying IAFF by US.

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Using a flipped classroom model to introduce cardiac ultrasound to pre-clerkship medical students

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Institution: The University of Ottawa Faculty of Medicine “The integration of point-of-care ultrasonography (POCUS) in pre-clerkship medical education is currently popular and based on the notion that POCUS may improve diagnostic and procedural skills in medical students. However, empirical evidence demonstrating that POCUS can enhance clinical skills in pre-clerkship students has been lacking. Currently, the University of Ottawa does not have a formal ultrasound curriculum. We sought to evaluate anatomical sonographic knowledge and ultrasound generation capabilities associated with the implementation of a 3-hour echocardiography training camp led by 2 emergency physicians and using a flipped classroom design. Furthermore, student perception around POCUS was explored.

Pre-clerkship students from the University of Ottawa (n = 32) we’re recruited to participate. A flipped classroom model was adopted, providing students with a cardiac ultrasound manual before the workshop so as to maximize scanning times (2 hours of reading). A pretest Likert design was used to assess student perception of the ultrasound tool. Similarly, a pretest/posttest model was used to assess sonographic anatomical identification. In addition, a subsequent Objective Structured Clinical Examination (OSCE) test was done 3 weeks after the hands-on session, in order to evaluate image generation (four cardiac views: parasternal long, parasternal short, subxiphoid and apical four chamber), understanding of knobology and structural labeling.

Each cardiac view was ascertained using a detailed grid outlining specific sonographic structures (septum, valves, etc.) that had to be visualized in order to have a successful scan. A simulated patient was scanned by an emergency physician ahead of time in order to establish the gold standard for all four cardiac views.

The perception pretest revealed that 100% of students agreed or completely agreed that the ultrasound tool would enrich their learning towards a diversity of modalities (anatomy, physiology, radiology). Furthermore, 92.5 % of students agreed that ultrasound skills will enhance their clinical abilities in clerkship. For the sonographic anatomy, there was a statistically significant increase ($p < .001$) between pretest (average = 12.12) and posttest (average = 18.85) on the paired sample t-test. The OSCE, which also ascertained knowledge retention, found that 81 % of students were able to perfectly generate all four cardiac views, 6% were able to obtain three views, 10% obtained two views and 3% successfully generated a single view. The most challenging scan to generate perfectly was the apical four chamber view.

The positive outcomes stemming from this study reinforces the notion that formal curricular integration of POCUS at the pre-clerkship level has tangible benefits for medical students. Furthermore, the study showed that cardiac bedside ultrasound skills can be effectively and succinctly taught using a flipped classroom model.

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Perceptions of the Initial: Integration of Ultrasound into the Curriculum of First-Year Medical Students.

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Early incorporation of ultrasound into medical school curricula is in transition. Ultrasound education ranges from rare trial-basis sessions to regular whole class curriculum sessions. Opinions about ultrasound are generally positive, but can vary based on students' ultrasound experience. We sought to assess the opinions of the initial class of first-year medical students to receive an ultrasound curriculum after one semester. Surveys were sent out to students after their first five months of ultrasound curriculum. Questions were answered using a Likert scale from 1-5. Data was analyzed using descriptive statistics. 69 students responded.

Students overall responded positively and offered helpful suggestions for optimizing the curriculum. 78% of respondents felt that ultrasound was a beneficial addition to their medical school curriculum. 84% of respondents felt that ultrasound should be part of their clinical skills and medical decision making curriculum specifically. 57% of students felt more hands on time would enhance the ultrasound curriculum and identified this as the primary problem with the curriculum. Several students commented that they wanted more dedicated time for ultrasound learning and more access to machines.

Students in the first year of a newly introduced integrated ultrasound curriculum overall felt ultrasound should be a part of their clinical skills. The majority of students feel the ultrasound curriculum is beneficial to their medical curriculum. They also felt that increased access to machines and having more dedicated ultrasound time would enhance the curriculum.

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A Critical Comparison of Sonographic Metrics of Jugular Venous Pressure

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Accurate assessment of Volume Status (VS) is a critical component of managing Acute Heart Failure (AHF) and End Stage Renal Disease (ESRD) patients. Collapsibility of the Inferior Vena Cava (IVC-CI) is a popular sonographic metric of intravascular volume, but can be challenging for students and is not feasible for certain patients. Ultrasound of the internal jugular vein (JUS) can be done for patients with a wide range of body habitus, and has been previously shown to be easier for medical students to learn. A number of JUS metrics for estimating jugular venous pressure have been proposed, but there is no consensus as to which metric has the most clinical utility. Here we present a preliminary analysis of a larger study which aims to compare the relative abilities of the four most cited JUS metrics to predict Volume Overload (VO). To our knowledge, this is the first such study in a non-critically ill population.

AHF and ESRD patients admitted with suspicion of VO underwent JUS using a portable ultrasound device. The cross-sectional areas (CSA) of the Internal Jugular vein (IJ) and Common Carotid Artery (CCA) were recorded along with the Anterior-Posterior (AP) and lateral diameters of the IJ on both ends of the respiratory cycle. These measurements were then used to calculate four JUS metrics described in the literature: Jugular Aspect Ratio (IJ-AR), the IJ to CCA Ratio (IJ/CCA), and two IJ Collapsibility Indices, IJ-CI (AP) and IJ-CI (CSA). Retrospective chart review was done to see if one of the treating nephrologists, cardiologists, or hospitalists had diagnosed the patient with VO within 24 hours of the scan. Receiver Operator Characteristic (ROC) curves were calculated using the attending physician's VS impression as a gold standard. Youden's index was calculated for the JUS metric with the highest area under the ROC curve to propose a clinically useful cutoff that maximizes sensitivity/specificity for predicting VO.

38 patients admitted with ESRD (n=13) or AHF (n=25) underwent JUS, with 32 having notes that stated the attending physician's impression of VS; a sub-cohort of 23 also had IVC scans. The area under the ROC curve (AUC) for the IJ/CCA ratio was 0.51 [95% CI, 0.33-0.69], for IJ-CI (AP) 0.58 [0.37-0.75], for IJ-CI (CSA) 0.51 [0.33-0.69], and the highest AUC was IJ-AR at 0.67 [0.48-0.83]. An independent analysis of IVC-CI found the AUC to be 0.59 [0.36-0.79]. The optimum cutoff for IJ-AR was 0.81 [sensitivity 38%, specificity 100%].

The size of and degree of overlap between confidence intervals made post-hoc significance testing of the ROC curves prohibitive -this is likely secondary to a limited sample size. However, comparison of the AUCs for each JUS metric suggest that JUS Aspect Ratio is the most predictive of VO. We further propose that a IJ-AR >0.8 may have utility for ruling-in volume overload in ESRD and AHF patients.

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Ultrasound in Medical Education: Can Students Teach Themselves?

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As the uses of point-of-care ultrasound (POCUS) have expanded over the last few decades and more specialties have begun to use POCUS, it has become apparent that ultrasound is a skill that must be taught while learners are still in medical school. Studies have shown that medical students benefit by learning POCUS even in their preclinical years. POCUS helps students to better understand anatomy and physiology, and what is more, it is something that they want to learn. However, as medical schools are limited by the amount of classroom time students are allowed to have, schools are also often limited by the number and availability of qualified instructors and by the expense of ultrasound machines. One solution to this is to have students do some of the basic learning through self-directed ultrasound teaching modules using an ultrasound simulator. Sonosim is one such simulator. This study aims to evaluate if the Sonosim, through self-directed learning modules, can teach medical students basic cardiac ultrasound anatomy and physiology. Subjects using Sonosim will be compared with subjects receiving traditional live ultrasound instruction. We also want to assess the students' overall satisfaction with each of the teaching techniques.

Over a one-year period, two ultrasound teaching sessions were held with year 1 and 2 medical students who volunteered to participate in the study. Each participant took a pre-test and then they were split into groups. The simulator group was given a set of cardiac teaching modules on the Sonosim to complete and the traditional teaching group was given a 10 minute lecture followed by hands-on instruction with live models. Each participant was then given a post-test with different questions but covering the same content as the pre-test and a survey on their experience. Each participant had the option of using the other method of teaching after the post-test was completed.

Twenty-one students participated, 12 in a traditional teaching group and 9 in a simulator group. Both groups increased their post-test scores (average increases of 5.2% in traditional teaching group and 10.4% in simulator group), without a significant difference between the groups ($p=0.437$). There was no statistically significant difference between groups in how effective or enjoyable the session was, or in opinions of how much the lessons improved anatomy or physiology. Of the students who tried both methods, 86% preferred the traditional methods more.

Self-guided learning with simulators and traditional faculty-led lectures are both effective for teaching basic cardiac anatomy and physiology via ultrasound. However, students seem to prefer learning with faculty if given the opportunity. Given the cost difference and the portability of some ultrasound simulators, it may be beneficial for medical schools to use simulator-based learning as an adjunct to ultrasound teaching during the preclinical years.

Michael Hofer

Ultrasound FOMO: Medical Students' Opinions On The Lack of Ultrasound Curriculum

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INTRODUCTION:
The incorporation of point of care ultrasound into medical school curricula is becoming more common. Despite this, there are still many students who do not have the opportunity to learn ultrasound in their curriculum. In our study we sought to assess the opinions of these students not yet included in ultrasound curriculum integration.

METHODS:
Rising third year medical students in a medical school implementing a new ultrasound curriculum for more junior classes were surveyed. Questioned were answered with a mixture of multiple choice and Likert scale rating from 1-5. The final question was open ended to allow for additional comments. Data was analyzed using descriptive statistics.

RESULTS:
Only 34% of students were aware of the existence of medical schools who incorporated ultrasound into their curriculums. However the majority of students felt students learning ultrasound would have been beneficial to their education (96%). 92% of students would have liked to learn ultrasound during the first two years of medical school and 100% would like to learn US in upcoming clinical curriculums. When asked if they wished that ultrasound had been more included in their medical education, 68% responded positively. Student felt the areas of their education that would have benefitted included anatomy (77%), physical exam skills (73%), and for some Step I (23%).

Conclusion:
Many medical students without ultrasound in their curriculum aren't fully aware of the landscape of ultrasound in medical education. However they still believe learning ultrasound would benefit their education and that it is a clinically valuable skill. Overall they wish they had more ultrasound in their past education and would like more in the future education. Students without ultrasound curriculums desire ultrasound training and would respond positively to its introduction.

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Using Three-dimensional Printed Heart Models to Supplement Cardiac Ultrasound Training for Undergraduate Medical Students

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We have found that undergraduate medical students struggle with visualizing dynamic aspects of cardiac anatomy and physiology when learning ultrasound. Cardiac imaging can be particularly difficult with respect to understanding 1) the heart's relationship to surface anatomy for proper probe placement, and 2) the orientation of the heart in the thorax and its correlation to ultrasound images of the heart. Three-dimensional (3D) printing is an emerging technology which has been used to produce accurate anatomical models. However, this powerful technology has not as yet been evaluated as an adjunct in teaching first-year undergraduate medical students integrated Point of Care Ultrasound (POCUS). Accordingly, the goal of this study was to determine if 3D heart models are effective to aid students in acquiring and interpreting normal cardiac images obtained using B-mode ultrasound.

3D cross-sectioned models depicting both halves of a human heart cut along the parasternal long axis (PLAX) plane were created using computed tomography (CT) DICOM data from a normal adult male patient. This data set was processed to develop a solid model, and converted to a stereolithographic file format which was used to generate the 3D print. The resulting cross-sectioned heart models were made available to each group of first-year medical students (total n=196) completing a cardiac POCUS activity in the Structure and Function of Major Organ Systems block at Texas Tech University Health Sciences Center School of Medicine. As part of this cardiac ultrasound imaging activity using standardized patients, each student had to acquire and submit a PLAX image obtained during the session for a grade.

The in-house printing for both halves of our 3D cardiac models was only $64. This is considerably less expensive than commercially available models currently on the market. The post-evaluations indicated that the medical student found the 3D sectioned PLAX heart models to be extremely useful for orienting themselves during cardiac ultrasound training.

Experiential learning has been linked to improved skill development, with one benefit being better retention of clinical skills education. Our experience incorporating 3D printed heart models in medical anatomy and physiology education, provides evidence supporting 3D printed cardiac models help novice sonographers better understand relevant surface and cardiac anatomy. This translates into helping them achieve proper probe placement, as well as helping them to appreciate the orientation of the heart in the body, and thus aids them in rapidly becoming more proficient in obtaining suitable ultrasound images. Students recommended that similar models depicting various regions obtained during short axis imaging be developed and incorporated into the POCUS sessions. Accordingly, in-house printing of 3D cardiac models is a cost-effective approach to facilitate development of clinical skills in first-year medical students.

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Ultrasound in Clinical Medicine, Administration, Research, and Education: An Update

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The Ohio State University (OSU) has created multiple programs to promote student education and involvement with ultrasound including the development of extracurricular educational tracks for all levels of learners and the creation of the Communities of Practice (COP) model which fosters mentorship and ultrasound education within individual medical specialties. The Ultrasound in Clinical Medicine, Administration, Research, and Education Pilot Program (UCARE) is the most recent innovation at OSU which aims to identify future leaders in ultrasound and to enhance student involvement in each of these domains of academia as they relate to ultrasound.

Over the course of two years, first year medical students who applied to the Beginner Ultrasound course were asked if they wanted more opportunity for leadership and research within ultrasound. Applications were evaluated to select motivated students to participate. Selected students explored clinical medicine through involvement with specialty-specific COPs as well as participated in advanced scanning shifts with ultrasound faculty. Administrative and research opportunities in the form of research internships were also established. Educational opportunities were provided for students to participate in the different domains of UCARE thorough ultrasound-related activities spanning the academic year. At the end of the program students were asked to complete a retrospective pre-then-post survey to assess learner's self-reported changes in knowledge of academic medicine. The survey used a 5-point Likert Scale where a score of 1 represented "strongly disagree", and 5 represented "strongly agree." A total of 46 students participated in the program over two years with 21 completing the post-academic year survey. Of those who responded, 409 hours of ultrasound related activities were completed. Prior to UCARE participation students reported on average 3.24 and 3.81 when asked about understanding of academic medicine and interest in pursuing a career in academic medicine. After program participation, students reported a slight increase in each category to 3.57 and 4.1 respectively. Students reported an average of 3.81 when asked if they had learned about academic medicine through participation in the program. Finally, there was no appreciable increase or decrease in self-reported leadership skills with a Likert score of 3.10 This program provides students with opportunities in clinical medicine, administration, research, and education relating to ultrasound. Based on two years of data from participants, the UCARE program provides students a pathway to explore academic medicine relating to the practice of ultrasound.

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OB/GYN Ultrasound Community of Practice: A Novel Method to Increase Medical Student and Faculty Exposure to Ultrasound

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We define an Ultrasound Community of Practice (COP) as a team of students and physicians dedicated to advancing point of care ultrasound within their specialty. Currently there is a paucity of resources for ultrasound education and coordination of projects specifically as they relate to the field of Obstetrics and Gynecology. Due to these issues, a group of students with a faculty mentor founded the OB/GYN COP at The Ohio State University College of Medicine.

We hypothesize that this program will allow increased opportunities for both students and staff to pursue education and research projects within OB/GYN ultrasound.

Milestones for COP progression have previously been developed at Ohio State and were used to establish early goals and guidelines for the OB/GYN COP. After an initial meeting, we sought to focus on educational, administrative, and research platforms. For education, we aim to equip medical students and practitioners with the pelvic ultrasound skills and knowledge to provide future patients with comprehensive care through hands on didactic and pathology sessions. To accomplish this, medical students and faculty were recruited through a school wide electronic survey and invited to participate in a pilot didactic session for graduating seniors entering OB/GYN residencies. Regarding research, we have student led investigations in place and plan to design a monthly pelvic ultrasound journal club. Our administrative goals are to establish a point of contact between student activities and staff at OSU.

Preliminary results of the survey and pilot didactic session showed significant interest in OB/GYN Ultrasound. We have partnered with the OB/GYN Interest Group to form a partnership regarding ultrasound education and with OSU College of Medicine curriculum coordinators to incorporate pelvic ultrasound into the Endocrinology and Reproductive preclinical block as well as the Ob/Gyn third-year Clinical Clerkship rotation. Additionally, we now have an Ob/Gyn faculty advisor and have worked with the Ohio State University Ohio Union to officially recognize our organization on campus. Lastly, members of our leadership team have attended national ultrasound conferences for both education and research.

We anticipate that employing the COP concept within OB/GYN ultrasound will allow efficient expansion of ultrasound resources to better educate students and staff and ultimately improve academic and patient outcomes. Future goals and directions include membership expansion, further legitimization of our organization through The Ohio State University to secure support for the development of our program, and increase collaboration between students, faculty and technology representatives in the field of Ob/Gyn.

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Ultrasound Competency Training During Global Health Rotation Using Distance Learning Technology

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Statement of Problem/Question: While historically global health efforts have emphasized disaster response, infectious outbreaks, and preventive care, the projected doubling of cancer, increase in abdominal visceral diseases, and cardiovascular deaths in developing countries over the next decade demonstrates the need for the use of ultrasound as a non-invasive screening and diagnostic tool in low-income, low-resource countries.

Objectives of the Project/Intervention: The advent of increased computing power has allowed tele-medicine to make strides in being able to deliver efficient and timely healthcare to people in developing economies. The trickle-down economics for advanced portable imaging technology is transforming medical sonography into an effective spearhead of health care solution for resource-deprived countries. While historically global health efforts have emphasized disaster response, infectious outbreaks, and preventive care, the projected doubling of cancer, increase in abdominal visceral diseases, and cardiovascular deaths in developing countries over the next decade demonstrates the need for the use of ultrasound as a non-invasive screening and diagnostic tool in low-income, low-resource countries.

Description of Project/Intervention: Our team assessed the logistics and feasibility of instructing 1st year medical students on basic positioning and image acquisition during cardio-abdominal sonography using distance learning technologies during a global health elective rotation at a primary care clinic in Chincha, Peru.

Findings to Date/Evaluate Results to Date: The hypothesis that using cardio-abdominal sonography in developing economies to provide care for problems such as cancer, abdominal visceral diseases, and cardiovascular issues has been proven feasible. Though statistical data is not available, factors such as lag time, clarity of images, and international online communication between health care professionals in the US and first year medical students in rural Peru were taken into consideration when determining if using ultrasound is a practical option to utilize in developing countries. First year medical students attended the annual PHOP global health initiative in Chincha, Peru to test the feasibility of this project, and found that factors such as lag time and clarity of images were not issues when using the portable medical technology. This along with the fact that international online was easily accessible and attainable, led to the conclusion that the utilization of cardio-abdominal sonography is both feasible and effective in developing economies.

Key Lessons Learned: A lack of lag time, clarity of images, and accessibility of international online communication has led to the conclusion that the utilization of cardio-abdominal sonography is both feasible and effective in developing economies.

Unanswered Question: So far, we don’t have statistical data that are quantifiable, but with continual tests in the future, we will be able to get numbers regarding the ability of sustainability and continual use of cardio-abdominal sonography in developing countries.

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Thyroid Ultrasound in Medical Education at The Ohio State University

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The use of ultrasonography to aid physicians in making clinical diagnoses and performing medical procedures has become a growing practice. The Ohio State University College of Medicine (OSUCOM) has incorporated ultrasound experiences in its curriculum to supplement the students' education of multiple organ systems. Thyroid ultrasound sessions have been introduced at OSUCOM for learning anatomy, physiology, and pathophysiology of the thyroid gland, including nodule diagnostic workup. Preliminary evaluations of these sessions have shown to be popular among students. However, there is a need for research studies assessing the efficacy of these educational experiences. This project aims to evaluate the efficacy of thyroid ultrasound sessions as an educational tool in the first-year medical school curriculum at OSUCOM.

Thyroid ultrasound sessions were offered as a required portion of the curriculum for first-year medical students during the 2019-20 academic year. Participation in the research project was optional though, with informed consent provided prior to the sessions following IRB protocol. Sessions started with a basic introduction to ultrasound, thyroid anatomy imaging, and thyroid nodule workup review. Students divided into small groups to learn and practice thyroid ultrasound techniques on both healthy subjects and patients with thyroid pathology. These groups were led by experienced proctors. A thyroid ultrasound-guided biopsy was demonstrated using a thyroid phantom made with chicken breast and olives. The sessions ended with an interactive discussion about thyroid pathophysiology and workup. To quantify the efficacy of these sessions, the students were asked to complete online pretests prior to and posttests after the sessions. The tests consisted of the same items, with items and answers appearing in a random sequence in the posttest. The average performance for the students who consented and took part in the pre and posttest were calculated along with the standard deviation. A paired t-test was calculated along with a Cohen's D effect size to estimate the size of the difference between pre and posttest scores.

Out of the 209 students who participated in the ultrasound sessions, 144 (68.9%) consented to participate in the research project. Of these students, 114 completed the pre and posttest (79.2%). Test data from the 114 students showed a mean score of 57.5% (st. dev 14.6%) in the pretest and 73.9% (st. dev 17.4%) in the posttest, with a difference of 16.5% (st. dev 19.6%) between both tests, with $t= 9.001$; $df=113$; $p < .001$; $es=1.027$.

Interactive thyroid ultrasound sessions incorporated in the OSUCOM first-year curriculum are an effective tool in improving students' knowledge of thyroid anatomy, pathophysiology, and diagnostic workup

Jeremy Carter DO, Stephen Alerhand MD, Ilya Ostrovsky MD

Medical Students Consider a Formal Pre-Clinical Ultrasound Curriculum to be Beneficial For Their Step 1 Exam Learning

Author(s): Jeremy Carter DO, Stephen Alerhand MD, Ilya Ostrovsky MD, Jeremy Carter DO

Institution: Rutgers New Jersey Medical School

The association of the USMLE Step 1 score with a successful Residency Match has been well established.1,2 Medical school administrators may thus design their learning objectives toward helping students achieve high scores. The use of formal ultrasound curricula in undergraduate medical education has greatly expanded over the last decade and been well-received by students.3 Given the extensive amount of learning material to cover in the pre-clinical years, designers of medical school curricula may be unsure how much ultrasound to incorporate into this limited time. Moreover, it is unclear how students preparing for the Step 1 exam may feel about additional non-core learning. Studies have also shown that such ultrasound curricula may improve assessments on the physical exam and anatomy, but these assessments have taken various formats.3, 4 We sought to assess students' perceptions of a novel ultrasound curriculum towards their Step 1 learning, as well as evaluate outcomes in the form of their cadaver-based practical anatomy assessment.

Over the MS1-MS2 academic years, a pre-clinical ultrasound curriculum was developed and implemented at the Rutgers New Jersey Medical School by Emergency Medicine faculty with advanced ultrasound training. Four didactic and hands-on learning modules were weaved into the existing system-based curriculum (Cardiac, Pulmonary, Renal, Abdomen). Each student in the class was required to participate in one of the modules. Pre- and post-module surveys containing statements scored on a 1-5 point Likert scale were distributed, and data analysis was performed. To further assess outcomes, cadaver-based anatomy practical exam scores were compared for each organ system between those students who did and who did not participate in that respective ultrasound module.

180 students participated in one of the ultrasound modules. Across the four modules, there was a statistically significant increase in Likert scale score after the module compared with before for the statement "I would like ultrasound to be integrated into the medical curriculum" (4.33 [Symbol] 0.58 vs 4.62 [Symbol] 0.50, p=0.0104). There was also a statistically significant increase in Likert scale score after the module compared with before for the statement "The session content will be/was relevant to my preparation for Step 1" (3.71 [Symbol] 0.78 vs. 4.57 [Symbol] 0650, $p<0.0001$). At the time of abstract submission, practical anatomy exam scores for each of the four organ systems were still being tabulated and collected for analysis.

Pre-clinical medical students considered an integrative system-based ultrasound curriculum to be beneficial towards their Step 1 learning. This information may be interesting to medical school administrators designing pre-clinical curricula in the setting of students' focus on Step 1 and limited time constraints.

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Advancing an Ultrasound Community of Practice in Otolaryngology at The Ohio State University

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The idea of Communities of Practice (COP) stems from the fact that this community should interact regularly to engage in shared learning experiences. An ultrasound COP consists of physicians, fellows, residents, and medical students dedicated to promoting sonography within their specialty. Two years ago, a faculty mentor at The Ohio University College of Medicine (OSUCOM) with a shared interest in otolaryngology and ultrasound founded the Otolaryngology—Head and Neck Surgery Ultrasound COP. Since that time, we have been working to organize resources, establish a curriculum, and advance otolaryngology point of care ultrasound (POCUS).

Communities of Practice milestones developed at OSUCOM measure four main areas of advancement: 1) clinical patient care, 2) education, 3) research, and 4) administration. For clinical patient care, we will work within the American Academy of Otolaryngology – Head and Neck Surgery (AAO-HNS) and the American Institute of Ultrasound in Medicine (AIUM) collaboration to establish credentialing for residents, fellows, and faculty. Regarding education, we will continue to hold ultrasound scanning sessions led by faculty teaching both residents and students. For research, we will hold regularly scheduled journal clubs with a resident leading discussion on current research. We will also create an otolaryngology ultrasound database to identify literature gaps to guide research projects within the COP. Progress will be evaluated via milestones graded from levels 1-5.

We attempt to quantify our COP by grading milestones on a Likert scale in four categories: 1 = contemplation, 2 = organization, 3 = output, 4 = sophistication, and 5 = aspiration; total = 20. We currently grade our clinical patient care at a 1 for having a written scope of practice, but no formalized protocols. Education is rated a 3 because we have developed multimedia education materials for use in hands-on sessions. Research is rated a 1, as we have cataloged the last 5 years of ultrasound research, but have not started regular journal clubs. Finally, we rate administration a 2 for having defined leadership roles and responsibilities, but not reporting regularly to the OSUCOM ultrasound interest group board. In sum, our COP milestone grade is a 7/20.

As a relatively new COP, we have significant room for development. We are making significant strides to make the Otolaryngology—Head and Neck Surgery Ultrasound COP a well-established entity with resources that can sustain annual leadership turnover. We anticipate that using this COP will improve academic and patient outcomes in the field of otolaryngology. Further data collection will analyze COP progression and look for improvements in ultrasound use throughout this community from medical students to physicians.

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U.S. Military Medic eFAST Performance with a Novel Portable Ultrasound Device: A Prospective, Randomized, Crossover Study

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Prompt battlefield recognition and differentiation of traumatic thoracoabdominal injuries remains challenging due to the resource limitations common to these often-austere environments. The Extended Focused Assessment with Sonography for Trauma (EFAST) has been proven to be an effective screening tool in the evaluation of thoracoabdominal trauma, and the miniaturization of ultrasound (US) allows it to be increasingly employed at the point of care by forward-deployed pre-hospital clinicians. The purpose of this study was to evaluate U.S. Military medic EFAST exam performance using a novel US device, produced under a DoD funded grant and designed specifically for U.S. Military frontline medics, compared to a commercially available portable US device.

This was a prospective, randomized, crossover study completed at a single site U.S. military installation. U.S. Army medics with no previous US experience were recruited as participants in the study. Participants completed a one-hour didactic lecture on performance of the EFAST exam, and were then randomized to undergo two hours of hands-on training and with either novel or conventional US device with both live human and phantom torso models capable of replicating both normal and abnormal findings. Participants were then tested on the respective US device, and then completed the same hands-on training and testing with the other US device. The primary outcome measure was total exam time. Secondary outcome measures included assessment for exam technical adequacy using criteria modified from a validated task-specific checklist (TSC) for the FAST exam, and diagnostic accuracy (normal/abnormal) with a simulated EFAST. Participants then scored each US device using a 5-point Likert scale for ease of use along with other features of the US device.

40 participants completed a total of 160 EFAST exams on both live human and US phantom models-80 scans with the novel device and 80 with the conventional device. Mean exam times utilizing the novel versus conventional devices were 391 seconds [95% CI, 364 - 417] and 352 seconds [95% CI 325-379], respectively (p = 0.71). Crossover mixed effect analysis did demonstrate a period effect, with mean time of period one of 416 seconds and a mean time of period two of 326 seconds (p=0.00). There were no statistically significant differences in exam technical adequacy (Novel = 75.0%, Conventional = 72.5% [p = .28]), diagnostic accuracy (Novel = 91.5%, Conventional = 89.2% [p = .57]), or mean OSCE scores (Novel = 21.1, Conventional = 0.6 [p = .32]).

US device design did not significantly impact EFAST exam performance. Demonstration of a period effect suggests amount of training and exam repetition is more likely to influence exam performance. Medics can be trained to complete POCUS for EFAST exams with promising diagnostic accuracy, however further training is needed to improve exam efficiency and technical adequacy. Future studies of POCUS by military medics should focus on learning gaps and US skill retention.

Cynthia C. Bennett, MD

Illustrative Anatomy (Anatomical Body Painting + Ultrasound) as a Teaching Tool in Anatomy Education

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Anatomy education presents a challenge to health care education programs because student contact time is limited and clinical relevance is a necessity. Since the early 2000s, several countries' programs have turned to anatomic body painting (ABP) as a teaching tool. Studies find ABP to be an effective teaching tool that is well-accepted by students and proves to be both fun and educational (1,2,3). The presenter has used ABP at their institution since 2013 as an adjunct to human donor dissection, finding it to be inexpensive, easy to facilitate, and effective in teaching anatomic structures and correlations (5,6).

With the increasing importance of ultrasound (US) in the clinical setting, health care programs have begun integrating US into anatomy courses to provide a dynamic, clinically relevant depiction of anatomy (7). The presenter is now utilizing US during ABP sessions in a process called Illustrative Anatomy, with the hypothesis that ultrasound will further enhance the educational value of the session.

STUDY OBJECTIVES:
1. Examine the efficacy and acceptability of Illustrative Anatomy as a teaching tool.
2. Identify specific ways that Illustrative Anatomy facilitates the learning process.
3. This presentation also will give guidelines for conducting a successful Illustrative Anatomy session at one's own institution.

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Sessions are performed with a minimum 2-hour window from topic assignment to presentation. Students have previously been familiarized with both US and the process of ABP (details on this orientation will be given to session participants). Students are divided into small groups of 4 or fewer involving at least 1 canvas, 1 painter and 1 researcher. Topics are assigned with emphasis on clinical correlation. Ultrasound is readily available with one device per 2-3 student groups and one US preceptor per 3-4 groups. Ultrasound is utilized both during the painting process to identify the structures being painted, and within topic presentations to illustrate structures underlying the body paint of participants. Topic presentations are an important part of the process, and students are not graded on their work.

Exit interviews and participant surveys indicate many educational advantages to Illustrative Anatomy. Anatomical body painting allows the addition of movement to structures that are static in the dissection lab, which helps many students in comprehension of musculoskeletal physiology. Visualization of structures in a moving form also improves understanding of clinical tests and physical examination findings. Ultrasound provides visual confirmation of the location of structures important to the region being painted and presented. It can reveal whether students have correctly located bony landmarks, accurately detected soft-tissue structures, and correctly determined the direction of muscle fibers. It also may provide reassurance to those with artistic or clinical skills discomfort while they perform ABP. Incorporating the familiar skill of palpation and the visual cues of painting may help students understand more about what they are seeing in US images, making their future learning curve for clinical ultrasound less steep.

Illustrative Anatomy may enhance understanding of anatomical relationships and physical examination findings, compared to both the traditional gross-dissection experience and the use of ultrasound alone. The method is well-accepted by students as fun, engaging and helpful in understanding dynamic anatomical relationships.

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PLAX-sectioned human plastinated heart models improve cardiac ultrasound training in novice learners

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The objective of this study was to evaluate the use of 3D sectioned human heart models as an aide for learning how to perform basic cardiac ultrasound (US) scanning and interpretation of normal cardiac anatomy seen in B-mode ultrasound images.

Plastinated human hearts were sectioned along two standard US views – parasternal long axis (PLAX) and parasternal short axis (PSAX) to create 3D sectioned heart models. Graduate students (N=25) enrolled in graduate gross anatomy which incorporates hands-on US sessions, were recruited during scheduled cardiac US sessions. All US scanning groups performed cardiac US scanning for 50 minutes with paper instructions and cardiac US view handouts. A paper questionnaire was then offered to all students which included eight multiple-choice questions (MCQs) related to cardiac US scanning and seven items evaluating self-reported confidence related to heart position, PLAX and PSAX probe orientation, as well as recall and identification of anatomical structures in both scanning views (1=Strongly Disagree, 5=Strongly Agree). Students were the given PLAX sectioned heart models, the same handouts, and repeat instructions to scan in the PLAX and PSAX view. After 20 minutes, another paper questionnaire was offered to students. This questionnaire included eight similar cardiac US MCQs, two items evaluating usefulness (1=not useful, 5=very useful), 7 items rating agreement with statements regarding sectioned heart models as aids for related to the first questionnaire items, and two items rating self-reported confidence in orienting the probe for PLAX and PSAX live scanning (1=Strongly Disagree, 5=Strongly Agree). Students were then able to use the PSAX sectioned heart models during any remaining time in the scheduled session and during open scan time which occurred after scheduled cardiac US scanning sessions were complete. Questionnaires showed participants (n=25) perceived PLAX sectioned models useful for learning PLAX US (100% agree; ratings of 4=Agree or 5=Strongly Agree) and sectioned heart models would be useful for learning PSAX (96% agreement). Mann-Whitney U test revealed significant improvement ($p<0.05$) on cardiac US MCQs after PLAX sectioned model use (mean 63.50% ±20.39% to 76.50% ±17.11%). Additionally, self-perceived confidence significantly improved (Mann-Whitney U Tests, both $p<0.05$) after using the PLAX sectioned heart models, specifically regarding ability to orient the probe into PLAX (64% to 92% agree) and PSAX (56% to 88% agree).

Participant performance on cardiac US questions and confidence regarding probe PLAX and PSAX orientation improved after using PLAX sectioned heart models. The PLAX sectioned heart models were perceived as useful aids to cardiac US training for novice learners and results suggest that PSAX sectioned models would be useful as well. Incorporating sectioned heart models into cardiac US training may improve novice confidence and cardiac scanning skills.

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A Standardized Format for the Delivery of Ultrasound Education to Undergraduate Medical Students

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With the implementation of extracurricular Ultrasound Interest Groups (USIG) undergraduate medical student access to point of care ultrasound (POCUS) education continues to improve. Concerns about hands-on ultrasound education being significantly proctor (educator) dependent are often expressed. In part this problem stems from inconsistencies in pre-scan lecture material and the structure of hands-on scanning sessions. This leads to a paucity of a single resource for students and educators to review the content of the scan in anticipation of the session. Currently, proctor guides used during hands-on scanning sessions are organized in an I AIM format. While this works well in sit-down didactic settings, it does not necessarily lend itself perfectly for 30 minute hands-on sessions. Proctors with varying levels of ultrasound experience, teaching experience and interaction with medical students freely decide how to best organize the hands-on session. At times this results in inadequate coverage of the content and inadequate student scanning time. With these concerns in mind, we aim to create a standardized framework for pre-lectures and proctor guides validated by Ultrasound Faculty. A pre-scan lecture template was created to ensure coverage of physics, anatomy and the indications, acquisition, interpretation and medical management (I AIM framework) for every scan. Existing curriculum content was adapted to the new template. A coordinating proctor guide template was also created to standardize the execution of hands-on sessions and current guides were converted to the new format. The new proctor guide organizes content in the order it is presented – with content covered during demonstration of the scan separated from content that should be discussed while students are actively scanning. Supplemental content is also included for teaching if time remains. The first portion of this content includes patient positioning, probe choice, specific instructions for image acquisition, components of an ideal image. The latter half discusses image interpretation, including discussion of indications. If time allows, management of pathology may be discussed to solidify material taught in pre-scan lectures.

The new proctor guide has been piloted at proctor training sessions and material was moved to the supplemental content section to better fit a 30 minute time allowance. Students will be asked to assess the new and old pre-lecture and proctor guide combinations. This will focus on format and delivery of the curriculum based on overall satisfaction, clarity, efficiency, and consistency using a 5-point Likert scale survey. We expect that the pre-scan materials will serve as a base of knowledge for students and proctors. We also predict the proctor guides will allow ultrasound educators of all experience levels to functionally teach standardized material with minimal preparation. The combination allows for consistent delivery of ultrasound education.

We have created a standardized framework to ensure consistent delivery of undergraduate ultrasound education. Future directions include importing the standardized proctor guides into Ohio State's POC_US app to improve accessibility to new and improved curriculum and proctor materials to programs outside of Ohio State. Further research is required.

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Not a passing fad: A review of ultrasound research at an academic medical center

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Ultrasound has evolved from a tool utilized within a few select specialties to rapidly being utilized across a wide range of medical specialties. As the technology improves, its range of practical applications will expand. Therefore, there is a demand for research to develop best practices in education and clinical use of this modality. Ultrasound research requires participation from medical students to faculty in order to sustain the technology's growth. We view The Ohio State University Medical Center (OSUCOM) as an early adopter of ultrasound, and as a leader in buffering the disruption brought about by this revolutionary technology. Therefore, we set out to analyze both the integration of ultrasound research across medical specialties (horizontal integration), as well as the integration of ultrasound research across the various stages of training of medical professionals (vertical integration).

By reviewing internal records and publicly available conference records, all ultrasound related research projects from the OSUCOM that had reached the presentation stage at a national conference from 2011-2016 were identified. To determine vertical and horizontal integration, the authors were reviewed against internal records to identify their stage in training, as well as medical specialty if applicable. Each project's publication status was also determined using the Medline database.

123 unique presentations were identified, with a combined total of 179 unique authors. 13 of these projects have been published. The breakdown of authors by stage in training is as follows: 44.7% medical students, 15.1% residents, 2.2% fellows, 27.9% faculty, and 5.6% were another medical profession. Additionally, 4.5% were involved across multiple stages in their training. 85 of the authors belonged to a particular specialty, with a total of 18 different specialties being represented. The three most common specialties were Emergency Medicine (36), Physical Medicine & Rehabilitation (10), and General Surgery (8).

"Medical students represent a majority of authors involved in ultrasound research at OSUCOM. A major driver of this finding may be the numerous organizations at the medical student level to increase ultrasound involvement, such as the Ultrasound Interest Group (USIG) and the Ultrasound Research Interest Group (USRIG). Additionally, there is a marked decline in resident and fellow participation in ultrasound research, possibly indicating their increased workload over medical students. Infrastructure needs to be built in to keep residents and fellows involved in ultrasound research, and create balanced vertical integration within the field.

This type of analysis can be used to assess the ultrasound research output at an academic institution. Ultrasound research is dispersed among numerous specialties at our institution, although emergency medicine represents a large proportion of those involved in research. The identification of ultrasound research champions across 18 specialties is promising for future growth, and is likely supported by Ultrasound Communities of Practice within many of these specialties.

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Introduction of the NALTA technique for ultrasound-guided vascular access and the assessment of procedural competency in graduating medical students

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Ultrasound-guided vascular access is a key skill taught in residency training that is used throughout physicians' careers. The Accreditation Council for Graduate Medical Education (ACGME) recognizes ultrasound-guided vascular access as a patient care milestone for residents across multiple disciplines. Additionally, the Liaison Committee on Medical Education (LCME) has identified vascular access as a graduation requirement for medical students prior to starting residency training programs. Our institution has attempted to standardize this training in undergraduate medical education by establishing a technique for ultrasound-guided vascular access using the mneumonic "NALTA:" Northstar, identifying the needle tip under the ultrasound probe; Angle, aiming the needle at 45-degrees; Leapfrog, alternating motions in advancing the probe and needle to allow continuous needle visualization of needle tip; Tenting, visualizing the needle contacting and compressing the vessel wall before venipuncture; and Aspiration, drawing negative pressure on the needle to confirm needle location. We then assessed its effectiveness in medical student ultrasound-guided vascular access education.

We taught medical students at The Ohio State University College of Medicine in three dedicated sessions throughout their third-year the NALTA technique for vascular access. Medical student retention of procedural competency was assessed on a Blue Phantom Gel and Linear Probe on the first day of their Emergency Medicine rotation in their fourth year using a standardized evaluation form completed by OSU Emergency Medicine Faculty. Students were scored as binary pass/fail for each competency including probe choice, probe orientation, vessel visualization, on each step of NALTA, and overall entrustment of procedural competency.

A total of 48 students participated in the study. 87.5% selected the correct probe (linear), 79.2% situated the leading edge to the operator's left, 97.9% visualized the vessel in the short axis, 77.1% performed correct Northstar, 81.3% performed the correct Angulation, 64.6% performed safe Leapfrog technique, and 97.9% Aspirated the syringe to confirm venipuncture. Overall, 34 of the 48 students (70.8%) were entrusted to perform this procedure under direct supervision while 14 of the students (29.2%) were not trusted to perform this procedure under direct supervision.

These results confirm the need for continued and increased ultrasound integration in the undergraduate medical school curriculum and widespread adoption of the NALTA technique. The NALTA technique is a reliable standardized framework for ultrasound-guided venipuncture and additional training in this method will likely increase medical student competency in similar procedures. Further data collection is warranted to identify the pitfalls of this technique and specific challenges medical students have with ultrasound procedural competency.

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Medical Students Consider a Formal Pre-Clinical Ultrasound Curriculum to be Beneficial For Their Step 1 Exam Learning

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The association of the USMLE Step 1 score with a successful Residency Match has been well established.1,2 Medical school administrators may thus design their learning objectives toward helping students achieve high scores. The use of formal ultrasound curricula in undergraduate medical education has greatly expanded over the last decade and been well-received by students.3 Given the extensive amount of learning material to cover in the pre-clinical years, designers of medical school curricula may be unsure how much ultrasound to incorporate into this limited time. Moreover, it is unclear how students preparing for the Step 1 exam may feel about additional non-core learning. Studies have also shown that such ultrasound curricula may improve assessments on the physical exam and anatomy, but these assessments have taken various formats.3, 4 We sought to assess students' perceptions of a novel ultrasound curriculum towards their Step 1 learning, as well as evaluate outcomes in the form of their cadaver-based practical anatomy assessment.

Over the MS1-MS2 academic years, a pre-clinical ultrasound curriculum was developed and implemented at the Rutgers New Jersey Medical School by Emergency Medicine faculty with advanced ultrasound training. Four didactic and hands-on learning modules were weaved into the existing system-based curriculum (Cardiac, Pulmonary, Renal, Abdomen). Each student in the class was required to participate in one of the modules. Pre- and post-module surveys containing statements scored on a 1-5 point Likert scale were distributed, and data analysis was performed. To further assess outcomes, cadaver-based anatomy practical exam scores were compared for each organ system between those students who did and who did not participate in that respective ultrasound module.

180 students participated in one of the ultrasound modules. Across the four modules, there was a statistically significant increase in Likert scale score after the module compared with before for the statement "I would like ultrasound to be integrated into the medical curriculum" (4.33 □ 0.58 vs 4.62 +/- 0.50, p=0.0104). There was also a statistically significant increase in Likert scale score after the module compared with before for the statement "The session content will be/was relevant to my preparation for Step 1" (3.71 +/- 0.78 vs. 4.57 +/- 0650, p<0.0001). At the time of abstract submission, practical anatomy exam scores for each of the four organ systems were still being tabulated and collected for analysis. Pre-clinical medical students considered an integrative system-based ultrasound curriculum to be beneficial towards their Step 1 learning. This information may be interesting to medical school administrators designing pre-clinical curricula in the setting of students' focus on Step 1 and limited time constraints.

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SHOSCE-Assessing Medical School Ultrasound Shock Competency Through a Cardiac Simulator

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Annually, more than one million ED patients present with shock, with mortality between 20% and 50%. Despite the value of a point-of-care ultrasound (POCUS) shock assessment tool, education is not universal. More medical schools are including independent low-stress learning on ultrasound simulators. Previously, students' ultrasound competency was tested by written exam, confidence scores, or healthy patient models. Simulators reproducibly assess normal and pathological ultrasound competency. Some simulated OSCEs (objective standardized clinical exams) include shock, but little is written on assessing ultrasound competency for shock pathology, despite the high frequency and mortality. We developed a cardiac simulator Shock OSCE (SHOSCE) to assess ultrasound knowledge, attitude, and skill.

All matriculating fourth-year medical students complete a 2-hour ultrasound shock lecture and didactic hands-on session, and a 20-question pre- and post-seminar knowledge exam. A survey asked 20 questions on ultrasound exposure and comfort on a 5-point Likert scale (1 = a novice requiring constant supervision, and 5 = an expert who can teach others). Advanced ultrasound trainees completed a SHOSCE on a Heartworks Trans-Thoracic Echocardiography (TTE) Simulator (Inventive Medical LTD., London, UK), (optional for all other students). The SHOSCE included one normal scan and one randomized pathology (cardiac tamponade, pulmonary embolism, LV dysfunction). Saved images were graded out of 10 points in 5 categories (chirality, location, anatomy, size, and shape), where 0 = inadequate, 1 = adequate, and 2 = exemplary. Additional interpretation and acquisition questions totaling 20 points brought the total SHOSCE score to 50 available points.

The matriculating class of 198 students has 34 advanced ultrasound students who will complete the SHOSCE. Data collection is ongoing, but early acquisition scores are 75% and 76% (n=2). Attitude and knowledge scores will be compared, with SHOSCE performance reported as a range. Heartworks should accurately stratify novice and advanced ultrasound students, with post seminar knowledge scores reporting higher than pre seminar scores, indicating a two-hour seminar improves performance and comfort. Finally, we will compare scores for three different pathologies and three different ultrasound views to adapt teaching methods to challenging pathologies and views.

The SHOSCE was developed to assess ultrasound competency, acquisition, and interpretation of normal and abnormal anatomy. Because the ubiquity of portable ultrasound technology warrants more trained operators, assessing shock patients is imperative for graduating medical students. SHOSCE is a preliminary method to assess ultrasound shock knowledge, attitude, and skill in matriculating fourth year students completing a shock ultrasound seminar. More research will determine whether this SHOSCE has validity and its relation to patient outcomes.

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DIY AI: Deep Learning Algorithm for Ultrasound Video Analyses and Classification

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Artificial intelligence (AI) is increasingly a part of daily life and offers great possibilities to enrich health care. Imaging applications of AI have been mostly developed by large, well-funded companies and currently are inaccessible to the comparatively small market of point of care ultrasound (POCUS) programs. Study Objectives: Given this absence of commercial solutions, we sought to devise and test a Do-It-Yourself deep learning algorithm to classify ultrasound (US) images to enhance the quality assurance work-flow for POCUS programs.

We created a convolutional neural network (CNN) utilizing publicly available software tools and preexisting CNN architecture. The CNN was subsequently trained using US images from 7 US exam types: pelvis, heart, lung, abdomen, musculoskeletal (MSK), ocular and central venous access from 149 publicly available POCUS videos. A total of 125,000 individual images were extracted from the videos, 80% were used for model training and 10% each for cross validation and testing, to simulate POCUS program workflow. To simulate algorithm transfer to a different POCUS program, we tested the algorithm for accuracy against a set of 160 randomly extracted US frames from US videos not previously utilized for training and which were performed on different US equipment. Three POCUS experts blindly categorized the 160 random images and results were compared to the CNN algorithm. Descriptive statistic and Krippendorff agreement correlation were then calculated.

The cross validation of the CNN approached 99% for accuracy during training. The algorithm accurately classified 98% of the test US images. In the new POCUS program simulation phase, the algorithm accurately classified 70% of 160 new images for good correlation with the ground truth, K = 0.64. The 3 blinded POCUS experts correctly classified 93, 94 and 98% of the images, respectively. There was excellent agreement among the experts with K = 0.87. Agreement between experts and algorithm was good with K = 0.74. The most common error was misclassifying MSK images for both the algorithm (40%) and POCUS experts (40.6%). The algorithm took 7 min 45 seconds to review and classify the new 160 images. The 3 expert reviewers took 27, 32 and 45 minutes to classify the images, respectively.

Our algorithm accurately classified 98% of new images related to its training pool, simulating POCUS program workflow. Performance was diminished with exam images from an unrelated image pool and US equipment, suggesting additional images and CNN training are necessary when using across different POCUS programs. In addition to improving workflow for POCUS administrators, the implications of our do-it-yourself AI for POCUS are scalable and further work to maximize the collaboration between AI and POCUS programs is warranted.

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The Simulated Shock Objective Standardized Clinical Assessment

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Point-of-care ultrasound can be used to diagnose undifferentiated shock and improve patient outcomes. The training and assessment tools to evaluate shock competency with ultrasound remain variable. Ultrasound simulators can be a modality to help assess competency in learners. The Simulated Shock Objective Standardized Clinical Exam (OSCE) was designed on the HeartWorks (Inventive Medical Ltd., London, United Kingdom) Cardiac Ultrasound Simulator Student Assessment and Review Tool (START) to address this problem.

Participants consisted of 4th year medical students completing the Advanced Medicine and Hospital Based Care – Emergency Medicine (AMHBC-EM) seminar on shock, a standard mandatory educational component in the final unit of the Lead. Serve. Inspire (LSI) medical curriculum at the Ohio State University College of Medicine (OSUCOM). Participants completed a 24-item survey that asked about their ultrasound training during medical school, how many scans they have taken from either models or patients, and their self-perceived ultrasound competency for acquiring the standard cardiac views on a five-point likert scale questionnaire.

The Simulated Shock OSCE consisted of a knowledge and simulation component. The knowledge component consisted of a 20-item, case-based knowledge assessment around the different major categories of shock related to cardiac ultrasound. The simulation component consisted of 3 shock pathology cases constructed on START. The pathologies included: Cardiac Tamponade, Global LV Dysfunction, and Hypovolemia. For each case, participants acquired 3 scans to include one of three combinations of standard cardiac views: Subxiphoid (SUX) and Inferior Vena Cava (IVC) with either Parasternal Long (PLAX) or Parasternal Short (PSAX) or Apical 4 Chamber (A4C). For each acquired scan, participants interpreted their cardiac ultrasound images with accompanying multiple-choice questions on Qualtrics.

Cardiac ultrasound images participants acquired were graded anonymously on a 0 to 5 sliding scale by the Ultrasound Division in the Department of Emergency Medicine at Ohio State Wexner Medical Center. The CLASS rubric was constructed to detail the difference between a poor image (0) and a perfect image (5), taking into consideration: “C” for chirality, “L” for location, “A” for cardiac anatomy, “S” for size and shape, and “S” for the septum.

Responses were received from 18 fourth-year medical students. 12 students (67%) attended the AMHBC-EM seminar. All 18 participants reported having at least some ultrasound training experience during medical school with an average of 2.90 ultrasound courses completed. Participants had a decent encounter with patients in shock (n=50) but very rarely did they perform an ultrasound exam (n=2.2) All participants reported having at least a beginning proficiency in acquiring the standard cardiac views. Participants averaged 71.39 % out of a 20-item Knowledge Exam (SD = 11.48). Participants averaged 50.86% out of 45-points for the image acquisition component of the Simulation Exam (SD= 24.10) Simulation provides learners a non-threatening environment to master basic ultrasound skills. Pilot data shows the Simulated Shock OSCE can be a comprehensive tool that can assess attitude, knowledge, and skill for shock ultrasound. More research needed to validate this tool among other cohorts of learners.

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The Creation and Validation of a Transesophageal Echocardiography (TEE) Objective Standardized Clinical Examination (OSCE)

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Transesophageal echocardiography (TEE) offers many benefits over transthoracic echocardiography (TTE) in cardiac resuscitation. These advantages include less time spent off the patient's chest during compressions and higher resolution imaging less confounded by visceral tissue or medical devices in the thorax. TEE, however, remains a complex skill that is highly operator dependent. Using a cardiac ultrasound simulator, an Objective Standardized Clinical Exam (OSCE) has been created to assess the relative skill, knowledge, and attitude of its participants in TEE. Our hypothesis was that operators with more ultrasound and TEE experience would achieve higher scores on the OSCE.

Anesthesiology and Cardiology residents (PGY1-PGY4), fellows (PGY5+), and faculty (PGY5+) were recruited for our study. Participants began with a demographic survey that recorded their medical specialty, previous TEE & TTE experience, and confidence levels in performing a TEE scan.

Participants then took our TEE OSCE and were awarded scores up to a maximum of 46 points. This consisted of a preliminary knowledge exam worth 10 points, a detailed 4-view normal physiology scan worth 24 points, and two 2-view cardiac pathology scans featuring abnormal ultrasound findings worth 6 points each. Scores were compiled and compared using standard student's t-tests.

Using a 5-item Likert scale, participants also completed a post-OSCE survey assessing the perceived difficulty of the OSCE and its potential use as an assessment tool for TEE competency.

Data was gathered from 18 participants: 8 residents, 7 fellows, and 3 faculty members. By specialty, 14 Anesthesiologists and 4 Cardiologists completed our study.

Out of 46 points, residents scored an average of 25.4 whereas fellows and faculty scored an average of 41.1. This yielded a p-value of 0.0029, suggesting that our TEE OSCE appropriately reflects medical learner experience and TEE proficiency.

Of note, those who reported prior TTE experience also scored higher than those who didn't (averages of 39.8 and 27.1 respectively). Lastly, while many reported that both the simulated and the knowledge components of the OSCE were more difficult than expected (rated 3.3 and 3.1 out of 5 respectively), almost all felt the OSCE was an excellent tool for assessing technical skill and knowledge in TEE (rated 4.2 out of 5).

Ultrasound simulation offers a low-risk environment in which learners can safely develop the psychomotor and decision-making skills to better approach real world clinical scenarios. As the use of TEE continues to gain popularity in the setting of cardiac arrest and peri-arrest, new training options will need to be developed to meet this rising need. We constructed an OSCE to create standardized benchmarks for judging TEE proficiency. In future studies, we hope to continue exploring novel means of assessing varying levels of TEE competency as well as potential avenues for reframing the way the technique is taught.

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An Update: The Continued Growth of the Community of Practice (COP) Framework at The Ohio State University College of Medicine

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Ultrasound Communities of Practice (COPs) are a concept originating from a student led organization, the Ultrasound Interest Group (USIG), at The Ohio State University College of Medicine (OSUCOM). The mission of a COP is meant to unite medical professionals across all levels of training who share a common interest of ultrasound utilization and advancement within a particular field. These diverse but like-minded groups then work towards advancing ultrasound across four major domains of academic medicine: Clinical, Research, Education, and Administration. Our goal was to establish a structured administrative framework to facilitate growth and ultimately, self-sufficiency of these COPs. Here we describe our current progress.

In an effort to ensure the continued growth of these organizations, each COP is registering as an official student organization with the university, thereby increasing each group's access to funding and additional institutional support. Secondly, a COP starter packet has been created, which includes numerous resources for existing and new COPs. It includes a handbook outlining the mission of a COP as well as the roles and responsibilities of each member in the organization. COP milestones are also outlined within the packet, which delivers a concrete way for each COP to quantify its progress, on a Likert scale, within the four domains of academic medicine. Finally, the packet includes a template constitution to allow the organization to more easily establish an initial infrastructure. Additionally, each COP is classified as "Active", "On Probation", or "Inactive" based on its activity each quarter. This classification is determined by faculty and student involvement, frequency of meetings or events, and established infrastructure.

The number of COPs at OSUCOM has increased from 10 to 12 over the past year as a result of the implemented changes. Of these 12, 4 are classified as active, 6 are on probation, and 2 are inactive. The 2 most active organizations have shown growth based on milestone measurements over the past year. The Internal Medicine COP has grown to reach a level 4 milestone in both research and academics, while the MSK COP has increased its education efforts, moving from a level 1 to a level 2 milestone within education. Reporting from the COPs remains irregular, and administrative efforts are being taken to maintain consistent communication with COPs. COPs are increasing in number at OSUCOM and as our administrative tools to monitor growth evolve we are able to develop a better picture of how COPs are contributing to the advancement of ultrasound at OSUCOM. The vertical integration of physicians, physicians in training, and students allows for an invaluable experience for those involved. Future challenges include: 1) as COPs progress towards self-sufficiency, leaders may feel less inclined to communicate with administrative leads in USIG, creating inaccurate depictions of COP activity 2) addressing misalignment between COP milestone measurements and the departmental goals specific to a particular COP.

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GET OUT: Gamified Escape Teaches Objective-based Ultrasound to Trainees

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As ultrasound continues to gain popularity in use and prevalence in medical school, novel teaching modalities should be explored to captivate new learners and enhance their retention. In the past, there has been success with simulations and models that allow for a hands-on approach to learning ultrasound. Our group hypothesized that by creating an ultrasound-themed escape room, we could synthesize the strengths of these previous teaching styles and scaffold them to a narrative to increase the memorable nature of the teachings. Escape rooms are a type of activity where participants are locked in a room and need to use the puzzles and games inside the room to escape it in a limited amount of time. Initial studies have shown promise for this concept. Our group believes that the use of simulation in point of care ultrasound (PoCUS) combined with the recent trends of the “gamification” of ultrasound education will result in a novel educational experience for students.

A pilot escape room was outlined with a series of novel puzzles requiring both knowledge and technical skill. Various answers to the puzzles are hidden in plain sight in the room so that competitors of all levels have a chance at escaping. The pilot cohorts will include 3 member teams of either fourth year medical students who are participating in an honors ultrasound curriculum or incoming first year medical students who lack ultrasound knowledge each with a goal of trying to escape the room within 30 minutes or less. Participants will take a pre and post survey to see if they objectively and subjectively found the experience to be educational. Immediate and delayed retention will be compared to traditional didactics.

Components of the puzzles themselves have all been performed piecemeal and have been used in extra-curricular ultrasound didactic sessions. Faculty have been consulted over the cost, time and logistics and are in support of piloting this novel approach to teaching ultrasound. Data will be collected using a survey software such as Qualtrics and will be analyzed looking at comparative statistics for significant differences.

Point of care ultrasound (PoCUS) is growing in medicine and there are an increased number of learners who consume information in multiple modalities ranging from traditional didactics to the “gamification” of learning such as scanning competitions held at both local and national conferences. Escape rooms are a novel way to impart ultrasound education in an easily digestible format that can potentially not only have built in variations tuned to the participants’ level of knowledge, but also offers an environment for improving teamwork and communication amongst its learners.

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Integration of ultrasound in medical school: effects on physical examination skills of undergraduates

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Since its discovery, ultrasound imaging has rapidly increased its application in almost every medical field. Nevertheless, only few universities provide teaching of ultrasound for medical students in their curricula. Emerging evidence is supporting the use of ultrasound to improve not only ultrasound (US) skills but also non-US skills and knowledge of medical students. The purpose of this review is to point up if the integration of ultrasound lessons into medical students' curricula improves their learning of physical examination and boosts skills and confidence when performing a physical exam. We performed a systematic review of literature by searching PubMed, Embase and Cochrane Library databases. Our inclusion criteria were studies of any level of evidence published in peer-reviewed journals. Evaluated data were extracted and critically analysed. PRISMA guidelines were applied, and risk of bias was assessed, as was the methodological quality of the included studies. We excluded all the article with high risk of bias and/or low quality after the assessment.

We applied the previously described criteria and we included 14 articles assessed as medium or high quality. Seven out of eight studies reported statistically significant improvement of physical examination scores and accuracy by students exposed to ultrasound lectures. Ten out of ten studies, which administered self-assessment questionnaires to students, reported strong agreement among students that ultrasound lectures contributed to a better understanding and learning of the physical exam and improved their confidence and skills when conducting a physical examination.

There is an increasing evidence that incorporating ultrasound in medical students' curricula might improve their ability and confidence when learning and performing physical examination. Further studies are needed to establish this evidence.

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Anesthesiology Ultrasound Community of Practice at The Ohio State University

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The Anesthesiology Ultrasound Community of Practice (COP) is a team of medical students and physician mentors who are dedicated to growing ultrasound practice within Anesthesiology through education, research, and clinical application. Point of care ultrasound is becoming increasingly widespread in the medical field with scattered training patterns. Training is crucial in a procedurally heavy specialty such as anesthesiology, in which ultrasound use is becoming the standard of care. Due to this discordance, a group of medical students, along with a resident and faculty mentor, founded the Anesthesiology Ultrasound COP at The Ohio State University College of Medicine. We hypothesize this organization will promote ultrasound exposure, training, and research opportunities for both students and faculty within the Department of Anesthesiology.

A COP handbook and milestone measurements for the Anesthesiology COP were generated from previously developed standards at The Ohio State University. The members of the COP will meet at regularly defined intervals throughout the year to establish goals and assess our progress toward milestones in research, education, and clinical application. We aim to identify research goals and launch student-led research projects, as well as conduct journal club sessions regularly for students and mentors. Our educational and clinical application goals are to hold didactic sessions for medical students that cover the fundamental applications of ultrasound in anesthesiology practice. These applications include transthoracic (TTE) and transesophageal echocardiography (TEE), critical care ultrasound, regional anesthesia techniques, and vascular access ultrasound. Administratively, we aim to promote collaborative efforts between students, residents, and faculty members.

Interest in the Anesthesiology Ultrasound COP is expanding with a roster of nine medical students and fourteen physicians across the different subspecialties in Anesthesiology. For this upcoming year, we have partnered with medical students pursuing ultrasound projects to plan didactic sessions focusing on TEE, critical care, and regional anesthesia. To fulfill research goals, we have catalogued 25 relevant anesthesiology ultrasound research articles from the past five years and lead a journal club session in which several of them were discussed. Lastly, we have met with The Ohio State University Union administration to discuss requirements for establishing the Anesthesiology Ultrasound COP as an official university-recognized interest group that would provide funding and support for further development.

We anticipate the Anesthesiology Ultrasound COP will lead to expansion of point of care ultrasound education and training within anesthesiology and consequently expansion in the use of ultrasound. Future goals include expanding medical student and faculty membership, establishing the group as a university-recognized organization, progressing through the COP milestones, and encouraging collaboration between medical students and Department of Anesthesiology faculty members.

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Auscultation of Bowel Sounds and Ultrasound of Peristalsis are Neither Compartmentalized Nor Correlated

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Auscultation of bowel sounds has been taught as a component of the physical exam since the beginning of the twentieth century. However, there has been little research or consensus on the significance of listening in different quadrants. Some textbooks indicate that bowel sounds indicate peristalsis in that region, while others state that bowel sounds can be generalized over the entire abdominal wall. With ultrasonography, peristalsis can be visualized in a dynamic and non-invasive manner. The purpose of this study was to determine the relationship between auscultation of bowel sounds and visualization of peristalsis with ultrasound, to understand whether or not bowel sounds and peristalsis are compartmentalized.

This study was IRB approved. Investigators received training in ultrasound detection of peristalsis, and the auscultation was performed by an experienced clinician with 30 years of practice experience. Study participants quietly lay supine, while one investigator positioned a 5-2 MHz curvilinear transducer on the abdomen visualizing the bowel, and a second investigator placed a stethoscope directly adjacent to the probe to auscultate for bowel sounds. During a two minute interval, a third investigator recorded responses from the first two investigators when a bowel sound was heard or peristalsis was seen, with three possible outcomes; A+/U+, A+/U-, A-/U+. Measurements were recorded from 4 quadrants (RUQ, LUQ, RLQ, LLQ) and the periumbilical region. Statistical analyses of each quadrant and periumbilical region included Fisher Exact test for parametric data to determine whether there were significant differences between the number of bowel sounds heard but not seen (A+/U-) and those seen but not heard (A-/U+) with sounds that were both seen and heard (A+/U+). Significance was determined with $p < 0.05$.

16 participants were included, with a combined 973 discrete bowel events, both auscultated and visualized. No quadrant showed significant correlation between and isolated sound (A+) or peristalsis (U+) and a combined event (A+/U+), indicating there were many events where an auscultated sound failed to correlate with observed peristalsis, and vice versa. The average p value was 0.544, with a range of 0.052-1.00.

This study showed that there is no significant correlation between auscultated bowel sounds and peristalsis within a given region. Oftentimes peristalsis would be continually seen on ultrasound, with only short, discrete auscultated bowel sounds being heard, calling into question where these sounds truly originate from, and what their significance may mean. Given that this study found no significant correlation between the location and the auscultated sounds, it is called into question whether auscultation of all four quadrants provides more meaningful information than auscultation of one central point of the abdomen. Advances in ultrasound are allowing us to rethink our previously held ideals of physical diagnosis, and utilizing it could provide key insight in translating what we are hearing into real, meaningful information for the patient.

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Language of Transducer Manipulation: Codifying Terms for Effective Teaching 2.0, A Preliminary Analysis

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Several studies and publications have sought to establish common terminology for cardinal ultrasound probe motions. To date, no studies have been performed to determine which of these terms have been adapted by the ultrasound community at large.

A survey instrument was developed which included videos of six common probe motions in addition to multiple demographic questions. The survey instrument was disseminated across various academic listservs and FOAMed resources. Initial data were collected over a 6 week period using Qualtrics (Qualtrics Provo, Utah).

The initial data collection yielded 419 unique responses. Of those providing demographic information in regards to training, 269 were sonographers and 162 were physicians. While a wide array of terminology is currently used, large differences in terminology were noted to the following probe motions:

Motion in the short axis of the probe along a fixed point on the body while changing the angle of insonation away from 90° : 85% of physician respondents refer to this motion as a fan, 55% of sonographer respondents refer to this motion as a sweep

Motion in the long axis of the probe along a fixed point on the body while changing the angle of insonation away from 90°: 55% of sonographer respondents refer to this motion as a heel-toe, 68% of physicians respondents refer to this motion as a sweep

Variation still exists between ultrasound practitioners and educators in the description of cardinal probe motions. Analysis of preliminary data suggests that some differences exist primarily between probe motion description of sonographers compared to physicians. An additional data collection phase will follow to increase response rate and to delineate if additional difference in probe motion description varies regionally or internationally.

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ARTIFACTS: Accumulated Rendered Tailored Image Folio Assess Continued Teaching in Sonography

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Medical students have been learning ultrasound in undergraduate medical education (UME); yet, it is not a requirement for graduation. Many medical schools have integrated ultrasound into parts of the 4-year curriculum and a minority of programs have a 4-year integrated curriculum. During the student's journey from the preclinical to clinical world of practicing medicine, multiple opportunities to encounter ultrasound exist in the simulation and clinical arena. Patient confidentiality and security of patient data make saving images in the clinical setting difficult. Saving images from ultrasound machines has become easier with the use of USB memory sticks and improvement in ultrasound machine technologies. A program at our institution encourages students to compile a longitudinal digital portfolio of images and items to document their learning throughout the four years of medical school. Portfolio coaches encourage use of collecting artifacts yet the program is sometimes ambiguous to the instructors as well as the students. We aim to improve a simple step that will improve how students use ultrasound images in our curriculum.

Our group has created a protocol to acquire ultrasound images from machines, maintain patient confidentiality and utilize simulation lab usage of ultrasound equipment. A working group is tracking the number of artifacts submitted to this program utilizing a specific digital tag. Members of specific ultrasound cohorts will be surveyed on their confidence on how to save images before and after releasing our protocols.

The method of saving images has been taught in our institution's honors ultrasound curriculum for a select group of 4th year medical students; however it has yet to be distributed to other medical students. We hypothesize that by standardizing the protocol to save ultrasound images, students will be more inclined to learn how to save images and use them for the curricular portfolio. We expect that user familiarity with the ultrasound machines and general confidence of acquiring images will increase after our intervention.

More research is needed in helping students define their professional identity through a portfolio program. ARTIFACTS can help operationalize the image acquisition process and lower barriers that exist for students to incorporate more ultrasound into their curricular projects, thereby enhancing an impactful step in the learning process.

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Development of Pulsatile Flow 3D-Printed Anatomical Model for Femoral Access Training

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With the ever-expanding number of endovascular and percutaneous procedures, femoral access must be in the surgeon's repertoire. Iatrogenic complications of femoral access increase patient morbidity, increase length of stay, increase costs, and are associated with decreased survival. Access technique and proper closure or hemostasis have been identified as primary intervention strategies to reduce these complications. Anatomic variation amongst patients is also implicated in the persistence of access complications. Access techniques that are employed clinically include: palpation of anatomical landmarks, fluoroscopic and ultrasound guidance, micro-puncture, and angiography.

Simulation based learning for placement of central lines has shown improvement in procedural skills, greater success rates, decreased needle passes, and decreased complication rates. More recently lower procedure related complications with haemodialysis catheter placements by nephrology fellows were associated with simulation-based learning.

Commercially available models for femoral access training are not anatomically detailed and have not been designed for the purpose of large sheath access. They do not include, for example, the bifurcation of the common femoral artery into the profunda femoral and superficial femoral artery, crucial anatomy for locating correct puncture site and teaching ultrasound guidance. They do not have radio-opaque bony structures to allow for fluoroscopic identification of the femoral head. Furthermore, these models are often cost prohibitive.

This study aimed to create an anatomically correct 3D-printed, pulsatile model for simulation of femoral access procedures.

The 3D and Advanced Imaging Lab at The Ohio State Univeristy Wexner Medical Center provided 3D reconstruction of CT angiogram and prepared .stl files for 3D printing. Research Information Solutions & Innovation (RISI) at The Research Institute at Nationwide Children¹s Hospital provided a pilot vessel in which a central line was placed and removed without leak under pressure. The vessel was placed in gelatin mold and ultrasound images were obtained showing vessel wall, compressibility, and the insertion of a catheter and guide wire within the vessel's lumen. (Fig. 1) A full pilot model was then created from these components with 3D-printed radio-opaque pelvis, anatomically correct vessels, and anatomic gel mold of the lower torso and upper thigh to include palpable landmarks. This model was covered with artificial skin and connected to pulsatile flow. (Fig. 2)

Pilot model was successfully used as part of our 2018 institutional, multi-departmental, fellow orientation for those fellows who would be performing large bore femoral access during their training. 3D printing of patient-specific femoral vascular and pelvic anatomy, including the addition of pulsatile arterial flow, provides a feasible, readily available, and more realistic training platform for ultrasound- and fluoro-guided vascular access. This training model aims to reduce iatrogenic complications of femoral access at our institution as part of an institutional Quality Improvement Project: "Implementation of Femoral Access Training to Reduce the Incidence of Iatrogenic Complications.

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Understanding the benefits and challenges of implementing a medical student-performed ultrasound program in a free clinic setting

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Columbus Free Clinic (CFC) is a student-run free clinic with 10 medical students serving as the executive board and approximately 500 additional student volunteers who room patients, take histories and physicals, and collaborate with physicians to diagnose and treat patients. The clinic provides primary care to over 1,000 patients a year. Of these patients, about 115 are referred outside the clinic for imaging studies. Off-site imaging is a burden to the patient and increases cost of care.

At the Ohio State University College of Medicine, students receive training in ultrasound acquisition and interpretation as part of the academic curriculum, with the opportunity to participate in extracurricular training. However, current medical student ultrasound education lacks direct patient contact and would be improved by exposure to patients with potential pathology.

The objectives of this study are to improve patient care by having on-site ultrasound imaging at CFC and to provide medical students with the opportunity to advance their ultrasound skills by working with real patients under physician supervision.

Patients will be identified by medical students and physicians based on their presenting complaint and assessment. Those noted to have an indication to receive one of several available scans will be invited to voluntarily participate in the study. Medical students will be recruited from those students who have finished at least a Beginner Ultrasound Course and Proctor Training Course, including a final exam that will require students to demonstrate competency in specific scans. These students will then be able to scan patients at CFC under direct supervision by physicians with knowledge in ultrasound. A physician or sonographer will then perform the same scan on the same patient to assess student performance.

The availability of ultrasound scanning in the CFC would have positive impact on patient care by providing imaging information for point-of-care decision making. Establishing a protocol through which trained medical students and physicians could perform ultrasound scans could positively impact the patient care at this clinic. A pilot study conducted with a new type of probe identified obstacles with technical aspects of the device, as well as questions over safeguarding patient confidentiality. In addition, this pilot revealed logistical issues relating to the interpretation of images by trained professionals. To evaluate the efficacy of medical student ultrasound education, students' scan acquisitions and interpretations will be compared with the physician's findings for each case, providing valuable insight into the learning process. The types of scans most frequently utilized within the setting of a free clinic will also be identified.

This project will help to determine effective strategies for implementing ultrasound imaging into a free clinic setting, evaluating the benefit to patients, and evaluating if medical students can successfully identify the need for a scan, obtain appropriate images, and accurately interpret these images. Ultrasound imaging can be provided by medical students but navigating administrative challenges will remain a significant hurdle. This study will provide useful data in an area that has been understudied to date.

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Facing the Challenges of a Multi-specialty Point of Care Ultrasound Medical Student Elective

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The multi-disciplinary point of care ultrasound (POCUS) medical student elective was developed to meet the demand for further POCUS clinical experience. This unique 4-week curriculum provides hands on skill development taught by 10 departments to prepare the student for their respective specialty. The interprofessional collaboration has provided a wide range of ultrasound experiences; however, the complexity of organizing and maintaining these specialties has led to significant challenges including inconsistent schedules, loss of specialty support, lack of consistent POCUS skill assessment and continued demand for the latest technology. Our goal was to mitigate these challenges for the third year of the elective.

The process of coordinating 10 specialties with multiple POCUS educator schedules has been the most significant challenge to date. In response to feedback we were able to obtain funding from the medical school to support a central coordinator to assist with administrative duties. This has provided a more consistent schedule and improved feedback from the POCUS educators and respective students.

To help maintain and replace those specialties that could no longer support the elective it was essential to reach out to our hospital POCUS committee, fellows and community POCUS leaders. It was through those contacts that we were able to integrate our first dedicated pediatric collaboration and utilize our POCUS resources and educators in the community setting. The specialties currently include Pediatric Cardiology, Trauma Surgery, Community POCUS, Neuro Critical Care, Medical Critical care, Sports Medicine, Obstetrics-Gynecology, Vascular Surgery, Adult Cardiology, Neurology and Emergency Medicine.

In order to enhance and provide more objective grading assessment of ultrasound skill set we have added a direct observation testing component for FAST and cardiac modalities. These modalities were chosen due to the student being exposed to them from multiple different specialties. This update is outlined in the student syllabus and provides a more objective assessment in addition to the current assignments, presentation, quizzes and scan completion requirements.

The opportunity to utilize the Vimedix Ultrasound Simulator from our Center for Experiential and Applied Learning has provided exposure to technological innovation along with increased scanning time with our POCUS educator to enhance the student experience.

The inherent challenges of coordinating multiple specialties and scheduling POCUS educators can be minimized through a central coordinator. Continued communication with hospital and community POCUS leaders provides additional learning opportunities for the students. In addition, arranging for direct observation ultrasound assessments can provide more objective grading and improved feedback for the students and educators.

This senior medical student POCUS elective continues to grow and be in high demand while bringing unique challenges. In order to maintain the success of this elective in the future we will need to continue to innovate and communicate well with our specialties, educators, coordinators and medical students.

Future improvements would be through technologic innovation having the students utilizing portable hand-held ultrasound devices in the clinical realm in addition to virtual reality ultrasound experiences.

The authors have no conflict of interest to report.

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POCUS initiation workshop for family medicine residents

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The interest of point-of-care ultrasound (POCUS) as a diagnostic and screening tool in clinical practice is well-known and it is important to start teaching future family medicine physicians to use this tool as soon as possible in their practice. The aim of this workshop was to teach family medicine residents the different applications of POCUS in family medicine and the initiate them to the use POCUS.

The workshop was organized in November 2018 and May 2019 in Paris, France. Every session lasted 3 hours. Students were divided in small groups of 4-5 residents using one ultrasound machine. They were supervised by 4 family medicine doctors, trained in ultrasound.

A short theoretical presentation on the definition of POCUS preceded the hands-on session where residents scanned each other and performed ultrasound on an ob/gyn high-fidelity simulator.

The residents learned about the settings, different types of probes (curvilinear, linear, phased-array, endocavitary) and probe orientation. The basics of ultrasonographic semeiology of the abdomen, cardiac, vascular (measurement of the systolic pressure index), musculoskeletal, thyroid, obstetrics and gynecology were discovered through hands-on sessions by each student. Different types of ultrasound machines were used: classical sophisticated machines, portable and ultraportable. At the end of the course each student responded to an evaluation survey.

Twenty-seven family medicine residents in their last year of residency participated. The workshop enabled them to discover POCUS as a clinical tool but also as a teaching tool by using the concordance of the physical examination with the direct visualization of echoanatomy.

At the end of the workshop, 92% (25/27) of residents declared that the use of ultrasound as a teaching tool had improved their semiological skills. There were 92% (25/27) of residents who thought this teaching method was innovative. The time to discover POCUS was sufficient only for 55% (15/27) of the residents. All residents, 100% (27/27) declared that they would have liked such workshops earlier in their curriculum based on a global exploratory approach. Most of the students 96% (26/27) were willing to pursue their training in ultrasound in order to integrate it in their future practice.

This interactive student-centered workshop focused on the learning of the basics of POCUS through hands-on sessions was appreciated by family medicine residents. This is the first time POCUS is integrated in a family medicine curriculum in France at our knowledge. In the future, this beginner could be proposed earlier during family medicine residency followed by an intermediate course.

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Variability index of optic nerve sheath as a predictor of response to treatment in the endocraneal hypertension

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Elevated intracranial pressure (ICP) is a serious complication that often leads to adverse outcomes. It is a syndrome with multiple etiologies whose diagnosis and treatment must be done urgently to save the patient's life and prevent the development of important disabilities. The onset of this syndrome is due to increased volumes and, in turn, pressures of intracranial contents, conditioning underlying cerebral edema.

The dilatation of the diameter of the optic nerve sheath (ONS) has been shown to be the manifestation prior to the elevation of the ICP. Being a non-invasive monitoring tool.

To provide reliability to the index of variability of the diameter of the ONS as a treatment response and prognostic factor.

Fourteen patients with acute neurological injury were monitored with non-invasive monitoring by applying insonation of the ONS to data suggestive of hypertensive skull, providing osmolar therapy before a value greater than 5.2 mm, the variability index is determined: Diameter before therapy osmolar – Diameter after therapy osmolar/ Diameter before therapy osmolar X 100. An average (diameter decrease) of 0.38 mm was obtained after osmolar therapy, with improvement in prognosis whit index of variability greater than 7%.

The measurement of the diameter of the optic nerve sheath by ultrasonography is an alternative method of monitoring, for patients with acute neurological injury, and the determination of the new variability index allows determining a treatment response and prognostic factor.

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Teach the Teacher Model: An Innovative Method for Developing A Point of Care Ultrasound Curriculum within a Large Academic Institution

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Point-of-Care Ultrasound (POCUS) enhances the physical exam and is emerging as a necessary skill in modern medicine. Designing an Internal Medicine (IM) resident POCUS curriculum is difficult with limited faculty who are trained and comfortable using ultrasound. Our objective is to circumvent this obstacle and promote a cultural shift towards embracing bedside ultrasound by creating a “teach the teacher model” as the foundation of our IM POCUS curriculum.

In July 2018, 105 IM residents were in need of ultrasound training and only 1 inpatient POCUS trained IM faculty was available for teaching. 25 upper level residents received early structured POCUS training from July through September to be “POCUS champions.” They went on to be peer instructors alongside faculty during workshops and in the clinical setting the remainder of the year. Training begins with POCUS lectures on the lung, heart, and IVC followed by hands on workshops with standardized patients. POCUS champions participate in gel rounds, where they perform 25 lung, heart, and IVC exams on real patients under trained faculty supervision. They must demonstrate proficiency before training other residents. In the multiplier phase, POCUS champions become mentors for 4-5 untrained residents and are allowed to supervise exams. All untrained residents are expected to complete 25 supervised lung, heart, and IVC exams by the end of the academic year. The rising PGY2s and PGY3s with the most interest and skill are selected to be the new POCUS champions the subsequent year. The current curriculum focuses only on cardiac and pulmonary imaging. It will expand to cover other organ systems and POCUS education will be further augmented through additional training methods.

A survey prior to implementing the curriculum showed that over 70% of residents felt uncomfortable or very uncomfortable performing POCUS exams. 21 of the initial 25 residents received their POCUS champion teaching privileges at the faculty’s discretion. The curriculum is still in its early stages so compiled data is limited. We plan to evaluate the curriculum and resident POCUS proficiency in the following ways: 1) annual surveys to assess resident comfort; 2) tracking exams to measure POCUS use; 3) remote image assessment to evaluate quality; 4) tests to assess knowledge, image interpretation, and clinical application.

POCUS is not meant to replace radiology or cardiology expertise, but using POCUS as an extension to the physical exam is becoming an essential skill in general medicine. Our “teach the teacher” model overcomes the obstacle of having limited faculty who are comfortable using and teaching ultrasound by distributing the responsibility for POCUS education to the stakeholders themselves. Upper level residents perpetuate a continuous cycle to teach POCUS and interns have the opportunity to learn while simultaneously taking care of their hospitalized patients. This helps produce a cultural shift towards using POCUS within IM. The mentorship model within our POCUS curriculum is changing our practice as educators and learners. The key to POCUS proficiency is supervised repetition, achieved through program support of its use in a clinical setting. Workshops can only introduce concepts, but continued use of POCUS in practice is what really matters. We as educators must remember that learners can evolve into teachers, and teachers continue to learn through experience.

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The Variable Journey in Learning to Interpret Pediatric Point-of-Care Ultrasound Images: A Multicenter Prospective Cohort Study

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To complement bedside learning of point-of-care ultrasound (POCUS), we developed an online learning-assessment platform for the visual interpretation component of this skill. This study examined the amount and rate of skill acquisition in POCUS image interpretation in a cohort of Pediatric Emergency Medicine (PEM) physician learners.

This was a multicenter prospective cohort study. PEM physicians learned POCUS using a computer-based image repository and learning-assessment system that allowed participants to deliberately practice image interpretation of 400 images from four pediatric POCUS applications [soft tissue, lung, cardiac and focused assessed with sonography for trauma (FAST)]. Participants completed at least one application (100 cases) over a four-week period.

We enrolled 172 PEM physicians (114 attendings; 65 fellows). The increase in accuracy from the initial to final 25 cases was 11.6%, 9.8%, 7.4% and 8.6% for soft tissue, lung, cardiac and FAST, respectively. For all applications, the average learners (50th percentile) required 0-45, 25-97, 66-175, and 141-290 cases to reach 80%, 85%, 90%, and 95% accuracy, respectively. The least efficient (95th percentile) learners required 60-288, 109-456, 160-666, and 243-1040 cases to reach these same accuracy benchmarks. Generally, the soft tissue application required participants to complete the least number of cases to reach a given proficiency level, while the cardiac application required the most.

Deliberate practice of pediatric POCUS image cases using an on-line learning and assessment platform may lead to skill improvement in POCUS image interpretation.

Importantly, there was a highly variable rate of achievement across learners and applications. These data inform our understanding of POCUS image interpretation skill development and could complement bedside learning and performance assessments.

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Sonographic Volume Assessment by Novice and Expert Scanners of Healthy Patients and Patients with Chronic Disease Pre- and Post-Blood Removal

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Previous research in the field of ultrasound has explored many different scans aimed to assess volume status. Our study wishes to compare head to head the accuracy and reliability of ultrasound scans for volume assessment that performed well in other studies. Recent studies found success in volume assessment using multiple measurements of the internal jugular vein, carotid artery, subclavian vein, left ventricular outflow tract and inferior vena cava. Additionally, our study will look at the inter-rater reliability of each scan and the impact a scanner's training level has on results.

A study by Mackenzie et al. observed the effect of acute blood loss on corrected carotid artery flow time. Their methods included obtaining a pre- and post- blood loss Doppler scan of carotid artery blood flow. It was concluded that after acute blood loss, there was a decrease in corrected carotid artery flow time. The researchers stated in their conclusion, "Further investigation of corrected carotid artery flow time as a predictor of volume responsiveness is warranted." Our study will extend from this conclusion as we wish to study the use of the carotid artery for volume assessment in comparison to other ultrasound volume assessment scans. A paper by Hossein-Nejad et al. confirms the use of the carotid artery for volume assessment. The researchers investigated a possible correlation between carotid corrected flow time and changes in volume status. It was concluded that changes in carotid corrected flow time may predict changes in intravascular volume.

One study by Murthi et al. observed the ability of ultrasound to predict volume response. One of the ultrasound scans that they examined was the internal jugular vein diameter with positional change. It was found that ultrasound of internal jugular vein change was one of the best predictors of volume response. In the conclusion, the author notes that "Future work should focus on [the internal jugular vein]." Our study will extend from this conclusion as we wish to study the use of the internal jugular vein for volume assessment in patients undergoing volume loss.

Finally, in a study by Fields et al., the researchers looked at the inter-rater reliability of inferior vena cava ultrasound and how the scan would best be utilized in volume assessment. They found that ultrasound measurements of inferior vena cava diameter have a high inter-rater reliability. Alternatively, a study by Corl et al. investigated if ultrasound measurements of the inferior vena cava are an accurate measurement of fluid responsiveness. They concluded that inferior vena cava measurements are not accurate in predicting fluid responsiveness.

Additional studies evaluating use of subclavian vein collapsibility, left ventricular outflow tract velocity time integral, and internal jugular vein to common carotid artery ratio have all demonstrated potential as modes of volume assessment (Bailey et al, Blanco et al, Kent et al). Our study aims to take all of these published methods of ultrasound volume assessments and analyze them in comparison to one another, head to head.

In conclusion, these previous studies lead us in the direction of observing seven different ultrasound scans for volume assessment. Each scan that we have selected to use (common carotid artery flow time, internal jugular vein diameter with positional change, inferior vena cava long axis collapsibility, inferior vena cava short axis collapsibility, internal jugular vein to common carotid artery ratio, subclavian vein collapsibility and the left ventricular outflow tract velocity time integral) has previously been studied and shown promise for accurate volume assessment. Now, our experiment will put the scans head to head to learn more about the reliability and accuracy of each compared to each other. Overall, potential benefits of this study include discovery of non-invasive means of assessing volume responsiveness in various patient populations including the chronically and critically ill.

We began by recruiting ultrasound scanners, both novice (medical students) and expert (residents, ultrasound fellows and attending physicians), to participate in our study. Each scanner watched a tutorial video giving basic instructions on how to execute the seven scans that they would be performing in the study (common carotid artery flow time, internal jugular vein diameter with positional change, inferior vena cava long axis collapsibility, inferior vena cava short axis collapsibility, internal jugular vein to common carotid artery ratio, subclavian vein collapsibility and the left ventricular outflow tract velocity time integral).

i. Common Carotid Artery Flow Time. The examiner will measure the common carotid artery flow time. With the patient supine, the examiner will obtain a long axis view of the common carotid artery with a linear transducer. Next, the diameter will be measured intima to intima 2 cm proximal to the common carotid bulb. The carotid flow time will then be measured on the pulse wave Doppler tracing of flow through the artery between the upstroke of the flow tracing and the dicrotic notch. This measurement will be corrected for pulse rate by dividing flow time by the square root of the cardiac cycle time to calculate corrected carotid artery flow time. The cardiac cycle time will be obtained with electronic calipers in the ultrasonographic machine's software by measuring the distance between heartbeats at the beginning of the doppler flow upstroke.

ii. Internal Jugular Vein Diameter with Positional Change. With the patient supine, the examiner will use a linear transducer to image the left internal jugular vein in the mid-neck. Measurements of the diameter of the internal jugular vein will be taken in short axis using B mode. Then, the head of the bed will be moved to 90 degrees and the same measurements on the mid-neck left internal jugular vein will be taken.

iii. Inferior Vena Cava Long Axis Collapsibility. The examiner will measure the collapsibility index of the inferior vena cava (IVCCI). With the patient supine, the examiner will visualize the inferior vena cava with a phased array transducer in the sub-xyphoid transabdominal long axis 2-3 cm from the IVC to right atrium junction. Next, a video will be acquired of the IVC throughout the respiratory cycle. The patient will then be asked to take a short quick inspiratory effort ("sniff"). The video in still frame will be used to find the maximal IVC diameter during passive respiration and the minimum IVC diameter recorded during the sniff using B mode. Minimum and maximum IVC diameter will then be measured using M mode. Inferior vena cava collapsibility index (IVCCI) for both M mode measurements and B mode measurements will be calculated using the formula [(IVCmax – IVCmin)/ICVmax] x 100.

iv. Inferior Vena Cava Short Axis Collapsibility. The examiner will measure the inferior vena cava collapsibility index (IVCCI). With the patient supine, the examiner will visualize the inferior vena cava with a phased array transducer in the transabdominal short axis just inferior to the inflow of hepatic veins. Next, a video will be acquired of the IVC throughout the respiratory cycle. The patient will then be asked to take a short quick inspiratory effort ("sniff"). The video in still frame will be used to find the maximal IVC diameter during passive respiration and the minimum IVC diameter recorded during the sniff using B mode. Minimum and maximum IVC diameter will then be measured using M mode. Inferior vena cava collapsibility index (IVCCI) for both M mode measurements and B mode measurements will be calculated using the formula [(IVCmax – IVCmin)/ICVmax] x 100.

v. Internal Jugular Vein to Common Carotid Ratio. With the patient supine, the examiner will obtain a short axis view of the internal jugular vein (IJV) and common carotid artery (CCA) using a linear transducer in B-mode at a level in lower half of the neck. The probe is to be positioned perpendicular to the skin with the minimum pressure necessary to obtain image, taking care not to distort the IJV. A video clip will be obtained and saved. The saved clip will be reviewed frame by frame and the frame with both the CCA and IJV at their greatest circumference will be selected. This frame is then used to measure the diameter of the IJV and CCA. Ratio is calculated by IJV/CCA. In this same short axis frame, the examiner will measure the surface area of both the IJV and CCA. The surface area of the vessels will then be used to calculate an additional internal jugular vein to common carotid artery ratio.

vi. Subclavian Vein Collapsibility. The examiner will measure the subclavian vein collapsibility index. (SCVCI). With the patient supine, the examiner will visualize the subclavian vein in short axis with a linear transducer at the delta-pectoral triangle. Next, a video will be acquired of the vein. The video will be reviewed and frames identified to find the maximal and minimum SCV diameters. Subclavian vein collapsibility index (SCVCI) is calculated using the formula: [SCVCI = (max diameter – min diameter)/max diameter × 100].

vii. Left Ventricular Outflow Tract Velocity Time Integral. The examiner will measure the left ventricular outflow tract velocity time integral with the patient in the supine position using the phased array probe. The examiner will first obtain a parasternal long axis view of the heart and measure the left ventricular outflow tract diameter using B mode. The diameter of the LVOT will be measured up to 0.5cm back from the aortic valve leaflet insertion points. Next, an apical 5 chamber view will be obtained. In this view, the examiner will use pulse wave Doppler to record the waveform. Using the ultrasound machine, the velocity time integral will be measured as the area under the curve of the largest wave.

Next, we arranged to attend local blood drives and recruited volunteers to be our healthy patient population. Each healthy patient was scanned by one ultrasound scanner, either novice or expert. The scanner performed the seven scans before the patient's blood donation and after the patient's blood donation. Measurements of the scans were recorded on an online form and the scans were recorded on the ultrasound machine.

Data was analyzed to determine if there is a statistically significant change pre- and post-blood removal for each scan and the p-values were compared to determine the most reliable scan. Each ultrasound scan was calculated to a pre- and post-blood removal value for each patient. Then, the pre- and post-blood removal values were subtracted from each other to achieve one value for each patient representing the change in blood volume. This change in blood volume is reflective of how sensitive the ultrasound scan is at detecting blood loss. Lastly, a one-tailed paired t-test was performed on the pre- and post-blood removal values for each patient to determine the p-value of each ultrasound scan.

The inferior vena cava short axis collapsibility in B mode and the inferior vena cava in long axis collapsibility in M mode both achieved statistical significance with p-values less than 0.05 (0.023 and 0.015, respectively). This shows that these two scans would be the best predictors of volume status. When a patient enters the hospital and the physician would like to know what the volume status of the patient is, the physician can reliably perform one of these two scans to find out if the patient needs to receive fluids or not. This finding was surprising because Corl et al. concluded that the inferior vena cava measurements are not accurate in predicting fluid responsiveness. Additionally, the common carotid artery flow time achieved statistical significance to a lesser degree with a p-value of 0.043. This scan could also reliably be performed in the assessment of a patient with an unknown volume status. This scan however had the largest variability in time and ease of acquisition between novice and expert users and thus would be less applicable in a clinical setting with providers of variable skill level.

The scan that would be the worst predictor of the volume status of a patient is the internal jugular vein diameter with position change (p=0.497). This scan resulted in the highest p-value. The scan is simple to perform, so these results suggesting that the scan is the least helpful is unfortunate given ease of acquisition and reproducibility across various provider skill levels. However, given the need to perform a position change for the patient, this scan might be the most uncomfortable and least feasible for a patient that is critically ill.

The future of this study will be to continue collecting data from blood drives. Additionally, we will attend local dialysis clinics to collect data from patients with chronic disease and compare the data to the healthy patient population. Finally, scans will be assessed for accuracy by a blinded expert reviewer using a previously published B-QUIET Scale. This data will help to compare novice vs. expert scanners.

In conclusion, our study has determined that the best ultrasound scan to perform to assess a patient's volume status would be the inferior vena cava collapsibility in M mode scan. This scan is the most sensitive to the change between pre- and post-blood removal and able to determine if a patient is volume depleted. The ultrasound scan is non-invasive and quickly performed at the bedside, saving precious minutes and rapidly providing evidence that a patient needs fluids.

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Lifelike Ultrasound Experienced from an Innovative Technique Applied to Cadavers When Teaching and/or Maintaining Ultrasound Skill Sets

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INTRODUCTION. Acquiring ultrasound imaging and identifying subsequent anatomy is strongly sought after and time has been created in virtually all medical school curriculums. Most expose medical students during their clinical curriculum and some institutions are integrating ultrasound training during basic science curriculum. Universal problem is not enough ultrasonographers available to teach. Rarely is ultrasound taught simultaneously with anatomy lab because vessels are collapsed following the embalming technique. Surface and structural anatomical understanding of human body is paramount to acquire and interpret diagnostic quality ultrasound imaging. Simulation ultrasound can be helpful, but not comprehensive for a novice to transition to live subjects effectively. Objective of this study was to assess a contrast medium in donor cadavers using ultrasound enabling students/trainees to identify sonoanatomy structures and/or acquire POCUS skills from a full vascular system and appreciate orientation of surrounding structures.

METHOD. Novel safe contrast agent and perfusion technique was successfully administered to embalmed cadavers (6) resulting in contrast filling the arterial and venous systems. Ultrasound was conducted to acquire images to assess patent vascular system and orientation of structures.

RESULTS. Ultrasound linear and phased array probes successfully acquired imaging of limb, thoracic, and abdominal vessels. Interestingly, the contrast filled the bladder in some cadavers and allowed ultrasound of the pelvic region with a full bladder. All cadavers were CT scanned post perfusion.

CONCLUSION. This study revealed a contrast agent can be perfused into a cadaver providing opportunities to learn surface and sonoanatomy for ultrasound probe placement while identifying deeper structures and/or acquire POCUS skills prior to dissection. The techniques in this study demonstrate experiential learning.

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Integrating Ultrasound with Anatomy Cadaver Model Designing a Thoracotomy Procedure Technique For Emergency Physicians

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INTRODUCTION. Emergency thoracotomy conducted in emergency departments (ED) have notoriously been associated with very poor outcomes. Most trauma experts agree the primary factor leading to very poor outcomes is due to timing of the decision to conduct a thoracotomy and the procedural difficulty. To gain access to the heart, the conventional thoracotomy approach for ED physicians is a left anterolateral approach. The objective of this study was to provide a technique revealing critical anatomy which would enable non-surgeon(s) to conduct life-saving thoracotomy for cardiac tamponade and cross clamping descending thoracic aorta of male and females.

METHOD. Following practice of left anterolateral and bilateral anterolateral or clamshell approaches conducted on unembalmed, lightly and traditionally embalmed human cadavers (n=34), clamshell approach was chosen for ease of procedure (required tools, skill of tool use and degradation of technique), rapid efficient access, and working visibility. Required tools were scalpel and trauma scissors for single user with assistant or scalpel, trauma scissors and Fianchetto spreaders for single user conducting a clamshell thoracotomy technique. Whether single or multiple assistant support, ultrasound can confirm 4th or 5th intercostal space (ICS).

RESULTS. Entering and maintaining the 4th or 5th intercostal space resulted in consistent optimal exposure of thoracic structures for emergency physician skill sets. Current literature reveals lack of consistently identifying 4th or 5th ICS on palpation alone. This technique included ultrasound for assisting ideal transverse exposure revealing wide visual anatomical field to conduct a vertical incision of the pericardial sac anterior to the phrenic nerve, evacuating pericardial effusions and more easily enabling cross clamping of the descending thoracic aorta for non-surgeons while avoiding the oesaphagus. Procedure affords a satisfactory suture closing technique for ED physicians, avoiding higher infection rates associated with midline sternotomy procedures.

CONCLUSION. In summary, clamshell technique is not sophisticated, easily and rapidly performed, provides optimal anatomy exposure enhanced by ultrasound, and can be closed satisfactorily. The technique can be done as a single user with 3 tools or 2 tools with an assistant and be taught in anatomy labs prior to chest dissection.

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Innovative Portable, Wireless, Handheld Ultrasound-Probe-System Utilizes Artificial Intelligence Enabling Diagnostic Imaging for Teaching/Learning Face-to-Face Sonoanatomy and Ultrasound Skills During Online and/or Distance Learning

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INTRODUCTION. Natural disaster triage, increased emergency medicine visits with time sensitive expectations and improved military field medicine outcomes could be addressed achieving desired outcomes with ultrasound. Issues and solutions are ultrasound design, medical education, anatomy, teaching-learning theories, internet byway and emerging technologies. Notable shortage of ultrasound educators for face time teaching requires cross-pollination from peripheral experts to deliver ultrasound skills worldwide. Objective of study was to identify a portable handheld wireless battery-powered-ultrasound-probe-system using artificial intelligence (AI) acquiring quality diagnostic imaging (QDI) enabling andragogy and heutagogy teaching techniques of sonoanatomy for online and/or distance learning to healthcare providers globally.

METHODS. Technology insider knowledge revealed Clarius portable handheld wireless multiprobe ultrasound-system compatible with Apple and Android mobile devices. Clarius was introduced and used for face-time, online and distance learning for premed students during an upper division full cadaver dissection baccalaureate course.

RESULTS. QDI was acquired and comparable to cart-based systems, allowing quality universal sonoanatomy teaching and learning. Clarius is shock and water resistant and utilizes automated AI with a real time automated time-gain-compensation (TGC) engine. Traditional ultrasound systems require users adjusting several TGC controls to optimize imaging and when changing scanning plane, differences in tissue results in attenuation variance and forces users to adjust TGC. Clarius automated AI overrides user interaction with TGC controls if desired. Analyzing each single ultrasound image captured during scanning at rates of 30 frames per second, gain can be tuned with high level precision to 1mm, all in real-time, with instant feedback. Clarius App is a secure point-to-point wireless network enabling both user and learner(s) to view images on mobile devices simultaneously within a room or via cloud from continent to continent.

CONCLUSION. In summary, Clarius(portable handheld-wireless-battery-powered-ultrasound-probe-system) reaches within a classroom, remote/dense regions within and between countries who possibly have limited resources (imaging, electrical, lack of and/or minimally trained providers). Clarius technology uses AI to provide easy high resolution imaging for universal sonoanatomy teaching/learning and fertile online and distance learning development, incorporating machine and/or deep learning techniques providing classic competency and innovative capacity learning.

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Lateral Collateral Ligament is Actually Two Ligaments, the Anterior and Posterior Lateral Collateral Ligament Proven by Ultrasound and Cadaver Dissections

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Western University of Health Sciences INTRODUCTION. Original anterolateral ligament(ALL) term has been used to describe capsulo-osseous layer of iliotibial band(2007) and subsequently in 2013 given to yet another structure sharing proximal attachment of lateral collateral ligament(LCL). Additional structure reported as ALL has become recognized and important in surgical and non-surgical musculoskeletal arenas due to its association with rotational knee stability, anterior cruciate ligament injuries, Segond fractures and posterolateral knee pathologies. LCL runs posteroinferiorly from its known attachments. ALL morphology has been described in multiple anatomical studies with debated descriptions. Authors designed anatomical ultrasound protocol(USP) identifying currently known ALL structure. Study objective was to confirm if ALL is actually part of the LCL and provide a proper clinical anatomy term supported by ultrasound, MRI and cadaver dissections.

METHOD. Literature search was conducted on ALL and ultrasound. USP with 12, 18, and 22Hz classic linear ultrasound probes and Sonavate linear finger probe was used to identify ALL in 10 unembalmed, 10 lightly embalmed and 40 traditionally embalmed cadaver knees(N=60). MRI was completed on 6 unembalmed knees.

RESULTS. Dissection of donor cadaver knees was completed to reveal the morphology of the ALL(59:60). ALL identification noted on ultrasound and MRI were compared to morphology of ALL on dissection. MRI and dissection confirmed morphology of ALL as visualized on ultrasound imaging. ALL either shared the proximal attachment of lateral femoral epicondyle(44:60), branched from descending LCL(13:60), attached inferomedial(1:60) and no evidence of ALL(1:60). Distal attachment was consistently between anterior fibular head and Gerdy's tubercle(59:60,1-absent). ALL is now surgically repaired making terminology and imaging options important. Author's anatomical USP consistently identified ALL in non-injured knees.

CONCLUSION. In summary, dissection, ultrasound and MRI successfully identified ALL, which shared proximal attachment or originated from LCL suggesting proper clinical anatomy terminology as anterior lateral collateral ligament(ALC), and current LCL as posterior lateral collateral ligament(PLC).

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Femoral Canal is the Distal Segment of the Iliofemoral Canal Identified by Ultrasound

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INTRODUCTION. The femoral canal(FC) houses lymphatics within femoral sheath(FS). Generally FC is not defined in contemporary anatomy texts or is defined as the femoral ring, which is often considered the proximal end of the FC, not representing the entire canal. FC is conventionally, but inaccurately, described proximally from femoral ring distally towards apex of FS. For surgeons, radiologists and POCUS providers this is not comprehensive or accurate enough. They engage an intra-abdominal proximal FC region with different boundaries, which is critical when addressing femoral hernias. 20 million hernia repairs occur annually. Objective of this study was to define and delineate cone shaped FC integrated with ultrasound.

METHODS. Intra-abdominal and femoral dissections, ultrasound with and without laparoscopes on 5 unembalmed, 10 lightly embalmed and 26 traditionally embalmed cadavers(N=41) was conducted.

RESULTS. Dissections, ultrasound and laparoscopes on various cadaver preparations revealed 3 regions within FC (abdominal, inguinal, femoral). 1.Abdominal boundaries are: Anteriorly-iliopubic tract (transversalis fascia), Medially-arching iliopubic fibers joining pectineal ligament on superior pubic ramus, Posteromedially-curving iliopubic tract and transversalis fascia and Posterolaterally-iliopubic tract with pectineus fascia, Laterally-fatty tissue/lymphatics covering external iliac artery. 2.Inguinal(femoral ring) boundaries are: Anteriorly-inguinal ligament, Medially-transversalis fascia/ lacunar ligament, Posteriorly-pectineal ligament, Laterally-external iliac/femoral vein with septum of areolar tissue. 3.Femoral boundaries within FS are: Anteriorly-blended transversalis fascia/fascia lata, Medially-blended pectineal/ iliacus/ transversalis fascia, Posteriorly-blended pectineus/iliacus fascia, Laterally-areolar tissue septum of femoral vein. Many authors only define femoral ring boundaries providing inaccurate perception of FC proper. FC abdominal opening boundaries are critical anatomy for laparoscopic hernia surgery. Inguinal aspect or femoral ring structures of FC maintain patency preventing collapse and/or resisting compression. FS region of FC tapers distally from femoral ring allowing venous dilation and lymphatic drainage. Sir Ashton Cooper was emphatic regarding anatomical detail of the amazing architecture of the ‘groin’ region.

CONCLUSION. In summary, medical technology and procedures with or without ultrasound have evolved requiring detailed descriptions placing the FC within Iliofemoral canal improving clinical anatomy knowledge and pathology. Authors suggest universal terminology be assigned to 3 regions of the Iliofemoral Canal.

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Portable Handheld Ultrasound Aids or Confirms Deltopectotal-Acromio-Coronal-Technique During Humeral Intraosseous Cannulation

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INTRODUCTION. Conscious effort to challenge paradigms in trauma resuscitation combined with the pace of progressive medical technology has enabled healthcare educators, innovators, researchers and providers to bring peripheral ideas to mainstream medicine. For nearly 40 years, intraosseous access for fluid and drug delivery was reserved for secondary sites when traditional intravenous access was compromised. Humeral intraosseous access (HIOa) technique was recently investigated and established by Benninger et al 2019. The Deltopectoral-Acromio-Coronal technique (DPACt) combined palpation and anatomical landmarks to aid a provider consistent identification of the grater tuberosity for HIOa. Objective of this study was to design and develop a technique using handheld portable ultrasound to identify greater tubercle for HIOa.

METHODS. Literature search was conducted on IO techniques and website videos. DPACt techniques was performed on Freedom art embalmed cadavers combining palpation, ultrasound and full dissection. Cadavers: N=30 sides:M-20, F-10, with no shoulder arthroplasty. The deltopectoral groove (DPG), acromial coronal plane (ACP), and greater tuberosity (GT) of the humerus were identified from static and dynamic palpation in neutral and internal rotation positions of the glenohumeral joint for DPACt. Sonavate finger probe, GE Vscan, Phillips Lumify and Clarius portable handheld systems were used to identify greater tuberosity. Visual, auditory, palpation, imaging learning (VAPIL) ratio method was designed as a teaching technique for skill acquisition and sonoanatomy.

RESULTS. DPACt was successful identifying DPG, ACP and GT during static and dynamic palpation and confirmed subsequently with each portable handheld US systems used on study cadavers. Increased childhood and adult obesity inevitably will challenge experienced and novice providers to accurately identify GT during palpation. Portable handheld US systems can be used to confirm GT landmark for varied skill levels of provider and for multiple pathologies requiring HIOa.

CONCLUSION. This study revealed portable handheld US systems can be used to confirm and/or identify GT for HIOa using DPACt conducted on cadavers. This study suggests the anatomy lab can be a robust training ground integrating VAPIL with ultrasound and physical exam skills for HIOa.

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Three Pull Trigger Technique Using Innovative Thoracostomy Chest Tube Introducer with Ultrasound Should Surpass Conventional Techniques

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INTRODUCTION. Commonest intervention in thoracic trauma is conducting a thoracostomy placing a chest tube into pleural space for draining fluid/air. It is widely successful, diagnostic, therapeutic and often definitive treatment for presenting symptoms. It can be used to introduce agents for pleurodesis or deliver drugs for chest infections or chemotherapy. Despite its common use, technique has remained rather crude and unchanged over 50 years and with experience, be completed in 5-10 minutes. Objective of this study was to design an innovative technique for thoracostomy chest tube(TCT) initially on pig ribs and subsequently cadavers.

METHODS. We developed a visual, auditory, palpation, imaging, learning(VAPIL) ratio in anatomy lab using Sectra(2D/3D cross-sectional imaging) ultrasound and prosected cadavers prior to using 3-pull trigger technique with Reactor (minimally-invasive surgical TCT placement technology). Adult pig ribs with skin for kinesthetic sense and structure orientation was used before cadaver attempts.

RESULTS. Clinically a high rate of failure has been observed with the classic technique of needle decompression for tension pneumothorax. With time difference between basic science learning and skills acquisition, it seems logical to integrate anatomy with such skills during year 1 curriculum. TCT was repeatedly conducted in less than 2 minutes (minus adhesive tape or suturing).

CONCLUSION. Employing VAPIL with ultrasound as the imaging method in anatomy lab employing a 3-pull trigger technique using the Reactor suggests novices could perform accurate surface anatomy and TCT placement in under 2 minutes. Further TCT- Reactor studies could revolutionize thoracostomy (chest tube) placement efficiency, retention and reduced reproducibility , diminished pain and morbidity.

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Teaching Ultrasound Skills by Applying Disruptive Innovation with Inexpensive Security Technology with Portable Handheld Systems as Online and/or Distance Learning Tools

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INTRODUCTION. Distance-learning can be viewed from three levels; 1. Through rose colored glasses where delivery from a world expert and or innovative minds stimulating others from less accessible corners of the world; 2. Creating a cost-effective delivery of curricula from one campus site to another often referred to as streaming etcetera; 3. Inexpensive delivery with live quality audio +/- live video +/- video recordings. The objective of this project was to identify technology less than $200 which transmits live audio lecture +/- live visual recording +/- recordings of skills.

METHODS. Search was conducted identifying technology under $200 with cloud service. Assess live lecture delivery and visual recordings.

RESULTS. Ring was the home security system identified with speaker system, 180° panoramic visual and recording capabilities. Free Ring app download to iPhone linked with handheld Ring unit. Lecture was successfully delivered from coffee house in New Zealand with iPhone to Ring unit in Oregon while seven people listened. Lecturer heard comments and viewed recorded activity for 10-20seconds which populated immediately on iPhone app. Live visual movement was not good, but recorded visual activity was good.CONCLUSION. This project exercised disruptive innovation using an inexpensive cloud-based home security system by Ring delivering anatomy lectures between countries for distance learning. This suggests students from distant sites (countries) don’t all have to own computers and be connected to WIFI to receive tutorials or lectures from another country.

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Integrating Ultrasound with an Innovative Video Laryngoscope and Bronchoscopy System Teaching and Maintaining Intubation Airway Anatomy and Skill Sets

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INTRODUCTION. Obtaining an airway accurately and in a timely manner safes lives and morbidity. We depend on pre-hospital care providers to be experts. Medical schools teach basic life and cardiac support which includes airway, but few students practice such skills, and fewer were taught anatomy of clinical intubation. Medical school anatomy lab exposes some to cricothyrotomy. Video laryngoscope(VL) is challenging known intubation techniques, anatomy, and protocols. Bronchoscope is used for intubation, tracheostomy, lavage, and biopsies. Knowing where best to conduct tracheostomy and understand intubation anatomy may alter with spinal curvature, degree of extension-flexion, anteroposterior diameter of chest and whether child or adult. Length of trachea in relation to surface landmarks needs understood. Objective was to evaluate if a simulator and donor cadavers could reveal functional airway anatomy using a VL and bronchoscope(BS) unit(VLBS) to teach airway anatomy and skill sets.

METHODS. Integrating ultrasound with VLBS unit by Glidescope was used on 7-Sigma burn simulator and donor cadavers on separate days to evaluate reproducibility. VL and BS was placed into oral/nasal cavity singularly and together for single and two user training viewing nasal and oral cavity, pharynx, trachea and bronchial anatomy.

RESULTS. No known studies using a combined VLBS unit with ultrasound to teach or maintain anatomy and airway skills for medical students was identified. Consistent extensive anatomy was revealed from both simulator and cadavers at different times and days.

CONCLUSION. VLBS unit with ultrasound could be used as an anatomy-airway skill system to teach and/or maintain airway anatomy and skillsets in cadaver and/or simulation labs.

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When Does Ultrasound Fit in a Mixed Simulation Center or Clinical Anatomy Lab: Paradigm Shift in Teaching and Learning Sonoanatomy for training Healthcare Professionals

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INTRODUCTION. Teaching anatomy to healthcare students/trainees relies on pedagogical lecture- dissection practical. These conventional methods are reproducible and relatively effective. Pinned lab exams are biased poor measuring parameters of critical thinking and clinical skills. Students grow bored of didactic and lab experiences. Objective of this study is to reveal innovative philosophies and practices to teach todays expected anatomy knowledge base and skill sets for a changing paradigm in healthcare education.

METHODS. Literature search was conducted on student learning psyche, cognition, and behavior. Alternatives to conventional lecture and lab delivery was developed. Anatomy lab was redefined as a Simulation(SN) lab, subdivided into Dry, Wet and Mixed SN(DSN,WSN, MSN), and further stratified into 1st, 2nd, and 3rd order SNs based on the nature of the SN and how its integration with today's healthcare approach.

RESULTS. Search revealed multimodal SN improves learning favoring anatomy teaching integrating SN. Lectures converted to 3x15-minute didactic sessions with 5-minute breaks equaling 1-hour. Lab delivery of DSN, WSN and MSN with anatomy deconstruction/reconstruction(D/R) philosophies was applied. DSN included surface anatomy, 3D models, Sectra 2D/3D imaging, Opus mini robotics, live and SN ultrasound, and wearable SN. WSN included dissection/prosection cadavers with surgical equipment integrating cadavers, imaging and clinical skills. MSN combined DSN and WSN to integrate both D/R learning. Paradigm shift must occur to maximize anatomy teaching/learning experiences, dissection is augmented by SN technologies including mixed realities with D/R learning philosophy.

CONCLUSION. Sensorial rich mediums providing visualization and kinetic sense integrated with mixed simulation combined with D/R philosophy creates experiential learning of sonoanatomy and POCUS skills.

John Fitzsimmons

Use of Ultrasound as a Teaching Method to Improve the Physical Exam Skills of First-Year Medical Students

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Medical schools across the United States have incorporated Ultrasound (US) into physical exam (PE) instruction for improving technique, accuracy and confidence; however, evidence of impact is mixed. We examine its effectiveness in first year medical students (FYS) and whether such instruction affects standardized clinical skills assessments.

FYS who completed an elective Advanced Clinical Skills (ACS) course in Spring 2018 were included in this retrospective study. At the start and end of the course, students performed a PE to identify several body structures pre-identified via US. Rate of correctly identifying structures was recorded before/after the course and results compared. Students were given pre/post surveys about PE skills and confidence and responses compared. Performance in Progress Clinical Skills Exams (PCSE), a Step 2 Clinical Skills-style exam was compared to non-ACS students. All FYS took the PCSE twice before and twice after ACS was implemented.

Forty-eight FYS took ACS and were included. For PE accuracy assessment pre-ACS, the ACS group correctly identified a mean of 1.83 of 5 structures which increased to 3.13 at the end of the course ($p<0.01$). Student confidence in performing PE's improved; at the end of ACS, 79.6%, up from 44.7%, of students agreed with the statement "I am confident in my ability to perform invasive procedures" ($p<0.01$). Additionally, PCSE scores before/after ACS were examined and compared to the non-ACS FYS (N=150). The ACS and non-ACS group's PCSE scores before ACS showed no significant difference. Immediately after the course, the ACS group's average score was significantly higher. This difference was not observed in the second PCSE after ACS.

Participation in a clinical skills course in which US-aided PE skills were taught resulted in improved performance and confidence in first year students performing physical exams. A significant but temporary improvement in PCSE exam scores was observed in ACS students vs non-ACS students after the course.

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Delphi Survey of Curriculum Module Selection in the Ocular Application of Ultrasound in Gross Anatomy Training

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Ultrasound technology is an established, effective tool for teaching anatomy in medical school, however there is no standard regarding ultrasound knowledge and skills that a graduating student should achieve. This is an effort to generate a consensus of ultrasound and ophthalmology experts for the development of ocular anatomy curriculums.

A cross-sectional Delphi survey was conducted using surveys distributed to ultrasound and ophthalmology experts. A focus group informed the generation of the preliminary Delphi survey, resulting in the exclusion of non-applicable anatomical structures. Relevant structures were then included on the final survey, in which experts were asked to evaluate application of ultrasound for the given structures based on three criteria: 1-anatomical yield, 2-ultrasound feasibility and 3-clinical applications, rating each on a scale of 0-10. The scores were averaged, and structures with scores above 15 were classified as well suited for the training curriculum.

In the preliminary survey, 62 ocular structures were identified based on clinical anatomy outlines. 21 structures were then identified for the final survey. 20 ultrasound and ophthalmology experts found 11 of these structures to be well suited for ultrasound instruction with high anatomy educational yield, high ultrasound feasibility and important clinical application. These structures included the retina (27/30), vitreous humor (26/30), lens (24/30), optic disc (23/30), posterior chamber (21/30), optic nerve sheath (20/30), anterior chamber (19/30), retrobulbar space (17/30), iris (17/30), and pupil (16/30).

By developing a consensus among experts, we identified high yield applications to be included in teaching ocular anatomy using ultrasound. Similar scoring approach can be used as models to define priorities in other anatomy topics.

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A Simulated Observed Standardized Clinical Exam to Assess Cardiac Diastolic Function: A Feasibility Study

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Cardiovascular disease is the number one cause of mortality worldwide, with heart failure being a major contributor to disease burden. Heart failure with preserved ejection fraction (HFpEF) continues to increase steadily in prevalence, and now comprises the majority of heart failure cases. Diastolic dysfunction is the predominant pathology found in HFpEF, the severity of which can be evaluated by echocardiographic techniques. With the rise in diastolic heart failure, it has become imperative that learners recognize the anatomy and pathophysiology underlying the disease course. Literature suggests that ultrasound medical education through the use of ultrasound simulation is an effective means to teach and assess knowledge and skill in acquiring and interpreting images of point-of-care ultrasound. Heartworks, a cardiac ultrasound simulator (Inventive Medical LTD, London, UK), provides a mechanism by which trainees can understand and asses cardiac diastolic function as well as dysfunction under pathological states. Our study aimed to develop an Objective Standardized Clinical Examination (OSCE) of cardiac diastolic function through echocardiographic simulation and implement this tool through assessment of advanced ultrasound learners. The Ohio State University College of Medicine (OSUCOM) has implemented an advanced ultrasound curriculum in which medical students learn fundamental views and anatomy of cardiac ultrasound. We conducted a pilot study of fourth year students who have completed the OSUCOM advanced ultrasound series (with understanding of standard cardiac views) to determine feasibility of teaching cardiac diastolic function assessment on a simulator.

A cohort of 4th year senior medical students are piloted for a 2-hour didactic session in which principles of doppler ultrasound modalities and diastolic ultrasound assessment through transmitral flow assessment is taught on the Heartworks simulator. Pre- and Post-test assessment was conducted to document student confidence (in using the ultrasound equipment), knowledge (of standard cardiac anatomy and E/A ratio interpretation). The student cohort then undergoes an Objective Standardized Clinical Examination on the Heartworks simulator to be assessed on and skill (in obtaining apical 4 chamber view with transmitral flow acquisition in both normal and pathological states (ex. Chronic aortic stenosis). Images acquired during the OSCE are anonymized and graded by faculty expert sonographers. We collected pretest and posttest data pertaining to knowledge of doppler modalities and anatomical and physiological understanding in echocardiographic acquisition of transmitral flow diastology. Image quality and interpretation will be graded as defined above. Data statistical analysis pending the finalization of the study training program.

The simulated OSCE of cardiac diastolic function utilizing the Heartworks cardiac simulator was tested on a cohort 4th year medical students. Our results demonstrate feasibility of our study using a cardiac ultrasound phantom in medical education of diastolic function. This addition to our ultrasound medical education program may allow for enhanced learning of cardiac pathophysiology in diastolic dysfunction as well as basic competency in apical 4 chamber transmitral flow acquisition. Additional cohorts would be needed to assess feasibility in utilization of this program to enhance training of resident physicians and faculty towards interpretation of diastolic function and understanding steps in management in the clinical setting.

Ashley Gray

Sonographic Topography: Where are the Machines? An Initiative to Enhance Ultrasound Education for Medical Students

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Ultrasound usage is growing in medical specialties due to its safety and efficacy as an imaging modality. Currently, few established methods exist to analyze the ultrasound landscape across an entire institution. In preliminary work, a novel concept known as Institutional Sonographic Topography (IST) was developed in order to analyze ultrasound equipment data at our institution. The IST is a digital map of the ultrasound equipment and associated data across an institution. While the first phase of IST focuses upon ultrasound equipment locations, the framework is established for incorporation of other components including machine usage, user credentialing, policies, protocols, documentation, and reimbursement. This information is especially useful for medical students to identify areas for ultrasound training in the preclinical and clinical years. Specifically, third and fourth year medical students must navigate various rotations that may not have the infrastructure to effectively teach ultrasound. Institutional Sonographic Topography would facilitate ultrasound opportunities for medical students by providing them with information they need to succeed in learning how to use ultrasound in the clinical setting.

An inventory of current ultrasound equipment was collected in 2015 and 2019 from central services. Descriptive analyses comparing equipment locations across departments was collected in order to incorporate new machines, eliminate obsolete and inactive machines, and organize the current machine footprint from the initial data collection in 2015. Equipment was categorized as diagnostic or therapeutic, point-of-care or comprehensive, inpatient or outpatient, and attributed to a specific division or department. These locations will be made available to medical students via a Student Ultrasound Educational Interface (SUEI) where students can easily identify areas in the hospital where potential ultrasound learning opportunities during clinical rotations could occur. The SUEI is made easily accessible for students on the OSU ultrasound website.

In 2015, the institution had 287 active diagnostic ultrasound machines in 16 departmental categories. In 2019, there are over 350 active ultrasound diagnostic machines in 17 departmental categories. Additional calculations and statistical analyses are underway and will be included in the Institutional Sonographic Topography and the SUEI.

Institutional Sonographic Topography (IST) as a graphical construct can be applied to nearly any hospital system, especially large academic medical institutions that aim to refine ultrasound learning experiences for medical students. Although handheld ultrasound units such as capacitive micromachined ultrasonic transducers (CMUTs) may change medical student ultrasound education in the near future, they are not yet ubiquitous. Until this time, medical students can benefit from an established interface to access opportunities for ultrasound education that may currently be absent. The SUEI may help create such a network by linking students to an IST. Later phases of IST can incorporate accompanying machine usage, credentialed mentors, and policies. Perhaps IST will enhance ultrasound education by aiding medical students in locating areas for training and mentorship. Future studies are needed to evaluate this innovative model at other institutions.

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Where's the money? Funding ultrasound activities as a medical student ultrasound interest group

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Our medical school has had a well-developed ultrasound interest group for over a decade. As with any student organization, acquiring funding sources to support the organization and hold events can be challenging, so having a framework in place is vital for the sustainability of the organization. This abstract will illustrate best practices in funding a medical student ultrasound interest group to ensure the longevity of the organization from a financial standpoint.

To be registered as an official student interest group within our university, a group must have the following: a written constitution, at least 3 student officers, including primary leader, secondary leader, and treasurer, student membership of 5 or more, and a faculty advisor. By meeting these requirements, groups can receive $200 in operating funds to use for daily needs annually along with up to $3000 for individual qualified events directly from the university. In addition, medical student groups can leverage funding from other institutional sources, including the school's Student Council, Medical Student Alumni Council, and Interprofessional Council, along with individual hospital departments. Once funding is secured, it is imperative to accurately track inflows and outflows through the use of ledgers and funding management spreadsheets. According to each school's website, only two of the other six medical schools in Ohio have an official ultrasound interest group. The Ultrasound Interest Group at our medical school was established in 2007 and became registered as an official university student group in 2011, receiving approximately $3,200 annually in funding from the university since. The group has consistently maximized multiple funding sources to acquire over $5,000 each year to host an ultrasound symposium, which invites medical students from across the region for a day of hands-on ultrasound learning. An electronic, shared ledger has been successfully implemented to be able to quickly and easily know the financial status of the group, while providing transparency to all group leaders to facilitate financial discussions and promote accountability within the treasurer role. Securing funding for a medical student ultrasound interest group is essential to ensure the longevity of the organization. By seeking out and leveraging available funding sources, our group has found success not only with large-scale events, but also with developing and implementing four levels of ultrasound didactics to supplement the medical school curriculum. For those looking to develop an ultrasound interest group at the medical school level, it is imperative for the treasurer to do four things: prioritize funding early, understand the funding requirements the university has in place, seek out many sources to maximize funding potential, and keep accurate financial records to budget and allocate funds appropriately. Establishing a well-funded, student-run ultrasound interest group takes time and effort. Throughout the process, having a diligent treasurer with an organized funding plan sets a group up for long-term success so it will hopefully never have to wonder "where's the money?

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An Integrated Curriculum For Teaching Ocular Ultrasound to Medical Students

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The Ohio State University College of Medicine is fortunate to have the Ultrasound Interest Group—a co-curricular option for medical students to provide experiences beyond the established core competencies. The program has been looking to develop courses that enhance practical knowledge and skills necessary for today's medicine. Diagnostic ultrasound tool is a valuable asset for medical students to use throughout their medical training. Ophthalmology provides a unique way to teach ultrasound concepts but is also a beneficial subject to all students due to the increase of systemic diseases that present earlier in the eyes. Therefore, we designed an integrated course that would provide students a novel approach for learning ocular ultrasound, safety, and methods to acquire and interpret ultrasound images. The objective of this study is to create a curricular module that combines the fundamentals of ophthalmology and ultrasound so that students can have a framework for learning how to safely use ocular ultrasound throughout their training.This curriculum consists of three main components—didactics, hands-on learning and engaged assessment. Didactic presentations have been created to cover essential subject matter—these include understanding how ultrasound imaging works, how to perform a comprehensive ocular exam and a combined lecture on ultrasound imaging in ocular pathology. Students receive supplementary one-page handouts for all didactic sessions to utilize as reference material, as well as check-in questions incorporated into the sessions to assess for immediate understanding. There will also be an anonymous feedback link for students to provide questions and comments in real-time. Following didactics, students will participate in hands-on sessions in small groups led by expert proctors. During these sessions, students will learn knobology, how to use different ultrasound probes and specific techniques, how to utilize a direct ophthalmoscope and slit lamp and how to provide a correct and safe ultrasound scan of the eye. Then, students will have the opportunity to test their knowledge throughout a series of challenges that will enable them to demonstrate competency in set course objectives.

We expect that the introduction of an Integrated Ocular Ultrasound course will provide a foundation for pre-clinical medical students. This course will promote principles of interprofessional collaboration, critical thinking and basic ultrasound knowledge. We believe that it will provide a nuanced understanding of clinical skills and a universal ability to apply this understanding to all facets of medicine.

Ocular ultrasound can be a useful tool for helping differentiate a myriad of conditions. This integrated curriculum provides a basis for medical students to apply ultrasound principles in the care of ophthalmologic complaints. Future studies will examine knowledge retention from the initial course and throughout medical school.