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Abstract

An overview of the development and implementation of a novel, longitudinal point-of-care ultrasound curriculum implemented for third-year, allopathic medical students at a branch campus is presented. A model employing didactic and hand-on ultrasound education was incorporated into the newly established longitudinal MS-3 curriculum. The ultrasound curriculum was developed in conjunction with student didactics and simulation sessions in a theme-based approach.

Keywords: Ultrasound, education, medical student, regional campus

INTRODUCTION

A generation of physicians will need to be trained to view ultrasound as an extension of their sense, just as many generations have viewed the stethoscope. That development will require the medical education community to embrace and incorporate the technology throughout the curriculum.[1]

In 2010, the University of North Carolina School of Medicine (UNC-SOM) formally partnered with Carolinas HealthCare System in Charlotte, North Carolina to create the UNC SOM Charlotte Campus. Beginning with the 2013-2014 academic year, a program titled the Charlotte Longitudinal Integrated Curriculum was established, creating an environment in which third-year medical students were simultaneously enrolled in clinical experiences within all clerkships, rather than the standard 4 to 8 week individual clerkship blocks. This change in curriculum coupled with the lack of a formal introduction to ultrasound within the medical school curriculum and the growing role of "point-of-care" ultrasound (POCUS) in medicine led to the creation of the novel longitudinal curriculum described here.

The role of ultrasound in medicine has expanded greatly since its initial introduction in 1947, becoming heavily engrained in the fields of obstetrics/gynecology, cardiology and radiology.[2] However, it was not until technology advanced, making machines smaller and more mobile, that the concept of "point-of-care" ultrasound emerged.[3] Placing the imaging power of ultrasonography in the hands of the clinician at the bedside for immediate and simultaneous performance and interpretation revolutionized the field and allowed expansion into new and growing specialties.[3] The spectrum of applications and fields that have begun employing this diagnostic

Margaret R. Lewis, MD FACEP, Assistant Professor, Director of Ultrasound in Medical Student Education, Department of Emergency Medicine
Lisa Howley, PhD, Association of American Medical Colleges
Patricia White, MD, Carolinas Healthcare System
Celeste Colcord, MBA, Department of Medical Education, Carolinas Medical Center/ University of North Carolina School of Medicine Charlotte Campus
Bryant K. Allen, MD, Assistant Professor, Department of Emergency Medicine, Carolinas Medical Center/ University of North Carolina School of Medicine Charlotte Campus
Corresponding author: Margaret R. Lewis; Margaret.Lewis@carolinashealthcare.org 843-708-1043

technology continue to grow, now becoming used extensively in emergency medicine, OB/GYN, anesthesia, internal medicine, critical care, radiology, surgery and cardiology.[3-8] Moore, et al. cautions, however, that "ultrasound is a user-dependent technology, and as usage spreads, there is a need to ensure competence, define benefits of appropriate use, and limit unnecessary imaging and its consequences."[3]

Despite the massive expansion of the role of ultrasound in medicine, the growth of ultrasound training in undergraduate medical education (UME) has been limited and greatly varied. According to a 2012 survey, 62.2% of responding allopathic medical schools identified ultrasound as a component of their UME, though no consensus on methodology of introduction was present.[9] Presently a wide variety of methods for UME have been proposed. Early introduction of ultrasound as a tool to augment physical examination teaching has been shown to not only be well received by students, but also appears to improve overall physical examination skills.[10-12] Early introduction of ultrasound in medical school has led to success in both increased objectively graded Objective Standardized Clinical Examination (OSCE) testing and ultrasound skill level.[11, 13] Alternatively, short elective courses, seminars and symposia have also shown great success in engaging learners and improving ultrasound knowledge.[14-16] Finally, Hoppmann, et al at the University of South Carolina School of Medicine enacted a 4-year ultrasound experience, with exposure to ultrasound throughout both pre-clinical and clinical components of undergraduate medical education at a single campus.[17] Many institutions nationwide that have ultrasound components in UME incorporate ultrasound in the third year of medical school (MS-3), the traditional introduction of clinical rotations.[9]

Given the implementation of a new format of MS-3 curriculum for an entire campus, a unique opportunity to create a novel longitudinal ultrasound curriculum was born. The Society of Ultrasound in Medical Education (SUSME) curriculum database offered several innovative ultrasound curricula to use as a resource in the development of the UNC SOM Charlotte Campus ultrasound curriculum, most notably the iUSC curriculum[17], but no single published curriculum met the needs of the growing longitudinal training environment of the branch campus. The purpose of our review is to illustrate the components of the novel longitudinal curriculum and discuss the development of the ultrasound curriculum in conjunction with other aspects including traditional didactics and simulation.

LONGITUDINAL CURRICULUM

The Charlotte Longitudinal Integrated Curriculum (CLIC) hosted its first class in the 2013-2014 academic year. This was a pilot program, with six students the first year, and eight the second year. The curriculum was divided into two phases: 1) July -September; and 2) October - June. The first phase consisted of expedited block rotations through internal medicine, surgery, and obstetrics/gynecology. During the second phase of the curriculum, students were assigned to community preceptors in various specialties (family medicine, internal medicine, gynecology, neurology, psychiatry, and pediatrics) and have dedicated clinic time each week to see his or her "panel" of patients. These clinic settings tended to be located in urban underserved clinics, primarily Spanish speaking clinics, or more rural clinics.

In addition to the community experience, students participated in a variety of other educational opportunities to enhance their clinical education. These included emergency department shifts and "pulse weekends", formal didactics, simulation and ultrasound curricula. During the "pulse weekend", students reported to the emergency department on Friday afternoon and identified one patient to evaluate and follow throughout their hospital stay. The student then transitioned with the patient to the inpatient team, through surgery if needed, possibly to rehabilitation and outpatient office visits. This "pulse weekend" provided the student a unique perspective and understanding of the medical system.

In the second portion of the curriculum, Tuesday afternoons and Fridays at noon were reserved for the "thread" sessions – a combination of ultrasound, simulation, ethics, and didactics. These thread sessions were scheduled around common themes (Table 1). For example, students had lectures on chest pain, EKG reading and chest x-ray interpretation followed by a simulation session on chest pain evaluation. Students then had an ultrasound session on cardiac and thoracic ultrasound exams.

ULTRASOUND CURRICULUM

The approach to the longitudinal curriculum was to divide the intended content into 7 theme-based teaching sessions, with each session to have didactic and practical components. Sessions occurred in four-hour afternoon blocks over the course of the MS-3 year. The initial longitudinal curriculum components for academic year 2013-14 are illustrated in Table 2.

During the introductory year, the ultrasound course occurred over a total of seven four-hour sessions during the CLIC schedule, encompassing a time frame of approximately 8 months. Given the lack of previously described curricula in this setting, components from several examples, including those endorsed by SUSME, were adapted to maximize student exposure to point-of-care ultrasound education. With the goal of introducing MS-3 students to ultrasound as a tool for screening, diagnostic assessment and procedural guidance, the novel longitudinal curriculum was created. We used a combination of lectures, practical sessions and group competitions as outlined in Table 3.

Didactic activity

In order to cover content that incorporated multiple aspects of POCUS as well as review of previously covered topics, each session opened with a short, focused theme-based small group discussion. The discussions utilized a variety of patient scenarios to correlate with topics taught in their core didactic sessions as well as simulation. The intent was for the student to appreciate how ultrasound functions in the overall patient evaluation. These discussions were limited to one hour or less and were led by faculty or the fellow of the Division of Emergency Ultrasound within the Department of Emergency Medicine. Individual session topics described further in Table 2.

"Hands-on"/Practical activity

Following completion of the didactics, the participant group was divided into smaller groups of 2-3 students for the practical component of the session. Each small group then underwent direct instruction on a particular application of point-of-care ultrasound. Standardized patients were used for the majority of exam applications, except for the pelvic ultrasound and central venous catheter placement sessions, which employed Blue Phantom™ models. These models simulated human tissue and vascular structures that were identifiable by ultrasound as well as simulated female pelvic anatomy including uterus and ovaries. The models also allowed students to learn an invasive exam (transvaginal ultrasound) as well as needle guidance with ultrasound without utilizing standardized patients. After bedside instruction by faculty, students each demonstrated the application technique, receiving immediate feedback. Each student was given ample opportunity to obtain images adequate for clinical interpretation, and was offered additional exposure after completion of the session if desired.

Group competition

At the conclusion of sessions 2-6, the group was divided into two equal teams for a friendly ultrasound competition. Teams were either given clinical scenarios with corresponding ultrasound images (either normal anatomy or representing pathology) that they had to interpret and make clinical determinations using or they were tasked with performing a specific ultrasound application. The team that interpreted the image correctly and acted accordingly or that performed the desired exams and was found to obtain adequate images was awarded points. A running point total was kept for the duration of the curriculum. The winning team of this competition was awarded both

bragging rights and a small prize at the conclusion of the course.

Individual ultrasound exams

Students were instructed to assist with or individual perform ultrasound applications during their other clinical rotations within the CLIC. Largely, students performed the exams during their time in the Emergency Department, with the guidance of ultrasound faculty and/or EM residents. Each student maintained a log of these exams for the duration of the longitudinal curriculum, and all images underwent quality assurance review by ultrasound faculty.

Further Student Ultrasound Opportunities

Students also had the opportunity for a further, more focused ultrasound elective in their fourth year of medical school. In this elective, students rotated with ultrasound faculty members in the Department of Emergency Medicine, performing focused, bedside ultrasounds on emergency department patients. In this rotation, students performed a variety of ultrasounds and were exposed a wide array of pathology. Students also reviewed ultrasound related articles and gave a case-based presentation.

ULTRASOUND ASSESSMENT

Knowledge assessment/Course Pre- and Post-testing

All student participants underwent standardized testing on various ultrasound topics at the beginning and conclusion of the longitudinal ultrasound curriculum. These pre- and post-test consisted of 20 multiple choice questions authored by members of the faculty of the Division of Ultrasound within the Department of Emergency Medicine. The pre- and post-test were identical and were based on prior ultrasound exams given to first year emergency medicine residents during their ultrasound rotation. Given the timeframe between test administrations, no randomization or recoding of the test was performed. Questions covered topics involving ultrasound physics, ultrasound application logistics, and image interpretation. Results from the pre- and post-test are reported in Table 4.

Skills Assessment

During the final session, each student's ultrasound application skills were assessed through six "hands-on" stations. Tested applications include cardiac, thoracic, FAST, aorta, and central line placement with a Blue Phantom™ model. Each session was observed by faculty from the Division of Ultrasound in the Department of Emergency Medicine, an Ultrasound fellow or PGY-3 Emergency Medicine resident. Students performed each exam unassisted and informed the observing faculty when they felt an adequate image had been obtained. The faculty used a modified Likert scale to grade the image quality and demonstrated skill in obtaining the image (Table 5). Scores for each intended image were then averaged for the station. Students then participated in a session in which they had to identify a series of normal and abnormal ultrasound clips and images. The students were then asked to currently interpret each image, without information regarding the clinical case or scenario. Percentage of correct image interpretations was recorded. Results and scores from skills assessment for each initial student are included in Table 6.

Survey and Feedback

Each participant was asked to complete a brief survey at both the beginning and conclusion of the curriculum, assessing both their prior exposure and comfort level with ultrasound as well as their sentiment regarding ultrasound education as a component of UME. Survey questions are included as Attachments 1 and 2. Comments regarding the student experience were also collected during the post-course survey.

RESULTS

Pre-post Testing

Initial knowledge assessment was performed before any training in point-of-care ultrasound was performed, which was reflected in the scores. Data and individual scores are presented in Table 4. Average score on initial testing was 55%, with a range of 50-65% and median of 52.5%. The same test was given at the conclusion of the course without any changes in question or answer orders.

Students demonstrated significant improvement across the board, with a group average of 81.7%, ranging from 70-90% with a median score of 82.5%. The average improvement in scores after completion of the novel, longitudinal ultrasound curriculum was 26.7%, with a median individual improvement of 30%.

Skills Assessment

The skills assessment was compiled of practical application stations where ultrasound faculty evaluated individual ultrasound exam performance and an image identification station. Students were graded on a 5-point Likert scale by ultrasound faculty for each examination performed (delineated in Table 5) as well as on the percentage of correct image identifications and interpretations (delineated in Table 6). Students overall achieved scores of 3.8 to 5 for each application and were deemed to have "good" to "excellent" ability to obtain and optimize point-of-care ultrasound images. Image identification without supplemental information or description of clinical scenarios was found to be more difficult by students, demonstrated by the average score of 72.2%, with a range of 50-94.4%.

Student Perspectives Survey

To assess student perspectives regarding the novel, longitudinal ultrasound curriculum, students were given an anonymous mixed methods survey at the beginning of their ultrasound curriculum and during their final session. Responses were based on a five-point Likert Scale (results in Table 7).

Students were surveyed on different ways in which ultrasound education may or may not improve their medical education. Survey questions are listed in Attachment 2. Overall, the student thought that ultrasound education has value in undergraduate medical education and is best incorporated into clinical years.

DISCUSSION

We set out to describe the design and implementation of a point-of-care ultrasound course into a longitudinal third year medical student curriculum. The ultrasound course was created to complement the overall third year curriculum design and allow students to learn a unique skill. Students covered fundamentals including ultrasound physics and image acquisition, ultrasound-guided procedures, free fluid assessment, basic cardiac and thoracic, and early obstetric and gynecologic applications.

Overall the students had improvement in their ultrasound knowledge based on a multiple-choice test. Students were also able to perform a series of point-of-care ultrasound exams with good technique: Students were able to obtain particular images without prompting or direction, indicating knowledge of ultrasound anatomy. The students did have difficulty with the image interpretation portion of skills assessment, which was designed to test knowledge and identification of abnormal ultrasound images.

Throughout the course, students were shown ultrasound images representing normal anatomy as well as abnormal anatomy or pathology. However, the images representing pathology were always given with a corresponding clinical scenario. Students struggled when ultrasound images were taken out of context. The blinding to the clinical scenario is absent in modern point-of-care ultrasound, where the clinical provider is both the sonographer and interpreter, well versed in the current clinical case. Though one could assume that student's interpretations of images would have improved in accuracy with an association of the clinical scenario, this limitation certainly allows for further exploration and study.

Students of the novel curriculum felt that ultrasound education incorporated into their third year of medical school enhanced their knowledge of anatomy and pathology, as well as knowledge of diagnostic imaging choices and patient safety. The students also felt that this curriculum helped to improve their physical exam skills and helped them to correlate basic science with clinical reasoning. These results reflect the findings of the iUSC curriculum, in which students felt that ultrasound education enhanced their understanding of the physical exam and overall enhanced their medical school education.[25] These results are shared and

highlighted as part of the collaborative effort through SUSME.

With the growing role of ultrasound in clinical medical practice, much must be done to increase the prevalence of ultrasound education in undergraduate medical education. While some medical schools have achieved this through introduction of ultrasound into early physical examination and anatomy courses[11-12, 19], one-time seminars[14, 15] and 4th year electives[16], these approaches may not work across all medical school curricula. Previous success had been reported with implementation of a theme-based format when similar short blocks of time were used for educational purposes with point-of-care ultrasound (POCUS).[15] Additionally, ultrasound at the graduate medical education (GME) level has shown to be most successful when it has employed a combination of ultrasound faculty directed didactics and hands-on experience.[18] Within a review of emergency medicine resident competencies of POCUS, it was found that programs that had 15 hours of didactic education and a formal ultrasound rotation produced residents with higher test scores on standardized ultrasound testing and improved competancy.[18] When combined with bedside performance of ultrasound examinations by students, an elective course in POCUS combining 4-hours of didactics with image review proved an effective manner in which fourth year medical students could gain basic competency.[16]

Great strides have been made in graduate medical education to create standardized guidelines for ultrasound education. Findings such as those listed above have led to professional organizations creating standards for ultrasound education within GME.[20, 21] However, these consensus guidelines do not yet exist for UME.

A longitudinal approach to ultrasound education within the UME environment has seen significant success. Hoppmann et al. formulated a 4-year longitudinal curriculum for implementation in the University of South Carolina School of Medicine[17], resulting in students enrolled in the curriculum feeling that such an approach improved their overall medical education. This approach, however, is not easily reproduced, especially in the growing environment of medical school expansion into remote, branch campuses.

The approach we chose at a branch campus level allowed for scaling of the barriers that face curriculum implementation, including finding interested faculty, machines for training and funding. At the inception of the longitudinal MS-3 ultrasound curriculum, there was no comparable ultrasound curriculum at the main campus or other branch campuses. Point-of-care ultrasound has not been part of the core curriculum for the MS-3 year, and has been offered at the UNC SOM Charlotte Campus only as an adjunct to the core curriculum. Additionally, POCUS is not currently a part of the Core Entrustable Professional Activities (EPA's) as set forth by the Association of American Medical Colleges (AAMC).[26] Currently the main campus as well as other branch campuses of UNC SOM are investigating methods to integrate POCUS into their curriculum.

Kman et al. implemented a 10-month longitudinal curriculum at the Ohio State University, which was created for those students interested in Emergency Medicine as a career.[22] Students, as part of this curriculum, created and maintained an ultrasound portfolio. Their students expressed an improved feeling of preparedness for residency in Emergency Medicine after completion. The novel curriculum described here incorporated third-year medical students with diverse career goals, and they all endorsed the value of ultrasound education in the overall process of UME. The students also embraced the approach of introducing the information in a sequential and continuous pattern.

LIMITATIONS

The initial curriculum, a pilot program, was implemented on convenience sample of students participating in a longitudinal clerkship curriculum at a branch campus of a large university. The change in branch campus clerkship curriculum was small in scale, having only 6 students in the first year, significantly decreasing the exposure to the

novel ultrasound curriculum. Perspectives regarding the utility of ultrasound may be influenced by student's choice of medical specialty to pursue. We also noted that students overall suffered from a degree of "burnout" towards the end of their third year curriculum that may have affected their survey results.

CONCLUSIONS

Longitudinal clerkship curricula are growing in number, with programs adopting this approach worldwide.[23] The Consortium of Longitudinal Integrated Clerkships continues to gain members, with more than 2,700 medical students having completed a longitudinal curriculum in 2009.[23] With the growing push toward this approach to the clinical component of UME must come an effort to advance emerging clinical assessments and technology education within the construct. Our longitudinal ultrasound curriculum for MS-3 students enrolled in such a program provides a novel model with which to accomplish this goal.

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Table 1: Thread Session for the 2013-2014 academic year with ultrasound, simulation, ethics, and didactics.

Date	Session: Ultrasound, Simulation, Ethics & Didactics
8-Oct	Hypertension & Clinical Decision-making
11-Oct	Intro to Sim/ACLS Lite
15-Oct	Chest Pain I
22-Oct	Ultrasound Session: Introduction to Ultrasound
29-Oct	Chest Pain II: Cardiac Arrest
5-Nov	Approach to Asthma & COPD/Ethics I
12-Nov	Ultrasound Session: The Cardiopulmonary Patient
19-Nov	Abdominal Pain
26-Nov	Health Policy II/Ethics II
3-Dec	Ultrasound Session: The Acute Abdomen
6-Dec	Fever
10-Dec	Approach to Diabetes
7-Jan	Approach to CAD & CHF
14-Jan	Health Policy III
21-Jan	Dyspnea
28-Jan	Ultrasound Session: The Acute Abdomen II
4-Feb	Approach to Hypotension
11-Feb	Approach to the OB/GYN Patient
18-Feb	Approach to the Pediatric Patient/ Lumbar Puncture
25-Feb	Health Policy IV
4-Mar	Ultrasound Session: The Pregnant Patient
11-Mar	Altered Mental Status/Lumbar Puncture
18-Mar	Acute and Chronic Pain
25-Mar	Approach to the Psychiatric Patient
8-Apr	Direct Observation with Standardized Patients
15-Apr	Weakness/Fatigue
22-Apr	ICS I: Difficult Conversations

29-Apr	ICS II: Teamwork & Communication
6-May	Approach to Patients wit Musculoskeletal Symptoms
13-May	Ultrasound Session: Procedural Guidance
20-May	Approach to Cancer Patients
27-May	Direct Observations with Standardized Patients II
3-Jun	Ultrasound Final Assessment - Written test & OSCE
10-Jun	Approach to Neurology Patients
17-Jun	Presentations I - Care Assignments
24-Jun	Presentations II & Ethics Presentations

Table 2: Longitudinal ultrasound curriculum for the Charlotte Longitudinal Integrated Curriculum (CLIC) Program for academic year 2013-14.

Session	Didactic Objectives	Practical Objectives
1: Imaging, Acquisition & Orientation	Pre-test, Introduction to basic ultrasound physics, Image orientation & acquisition, Instrumentation & knobology	Introduction to ultrasound machines, knobology, sonographic appearance of different tissues
2: The Cardiopulmonary Patient	Ultrasound use in evaluating dyspnea, chest pain, hypotension & leg swelling	Focused cardiac echo, thoracic ultrasound, DVT ultrasound exams
3: The Acute Abdomen I - Free Fluid	Ultrasound use in evaluating peritonitis, the distended abdomen, back pain/ abdominal aortic aneurysm, free fluid	FAST exam for detection of free fluid in trauma & hypotension, abdominal aorta ultrasound exam
4: The Acute Abdomen II Ultrasound use in evaluating other causes of abdominal pain	Utility of ultrasound in evaluating Renal colic, flank pain, and right upper quadrant abdominal pain	Renal ultrasound and gallbladder ultrasound
5: The Pregnant Patient	OB/GYN applications of ultrasound including normal uterus & ovaries, early IUP, fetal presentation	Trans-abdominal pelvic ultrasound, transvaginal ultrasound with Blue Phanton model
6: Procedural Guidance	Role of ultrasound in medical procedures, ultrasound anatomy & patient safety	Central venous access, thoracentesis, paracentesis, lumbar puncture, & pericardiocentesis
7: Ultrasound course wrap-up	Knowledge assessment/post-test	OSCE - FAST, aorta, thoracic, procedural guidance; Image interpretation

Table 3: Sample schedule for ultrasound session

Ultrasound Thread Session: 1:00-5:00 PM		
Students	8	
Instructors	4	
Practical Stations	4	Students rotate through stations
Time	**Activity**	**Description**
1:00-2:00	FAST, Aorta Didactic	lecture

2:00-2:30	Station 1 - FAST Exam	(1) ID Morison's Pouch & where fluid will accumulate, (2) ID perisplenic view, (3) ID bladder view in transverse & sagittal planes, (4) ID fluid & bowel in ascites patient
2:30-3:00	Station 2 - Aorta	(1) ID proximal aorta, SMA & Celiac branches in transverse & Sagittal orientation, (2) Distinguish aorta from IVC, look for vertebral body & shadowing, (3) ID & measure mid and distal aorta in transverse and sagittal planes, (4) ID aortic bifurcation
3:00-3:30	Station 3 - Review FAST exam & Thoracic	Fast with pneumothorax detection
3:30-4:00	Station 4 - Review Cardiac	PSLA, PSSA, A4, SC images
4:00-5:00	Ultrasound Competition	Case-based ultrasound competition, students divided into 2 teams

Table 4: Knowledge assessment (Pre- and Post-test) scores

Student	Pre-test (%)	Post-Test (%)	Improvement (%)
1	50	85	35
2	65	80	15
3	50	70	20
4	50	80	30
5	60	90	30
6	55	85	30
Group Mean (%)	55	81.7	26.7
Median (%)	52.5	82.5	30

Pre-Test and Post-Test scores (percentages) for medical students participating in a longitudinal ultrasound curriculum, with percentage improvement across curriculum. Mean and median scores for pre- and post-testing included, as well as cumulative group improvement.

Table 5: Example of ultrasound assessment grading tool

Key:

1 - Very poor image acquisition - Does not know this view at all.

2 - Limited ability - Struggles with probe placement, image orientation

3 - Moderate ability to obtain image - General knowledge of image location/ where to obtain image on SP and orientation, image is poor quality
4 - Good Image acquisition - Able to obtain image, may needs to make depth or frequency/ gain adjustments, minor adjustments
5 - Excellent Ability - Obtains image and is able to optimize image

Fast Exam - Student must obtain the following images					
Score	1 - Very poor image acquisition	2 - Limited ability	3 - Moderate ability to obtain image	4 - Good Image acquisition	5 - Excellent Ability
Morison's Pouch					
Perisplenic					
Bladder - Transverse & Sagittal					
Subcostal or Parasternal Long					

Table 6: Skills assessment scores

Student	Procedure	Cardiac	Thoracic	FAST	Aorta	Image Identification (%)
1	4.5	3.8	5	4.8	4.8	94.4
2	5	3.8	4	3.5	4	77.8
3	5	3.8	4.5	3.8	4	83.3
4	4	3.7	4	3.8	4	61.1
5	5	4	3.5	4.5	4	66.7
6	5	4	4.5	4.3	3.8	50

Subjective assessment by ultrasound faculty of student's ability to perform ultrasound examinations, modified Likert scale (Scale: 1 = “Very poor image acquisition,” 2 = “Limited ability,” 3 = “Moderate ability to obtain image,” 4 = “Good image acquisition,” 5 = “Excellent ability”), and assessment of ability to correctly identify ultrasound images (percentage correct).

Table 7: Student perspectives on ultrasound curriculum

Student	US Training Valuable in 3rd Year		US Training Helps Anatomy Knowledge		US Training Helps Pathology Knowledge		US Training Helps Knowledge of Diagnostic Imaging		US Training Helps Improve Physical Exam Skills		US Training Helps Correlate Basic Science with		US Training Helps Improve Patient Safety		US Training has a Role in Medical Student Education	What Years Should US be Taught in Medical School
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Post-Course	Post-Course
1	5	5	5	5	4	5	4	5	4	4	4	5	5	4	5	MS3-4
2	5	5	5	5	4	5	5	5	3	3	2	5	5	3	5	MS3
3	5	4	4	5	4	2	5	5	5	4	5	3	4	4	4	MS1-4
4	5	4	4	4	3	4	5	5	4	4	4	4	4	4	5	MS3-4
5	5	5	5	5	4	5	5	5	4	5	4	5	4	5	5	MS3
6	5	5	5	5	5	4	5	5	5	4	5	5	5	4	5	MS3-4
Group Mean	5	4.7	4.7	4.8	4	4	4.8	5	4.2	4	4	4.5	4.5	4	4.8	
Median	5	5	5	5	4	5	5	5	4	4	4	5	4.5	4	5	

Table 7: Pre-course and post-course survey assessing MS3 Students Perspectives on Ultrasound Training. Scale 1-5 in Value: 1=Not at all, 2=Little/Limited, 3=Neutral, 4=Somewhat/Yes but not critical, 5=Absolutely. US=Ultrasound

Attachment 1: Pre-course survey

Q1: Do you think that ultrasound training will be useful as you rotate through 3rd year of medical school?
Q2: Do you think that ultrasound training will improve your understanding of anatomy?
Q3: Do you think that ultrasound training will improve your knowledge of pathology?
Q4: Do you think that ultrasound training will improve your physical exam skills?
Q5: Do you think that ultrasound training will improve your medical decision-making?
Q6: To what extent do you anticipate that ultrasound education will help correlate clinical knowledge with basic sciences?

Q7: Do you believe that learning ultrasound in the 3rd year of medical school will improve your overall knowledge of different diagnostic imaging modalities?
Q8: Do you believe that learning ultrasound in the 3rd year of medical school will help improve patient safety?
Q9: Do you believe that ultrasound will be useful in the following specialties?
- a: Surgery or surgical specialties
- b: Internal Medicine or medicine subspecialties
- c: Pediatrics
- d: Family Medicine
- e: Obstetrics and Gynecology
- f: Emergency Medicine and Critical Care
- g: Psychiatry
- h: Neurology

Q10: Please rate your experience with ultrasound (# of ultrasounds performed)
Q11: What field of medicine do you think that you will go into?
Q12: Please describe any previous or concurrent instruction you have had with ultrasound, either formal or informal.

Attachment 2: Post-course survey

Q1: Would ultrasound training be valuable as part of your 3rd year medical school education (MS3)?
Q2: Do you think that ultrasound training as a MS3 helps your understanding of anatomy?
Q3: Do you think that ultrasound training as a MS3 helps your understanding of pathology?
Q4: Do you think that ultrasound training as a MS3 helps improve your understanding of diagnostic imaging choices?
Q5: Do you think that ultrasound training as a MS3 helps improve your physical exam skills?
Q6: To what extend do you feel that learning ultrasound helps correlate clinical education with basic science knowledge?

Q7: Do you feel that using ultrasound helps improve patient safety?
Q8: Do you feel that ultrasound education has a role in medical school education?
Q9: Please rate the usefulness of ultrasound in the following specialties:
- a: Surgery or surgical specialties
- b: Internal Medicine or medicine subspecialties
- c: Pediatrics
- d: Family Medicine
- e: Obstetrics and Gynecology
- f: Emergency Medicine and Critical Care
- g: Psychiatry
- h: Neurology

Q10: Would you take an ultrasound course as a 4th year elective?
Q11: What years do you think that ultrasound should be taught in medical school?
Q12: What specialty are you planning to pursue?
Q13: Any other comments?
Q14: Please describe previous or concurrent instruction you have had with ultrasound, either formal or informal.
Q15: Please rate your prior experience with ultrasound. (Number of ultrasound perform