Integration of gross anatomy in an organ system-based medical curriculum: Strategies and challenges.

Brooks WS1, Woodley KT, Jackson JR, Hoesley CJ.

Abstract

The University of Alabama School of Medicine (UASOM) instituted a fully integrated, organ system-based preclinical curriculum in 2007. Gross anatomy and embryology were integrated with other basic science disciplines throughout the first two years of undergraduate medical education. Here we describe the methods of instruction and integration of gross anatomy and embryology in this curriculum as well as challenges faced along the way. Gross anatomy and embryology are taught through a combination of didactic lectures, team-based learning activities, and cadaveric dissection laboratories. Vertical integration occurs through third- and fourth-year anatomy and embryology elective courses. Radiology is integrated with anatomy instruction through self-study modules and hands-on ultrasound sessions. Our model of anatomy instruction is time efficient, clinically relevant, and effective as demonstrated by student performance on the United States Medical Licensing Examination® (USMLE®) Step 1 examination. We recommend that medical schools considering full integration of gross anatomy and embryology (1) carefully consider the sequencing of organ system modules, (2) be willing to sacrifice anatomical detail for clinical application, (3) provide additional electives to third- and fourth-year students, and (4) integrate radiology with anatomical education. Anat Sci Educ. © 2014 American Association of Anatomists.

J Clin Ultrasound. 2014 Aug 14. doi: 10.1002/jcu.22224. [Epub ahead of print]

Bedside ultrasound curriculum for medical students: Report of a blended learning curriculum implementation and validation.

Blackstock U1, Munson J, Szyld D.

Abstract

BACKGROUND:

Medical students on clinical rotations rarely receive formal bedside ultrasound (BUS) training. We designed, implemented, and evaluated a standardized BUS curriculum for medical students on their Emergency Medicine (EM) rotation. Teaching was aimed toward influencing four cognitive and psychomotor learning domains: BUS instrumentation

knowledge, image interpretation, image acquisition, and procedural guidance.

METHODS:
Participants viewed three instructional Web-based tutorials on BUS instrumentation, the Focused Assessment for Sonography in Trauma (FAST) examination and ultrasound-guided central venous catheter (CVC) placement. Subsequently, participants attended a 3-hour hands-on training session to discuss the same content area and practice with faculty coaches. A Web-based, multiple-choice questionnaire was administered before and after the session. During the final week of the rotation, students returned for skills assessments on FAST image acquisition and CVC placement.

RESULTS:
Forty-five medical students on an EM rotation were enrolled. Sonographic knowledge overall mean score improved significantly from 66.6% (SD ±11.2) to 85.7% (SD ±10.0), corresponding to a mean difference of 19.1% (95% CI 15.5-22.7; $p < 0.001$). There were high pass rates for FAST (89.0%, 40/45) and CVC (96.0%, 43/45) skills assessments. There was no significant difference between medical student posttest and EM resident test scores 85.7% (SD ±10.0) and 88.1% (SD ± 7.6) ($p = 0.40$), respectively.

CONCLUSIONS:
A formal BUS curriculum for medical students on EM rotation positively influenced performance in several key learning domains. As BUS competency is required for residency in EM and other specialties, medical schools could consider routinely incorporating BUS teaching into their clinical rotation curricula. J Clin Ultrasound, 2014.

J Ultrasound Med. 2014 Aug;33(8):1349-52. doi: 10.7863/ultra.33.8.1349.

Psychomotor skills in medical ultrasound imaging: an analysis of the core skill set.

Nicholls D[1], Sweet L[2], Hyett J[2].

Abstract

Sonographers use psychomotor skills to perform medical ultrasound examinations. Psychomotor skills describe voluntary movements of the limb, joints, and muscles in response to sensory stimuli and are regulated by the motor neural cortex in the brain. We define a psychomotor skill in relation to medical ultrasound imaging as "the unique mental and motor activities required to execute a manual task safely and efficiently for each

clinical situation." Skills in clinical ultrasound practice may be open or closed; most skills used in medical ultrasound imaging are open. Open skills are both complex and multidimensional. Visuomotor and visuospatial psychomotor skills are central components of medical ultrasound imaging. Both types of skills rely on learners having a visual exemplar or standard of performance with which to reference their skill performance and evaluate anatomic structures. These are imperative instructional design principles when teaching psychomotor skills.

Acad Radiol. 2014 Jul;21(7):893-901. doi: 10.1016/j.acra.2014.03.001.

Teaching point of care ultrasound skills in medical school: keeping radiology in the driver's seat.

Webb EM[1], Cotton JB[2], Kane K[2], Straus CM[3], Topp KS[4], Naeger DM[5].

Abstract

RATIONALE AND OBJECTIVES:
Ultrasound is used increasingly in medical practice as a tool for focused bedside diagnosis and technical assistance during procedures. Widespread availability of small portable units has put this technology into the hands of many physicians and medical students who lack dedicated training, leaving the education and introduction of this key modality increasingly to physicians from other specialties. We developed a radiology-led program to teach ultrasound skills to preclinical medical students.

MATERIALS AND METHODS:
To develop this new ultrasound program we 1) established a program leader, 2) developed teaching materials, 3) created a hands-on interactive program, and 4) recruited the necessary instructors. The program was piloted with the first-year medical student class of 154 students. The introductory session was assessed by pre- and post-activity Likert scale-based surveys.

RESULTS:
Of 154 (68.8%) students, 106 completed a voluntary online survey before starting the program and 145 students (94.2%) completed a voluntary survey after the session. Students found the program educationally valuable (4.64 of 5) and reported that it improved their understanding of ultrasound imaging (4.7 of 5). Students' reported confidence in identifying abdominal organs, intra-abdominal fluid, and Morison pouch that was significantly higher on the postactivity survey compared to the presurvey (P

< .001 for all).

CONCLUSIONS:
We piloted a radiology-led program to teach ultrasound skills to preclinical medical students. Students found the experience enjoyable and educationally valuable.

Ultrasound Q. 2014 Mar;30(1):13-9. doi: 10.1097/RUQ.0000000000000066.

National ultrasound curriculum for medical students.

Baltarowich OH1, Di Salvo DN, Scoutt LM, Brown DL, Cox CW, DiPietro MA, Glazer DI, Hamper UM, Manning MA, Nazarian LN, Neutze JA, Romero M, Stephenson JW, Dubinsky TJ.

Abstract

Ultrasound (US) is an extremely useful diagnostic imaging modality because of its real-time capability, noninvasiveness, portability, and relatively low cost. It carries none of the potential risks of ionizing radiation exposure or intravenous contrast administration. For these reasons, numerous medical specialties now rely on US not only for diagnosis and guidance for procedures, but also as an extension of the physical examination. In addition, many medical school educators recognize the usefulness of this technique as an aid to teaching anatomy, physiology, pathology, and physical diagnosis. Radiologists are especially interested in teaching medical students the appropriate use of US in clinical practice. Educators who recognize the power of this tool have sought to incorporate it into the medical school curriculum. The basic question that educators should ask themselves is: "What should a student graduating from medical school know about US?" To aid them in answering this question, US specialists from the Society of Radiologists in Ultrasound and the Alliance of Medical School Educators in Radiology have collaborated in the design of a US curriculum for medical students. The implementation of such a curriculum will vary from institution to institution, depending on the resources of the medical school and space in the overall curriculum. Two different examples of how US can be incorporated vertically or horizontally into a curriculum are described, along with an explanation as to how this curriculum satisfies the Accreditation Council for Graduate Medical Education competencies, modified for the education of our future physicians.

N Engl J Med. 2014 Mar 20;370(12):1083-5. doi: 10.1056/NEJMp1311944.

Point-of-care ultrasound in medical education--stop listening and look.

Solomon SD[1], Saldana F.

J Am Soc Echocardiogr. 2014 Mar;27(3):310-3. doi: 10.1016/j.echo.2014.01.011.

Handheld ultrasound devices and the training conundrum: how to get to "seeing is believing".

Mulvagh SL[1], Bhagra A[2], Nelson BP[3], Narula J[3].
Author information

Comment on

Development and evaluation of methodologies for teaching focused cardiac ultrasound skills to medical students. [J Am Soc Echocardiogr. 2014]

J Am Soc Echocardiogr. 2014 Mar;27(3):302-9. doi: 10.1016/j.echo.2013.12.006. Epub 2014 Jan 13.

Development and evaluation of methodologies for teaching focused cardiac ultrasound skills to medical students.

Cawthorn TR[1], Nickel C[1], O'Reilly M[2], Kafka H[2], Tam JW[3], Jackson LC[4], Sanfilippo AJ[2], Johri AM[5].
Author information

Abstract

BACKGROUND:
Handheld ultrasound is emerging as an important tool for point-of-care cardiac assessment. Although cardiac ultrasound skills are traditionally introduced during postgraduate training, the optimal time and methodology to initiate training in focused cardiac ultrasound (FCU) are unknown. The objective of this study was to develop and evaluate a novel curriculum for training medical students in the use of FCU.

METHODS:
The study was conducted in two phases. In the first phase, 12 first-year medical students underwent FCU training over an 8-week period. In the second phase, 45 third-year medical students were randomized to one of three educational programs. Program 1 consisted of a lecture-based approach with scan training by a sonographer. Program 2 coupled

electronic education modules with sonographer scan training. Program 3 was fully self-directed, combining electronic modules with scan training on a high-fidelity ultrasound simulator. Image interpretation skills and scanning technique were evaluated after each program.

RESULTS:
First-year medical students were able to modestly improve interpretation ability and acquire limited scanning skills. Third-year medical students exhibited similar improvement in mean examination score for image interpretation whether a lecture-based program or electronic modules was used. Students in the self-directed group using an ultrasound simulator had significantly lower mean quality scores than students taught by sonographers.

CONCLUSIONS:
Third-year medical students were able to acquire FCU image acquisition and interpretation skills after a novel training program. Self-directed electronic modules are effective for teaching introductory FCU interpretation skills, while expert-guided training is important for developing scanning technique.

Anat Sci Educ. 2014 Sep-Oct;7(5):340-9. doi: 10.1002/ase.1417. Epub 2013 Dec 10.

Can anatomists teach living anatomy using ultrasound as a teaching tool?

Jurjus RA1, Dimorier K, Brown K, Slaby F, Shokoohi H, Boniface K, Liu YT.
Author information

Abstract

The utilization of bedside ultrasound by an increasing number of medical specialties has created the need for more ultrasound exposure and teaching in medical school. Although there is a widespread support for more vertical integration of ultrasound teaching throughout the undergraduate curriculum, little is known about whether the quality of ultrasound teaching differs if performed by anatomists or clinicians. The purpose of this study is to compare medical students' evaluation of ultrasound anatomy teaching by clinicians and anatomists. Hands-on interactive ultrasound sessions were scheduled as part of the gross anatomy course following principles of adult learning and instructional design. Seven teachers (three anatomists and four clinicians) taught in each session. Before each session, anatomists were trained in ultrasound by clinicians. Students were divided into groups, rotated teachers between sessions, and completed evaluations. Results indicated students perceived

the two groups as comparable for all factors except for knowledge organization and the helpfulness of ultrasound for understanding anatomy ($P < 0.001$). However, results from unpaired samples t-tests demonstrated a nonstatistically significant difference between the groups within each session for both questions. Moreover, students' test performance for both groups was similar. This study demonstrated that anatomists can teach living anatomy using ultrasound with minimal training as well as clinicians, and encourage the teaching of living anatomy by anatomists in human anatomy courses using ultrasound. Repeating this study at a multicenter level is currently being considered to further validate our conclusion.

Med Teach. 2014 Jan;36(1):19-24. doi: 10.3109/0142159X.2013.847909. Epub 2013 Oct 24.

Twelve tips for teaching with ultrasound in the undergraduate curriculum.

Griksaitis MJ1, Scott MP, Finn GM.
Author information

Abstract

With ever increasing use of imaging as a diagnostic tool in medicine, medical schools are being urged to further integrate imaging into their curricula. Ultrasound is one such way of doing so-enabling students to bridge the gap between form and function, medical school and clinical practice. As a non-invasive imaging technique, with low risk when compared to other methods of imaging, ultrasound is ideal for integration into basic science and clinical teaching. The twelve tips given in this article offer advice on the practicalities of running a successful ultrasound imaging session in an appropriate environment, promoting safety and curriculum integration.

J Emerg Med. 2014 Feb;46(2):231-40. doi: 10.1016/j.jemermed.2013.08.028. Epub 2013 Oct 7.

Ultrasound exposure during gross anatomy.

Dreher SM1, DePhilip R2, Bahner D3.
Author information

Abstract

BACKGROUND:
As medical schools seek to standardize ultrasound training and

incorporate clinical correlations into the basic science years, we proposed that ultrasonography should have a greater role in the anatomy curriculum.

OBJECTIVES:
To describe the introduction of ultrasound into the curriculum of a first-year medical student anatomy course and evaluate the utility of this introduction.

METHODS:
First-year medical students attended two ultrasound lectures and three small-group hands-on sessions that focused on selected aspects of musculoskeletal, thoracic, abdominal, and neck anatomy. Pre and post surveys were administered to assess student perception of their ability to obtain and interpret ultrasound images and the utility of ultrasound in the anatomy course. Understanding of basic ultrasound techniques and imaging was tested in the practical examinations.

RESULTS:
Of the 269 first-year medical students who completed the course, 144 students completed both surveys entirely, with a response rate of 53%. Students' interest and self-perceived experience, comfort, and confidence in ultrasound skills significantly increased ($p < 0.001$) as a result of this early introduction to ultrasonography. Objective evidence, provided by practical examination scores on ultrasound images, is consistent with this self-perceived confidence reported by students.

CONCLUSIONS:
Ultrasound can be effectively incorporated into an anatomy course for first-year medical students by utilizing didactics and hands-on exposure. Medical students found the addition of ultrasound training to be valuable, not only in enhancing their understanding of anatomy, but also in increasing their interest and experience in ultrasound imaging.

West J Emerg Med. 2014 Sep;15(6):636-40. doi: 10.5811/westjem.2014.7.18480.

BE-SAFE: Bedside Sonography for Assessment of the Fetus in Emergencies: Educational Intervention for Late-pregnancy Obstetric Ultrasound.

Shah S1, Adedipe A1, Ruffatto B2, Backlund BH1, Sajed D3, Rood K1, Fernandez R1.

Abstract

INTRODUCTION:

Late obstetric emergencies are time critical presentations in the emergency department. Evaluation to ensure the safety of mother and child includes rapid assessment of fetal viability, fetal heart rate (FHR), fetal lie, and estimated gestational age (EGA). Point-of-care (POC) obstetric ultrasound (OBUS) offers the advantage of being able to provide all these measurements. We studied the impact of POC OBUS training on emergency physician (EP) confidence, knowledge, and OBUS skill performance on a live model.

METHODS:

This is a prospective observational study evaluating an educational intervention we designed, called the BE-SAFE curriculum (BEdside Sonography for the Assessment of the Fetus in Emergencies). Subjects were a convenience sample of EP attendings (N=17) and residents (N=14). Prior to the educational intervention, participants completed a self-assessment survey on their confidence regarding OBUS, and took a pre-test to assess their baseline knowledge of OBUS. They then completed a 3-hour training session consisting of didactic and hands-on education in OBUS. After training, each subject's time and accuracy of performance of FHR, EGA, and fetal lie was recorded. Post-intervention knowledge tests and confidence surveys were administered. Results were compared with non-parametric t-tests.

RESULTS:

Pre- and post-test knowledge assessment scores for previously untrained EPs improved from 65.7% [SD=20.8] to 90% [SD=8.2] ($p<0.0007$). Self-confidence on a scale of 1-6 improved significantly for identification of FHR, fetal lie, and EGA. After training, the average times for completion of OBUS critical skills were as follows: cardiac activity (9s), FHR (68.6s), fetal lie (28.1s), and EGA (158.1 sec). EGA estimates averaged 28w0d (25w0d-30w6d) for the model's true gestational age of 27w0d.

CONCLUSION:

After a focused POC OBUS training intervention, the BE-SAFE educational intervention, EPs can accurately and rapidly use ultrasound to determine FHR, fetal lie, and estimate gestational age in mid-late pregnancy.

Crit Care Med. 2014 Oct;42(10):2169-77. doi: 10.1097/CCM.0000000000000413.

Basic critical care echocardiography by pulmonary fellows: learning trajectory and prognostic impact using a minimally resourced training model*.

See KC1, Ong V, Ng J, Tan RA, Phua J.

Abstract

OBJECTIVES:

The spread of basic critical care echocardiography may be limited by training resources. Another barrier is the lack of information about the learning trajectory and prognostic impact of individual basic critical care echocardiography domains like acute cor pulmonale determination and left ventricular function estimation. We thus developed a minimally resourced training model and studied the latter outcomes.

DESIGN:

Prospective observational study.

SETTING:

Twenty-bed medical ICU.

SUBJECTS:

Echocardiography-naive trainees enrolled in the first year of our Pulmonary Medicine Fellowship Program from September 2012 to September 2013.

INTERVENTIONS:

We described the learning trajectory in six basic critical care echocardiography domains (adequate views, pericardial effusion, acute cor pulmonale, left ventricular ejection fraction, mitral regurgitation, and inferior vena cava variability) and correlated abnormalities in selected basic critical care echocardiography domains with clinical outcomes (mortality and length of stay).

MEASUREMENTS AND MAIN RESULTS:

Three-hundred forty-three basic critical care echocardiography scans were done for 318 patients by seven fellows (median of 40 scans per fellow; range, 34-105). Only one-third patients had normal basic critical care echocardiography studies. Accuracy in various basic critical care echocardiography domains was high (> 90%), especially beyond the first 30 examinations. Acute cor pulmonale was associated with ICU mortality when adjusted for Acute Physiology and Chronic Health Evaluation II score and presence of sepsis, whereas mitral regurgitation was associated with longer hospitalization only on univariate analysis.

CONCLUSIONS:

Basic critical care echocardiography training using minimal resources is feasible. New trainees can achieve reasonable competency in most basic critical care echocardiography domains after performing about 30

examinations within the first year. The relatively high prevalence of abnormalities and the significant association of acute cor pulmonale with ICU mortality support the need for basic critical care echocardiography training.

Acad Emerg Med. 2014 Apr;21(4):456-61. doi: 10.1111/acem.12349.
The core content of clinical ultrasonography fellowship training.
Lewiss RE1, Tayal VS, Hoffmann B, Kendall J, Liteplo AS, Moak JH, Panebianco N, Noble VE.

Abstract
The purpose of developing a core content for subspecialty training in clinical ultrasonography (US) is to standardize the education and qualifications required to provide oversight of US training, clinical use, and administration to improve patient care. This core content would be mastered by a fellow as a separate and unique postgraduate training, beyond that obtained during an emergency medicine (EM) residency or during medical school. The core content defines the training parameters, resources, and knowledge of clinical US necessary to direct clinical US divisions within medical specialties. Additionally, it is intended to inform fellowship directors and candidates for certification of the full range of content that might appear in future examinations. This article describes the development of the core content and presents the core content in its entirety.

J Emerg Med. 2014 Jun;46(6):833-8. doi: 10.1016/j.jemermed.2013.11.102. Epub 2014 Mar 29.
Patient perceptions of ultrasound educational scans in the emergency department.
Goldflam K1, Goett RR2, Lewiss RE3, Bania TC3, Saul T3.

Abstract
BACKGROUND:
Emergency medicine residents may perform bedside ultrasound (BUS) scans that are carried out solely for educational purposes. This may lead to confusion on the part of patients, as the implications in the context of their medical care may be unclear.
STUDY OBJECTIVES:
We hypothesized that a scripted introduction would improve understanding of the objectives and limitations of educational BUS.
METHODS:

A perceptual survey was completed by a prospectively enrolled convenience sample of patients in two emergency departments. In phase 1, fifty patients completed the survey after their educational BUS. During phase 2, sonographers were provided with a one-paragraph scripted introduction to use and 50 additional patients were recruited. Group data were analyzed using chi-squared tests, Kruskal-Wallis, and t-test.

RESULTS:

There were no statistical differences in demographics between the two groups. The scripted introduction changed several survey responses by a statistically significant amount for questions including whether their clinician ordered the study, whether it was part of their medical care, and whether it would be part of their medical record ($p < 0.01$). The responses as to whether they would tell their doctor that they had an ultrasound done were not significantly changed by the script ($p = 0.86$).

CONCLUSION:

This study demonstrates that the use of a scripted introduction regarding the purpose of educational BUS improved patient understanding of the objectives and limitations of such scans. There were still areas where the scripted introduction did not change patient's perception of the educational BUS scan.