SECOND WORLD CONGRESS

ULTRASOUND IN MEDICAL EDUCATION

SEPTEMBER 27 - 29, 2013

Concurrent Session Abstracts

Impact of a Single Exposure to Hands-on Ultrasound Education on Student Perceptions of Ultrasound in Medical Education

Jennifer Cotton[1], Brian Adkins[2], and Matthew Dawson[2].
[1]University of Kentucky, College of Medicine. [2]University of Kentucky, Department of Emergency Medicine, Lexington, Kentucky, United States

Medical student exposure to ultrasound education is on the rise. Schools, such as the University of South Carolina and UC Irvine, have already transitioned to a four year integrated ultrasound curriculum[1]. Even more medical students will be exposed to ultrasound education this year through the Society for Ultrasound in Medical Education's Year of Ultrasound campaign (2013YoU)[1]. Increased exposure and awareness of ultrasound's educational and clinical applications may impact medical student perceptions of ultrasound in undergraduate and graduate medical education. In our study we directly assessed medical student opinions of bedside ultrasound in undergraduate and graduate medical education before and after hands-on ultrasound education. Seventy students with minimal ultrasound experience participated in a student-organized bedside ultrasound workshop. An ultrasound fellowship trained physician provided lecture instruction with resident physicians providing hands-on small group instruction. Fifty-eight students completed surveys before and after the workshop. Surveys assessed student opinions of ultrasound in medical education on a Likert scale from 1 (strongly disagree) to 5 (strongly agree). Pre and post-workshop responses were compared to gauge student interest in ultrasound education and assess whether hands-on ultrasound education changed medical students' opinions of ultrasound in medical education. Following hands-on ultrasound education, 100% of students agreed that ultrasound enhanced medical education; 100% of students wanted more ultrasound in their curriculum; and 100% of students wanted ultrasound integrated into the medical school curriculum. Pre-workshop agreement with these statements were 98.3%, 94.8%, and 96.6%, respectively, suggesting a high baseline interest in ultrasound education. After ultrasound education, 98.2% of students agreed ultrasound should be integrated into basic anatomy courses; 94.7% agreed ultrasound should be integrated into physical exam courses; 84.2% were interested in a fourth year ultrasound elective; and 94.7% indicated they would like to learn more about ultrasound. Student opinions of ultrasound in graduate medical education also changed. Students planning on applying to residencies with strong ultrasound programs increased from 25.9% to 57.9% ($p<0.001$). For all survey questions the mean value of student agreement increased following their experience with ultrasound education. Medical students not receiving bedside ultrasound education in their medical school curriculum clearly want ultrasound education. Our results indicate that even single ultrasound education experiences positively impact student perceptions of ultrasound's value in medical education. Brief ultrasound education events may facilitate ultrasound integration into medical school curriculums by further stimulating student interest and motivating students to initiate a dialogue with school administration.

References:

1) Society of Ultrasound in Medical Education. "2013 Year of Ultrasound Declaration." January 9, 2013. http://www.susme.org/news/2013-year-of-ultrasound-declaration/. [Cited April 1, 2013].

Undergraduate bedside ultrasound teaching at McGill University medical school

Peter Steinmetz, MD[1]
[1]McGill University Faculty of Medicine, Montreal, Quebec, Canada

Objective: Ultrasound teaching has been introduced into the undergraduate curriculum since 2006 at select universities in the USA while similar teaching in Canadian medical schools is not yet available. We designed and will introduce a comprehensive bedside ultrasound course for undergraduate medical students at McGill University starting September 2013.

Methods: Course design is based on effective bedside ultrasound applications for clinicians. The teaching program begins in Year 1 as research indicates that early teaching of bedside ultrasound in medical schools enhances physical exam skills and anatomical knowledge 1-3. Early mastery emphasizes bedside ultrasound as an adjunct to the bedside clinical assessment (Stanford 25) 4. Year 1 and 2 focus on mastering the practical and cognitive skills necessary to generate and interpret excellent images of various organ systems. In year 3 students learn to integrate the interpretation of ultrasound images into their assessment of common clinical problems. In Year 4, students pursue electives in bedside ultrasound in diverse specialties. The course follows a problem-based, modular, practical format. Students prepare for the practical sessions by reading a customized textbook with supplemental web-based video material 5. The practical sessions are organized into 6 problem-based modules: dyspnea (lung), hypotension (heart and IVC), abdominal pain 1 (aorta), abdominal pain 2 (gallbladder), kidney injury (kidney and bladder), and swollen leg (vein). The practical sessions include well-defined objectives that compliment the Medical Council of Canada objectives for identifying the attributes expected of medical graduates entering supervised and independent practice in Canada 6. Emphasis is made on the principles of conduct for bedside ultrasound.
Instructors will evaluate a student's acquisition of bedside ultrasound skills at the end of each module. The student will be assigned a score on a sliding scale for probe choice, patient position, image generation, image interpretation and ultimately the incorporation of image interpretation into the assessment of a common clinical problem.

Conclusions: McGill University Faculty of Medicine is a national leader by implementing a comprehensive problem-based bedside ultrasound teaching program for undergraduate medical students.

References:

1. Paulman L. Utility of ultrasound in teaching gross anatomy. World Congress of Ultrasound in Medical Education, 2011.
2. Davis A. Integrated ultrasound curriculum. World Congress of Ultrasound in Medical Education, 2011.
3. Corlis B. Ultrasound in anatomy. World Congress of Ultrasound in Medical Education, 2011.
4. Stanford University 25: An initiative to revive the culture of bedside medicine.
5. Steinmetz P. Bedside ultrasound level 1, A line press, 2013.
6. Objectives for the qualifying exam. 3rd Edition. Medical Council of Canada, 2013.

Bedside Ultrasonography In Clinical Education And Practice Survey: Evaluation Of A Pilot Educational Intervention For Medical Students.

Katarzyna A. Hampton, MD[1], John R. Boker, PhD; Douglas F. Kupas, MD; Robert J. Strony, DO, RDMS
[1]Geisinger Health Systems, Danville, Pennsylvania, United States

Objectives: Competence in bedside ultrasonography (BUS) constitutes an integral part of EM practice, while it becomes increasingly recognized as an essential skill across many other medical specialties. BUS education is not yet integrated in most medial school curricula. To address some of these shortcomings our institution introduced a brief teaching intervention for the clinical campus students as part of their required curriculum. We hypothesized that a focused BUS training can lead to statistically significant increase in BUS-related knowledge, and more importantly, stimulate recognition for the role of BUS in medical education and clinical practice.

Methods: To evaluate the impact of the intervention, we designed a prospective survey which was administered anonymously to the students before and after the instruction (pre/post survey). We collected information about the learner's background, we evaluated the knowledge of BUS principles, and we also inquired about the attitudes towards BUS in clinical education and practice. T-test statistical analysis was performed.

Results: Twenty-two third-year medical students participated in the pre/post survey. None had prior experience as medical sonographer. Nineteen indicated „very little", and 3 marked „moderate" ultrasound teaching in medical school. We observed that mean knowledge and attitude scores increased respectively from 48.8% to 80.8% ($p < .001$), and 81.1% to 91.5 % ($p < .001$). Students" interest in future BUS education and use scores increased respectively from 66.4% to 76.4% ($p = .001$), and 69 % to 79% ($p = .005$).
Conclusions: A brief teaching intervention leads to significant increase in BUS-related knowledge and fosters an attitude of recognition for BUS in clinical education and practice among medical students. Further research is needed to determine whether brief classroom interventions have the potential to impact student's skills acquisition and clinical application of BUS.

References:
1. Gillman LM, Kirkpatrick AW. Portable bedside ultrasound: the visual stethoscope of the 21st century Scand J Trauma Resusc Emerg Med. 2012;20:18
2. Gogalniceanu P, Sheena Y, Kashef E, Purkayastha S, Darzi A, Paraskeva P. Is basic emergency ultrasound training feasible as part of standard undergraduate medical education? J Surg Educ. 2010;67:152-156
3. Platz E, Goldflam K, Mennicke M, Parisini E, Christ M, Hohenstein C. Comparison of Web-versus classroom-based basic ultrasonographic and EFAST training in 2 European hospitals. Ann Emerg Med. 2010 Dec;56(6):660-7. doi: 10.1016/j.annemergmed.2010.04.019. Epub 2010 Jun 11.
4. Angtuaco TL, Hopkins RH, DuBose TJ, Bursac Z, Angtuaco MJ, Ferris EJ. Sonographic physical diagnosis 101: teaching senior medical students basic ultrasound scanning skills using a compact ultrasound system. Ultrasound Q. 2007 Jun;23(2):157-60
5. Arger PH, Schultz SM, Sehgal CM, Cary TW, Aronchick J. Teaching medical students diagnostic sonography. J Ultrasound Med. 2005 Oct;24(10):1365-9.

Using Ultrasound to Teach Physical Examination Skills – Medical Educators' Perspectives[1]

Irene W. Y. Ma, MD[1], Ian Wishart, MD; Malgorzata Kaminska, MD, MSc; Kevin McLaughlin, MD, PhD; Sarah Weeks, MD; David Lautner, MD; Heather Baxter, MD; Bruce Wright, MD.
[1]University of Calgary, Calgary, Alberta, Canada

Background: Ultrasound is increasingly used to teach physical examination skills. Ultrasonography skills required for learning about general physical examination skills are somewhat less involved than skills required for point-of-care use. The opinions of medical educators on the use of ultrasound for teaching physical examinations are unknown. In particular, what are the concerns from educators regarding the use of ultrasound beyond its intended scope?
Methods: Educators from the University of Calgary Master Teacher Program were invited to complete a paper-based survey. Survey items were generated by two investigators, with input from an expert panel (n=5).
Results: 27 educators (out of 36; 75%) completed the 22-item survey. Examinations felt to be most useful for teaching physical examinations included: measuring the size of the abdominal aorta, identifying the presence/absence of ascites, identifying the presence/absence of pleural effusions, and measuring the size of the bladder. Examinations thought to be potentially harmful if trainees applied ultrasonography skills beyond its intended scope for learning physical examinations skills included: identifying the presence/absence of intrauterine pregnancy, measuring the size of the abdominal aorta, and identifying the presence/absence of pericardial effusion.
Conclusions: Examinations that are most useful for learning general physical examination skills may also be felt to be potentially the most harmful. When introducing an ultrasound curriculum for physical examinations, educators should weigh the risks and benefits of the chosen examinations. Whenever possible, a new curriculum should start by introducing examinations that are felt to be both useful and unlikely to cause harm should trainees misapply ultrasonography skills.

References:

[1] Ma I, Wishart I, Kaminska M, McLaughlin K, Weeks S, Lautner D, Baxter H, Wright B. Medical Educators' perspectives of teaching physical examinations using ultrasonography at the undergraduate level. Canadian Medical Education Journal 2013; 4(1):e59-68.

**Note: we have expressed permission from the Canadian Medical Education Journal to submit this abstract and 2nd World Congress Ultrasound in Medical Education conference organizer has also authorized the submission of this published work for consideration. Please do not hesitate to contact lead author if you have any questions*.

Does the addition of an integrated cardiac ultrasound curriculum to the first-year of undergraduate medical education enhance comprehension of cardiac physiology?

F. Lattanzio[1], D. Damon, M. Solhaug, R. Prewitt, D. Meyer, D. Propert, A. Levitov, D. Golay, C. Lind, D. Byars, B. Knapp and the EVMS Ultrasound Group.
[1]Eastern Virginia Medical School, Norfolk, VA, United States

Background: Understanding cardiac physiology is a formidable educational challenge encountered by entering medical students. The complex series of electro-mechanical events that occur during the cardiac cycle can be difficult to comprehend. Deficiencies in learning cardiac physiology are manifested in lower cardiac physiology test grades, coupled with lower student course evaluation scores. In addition, learning deficits may carry over into the second year, impairing performance in cardiovascular pharmacology. Our hypothesis is that by using ultrasound to visualize the cardiac cycle, medical students can better comprehend and retain the fundamental elements of cardiac mechanics and function throughout their medical school tenure and beyond. The purpose of this abstract is to present preliminary data examining this hypothesis.

Methods: The average GPA and MCAT scores of entering classes in years 2003 -2012 at Eastern Virginia Medical School (EVMS) were used to estimate performance of first year medical school students who were taught cardiac physiology presented in a consistent format by EVMS instructors over a ten year period. Standardized test questions were used to create two examinations encompassing cardiac physiology, with approximately 40 five-choice questions per exam. Student responses were graded and discrimination ratios determined for the questions utilized. Results of student course evaluations were collected using a 0 (poor) to 5 (excellent) scale. In addition to the standard curriculum, the most recent student group (2012) received ultrasound training. The ultrasound educational program included six didactic and five “hands on” laboratory sessions scanning standardized patients. Ultrasounds were performed using GE Logic e and V-scan ultrasound systems.

Results: The average GPAs and MCAT scores of years 2003-2011 entering medical students were not significantly different from year 2012. In 2003- 2011, medical students’ averaged scores for both cardiac physiology exams were 81.51 ± 2.83. In 2012, students’ averaged scores were 88.35, trending more than two standard deviations higher than the 2003-2011 average. Cumulative test scores for all other physiology sections were 83.50 ± 4.46 in 2003-2011 compared to 84.3 ± 2.37 in 2012 (not significantly different). Student physiology course evaluations averaged 3.92 ± 0.89 in 2012, trending higher than 3.21 ± 0.63 in the previous years. Of the 2012 students responding to course surveys, 123 of 124 (99%) affirmed that learning ultrasound improved their overall medical school experience.

Conclusions: Our preliminary data demonstrate upward trends in cardiovascular physiology test scores and student course evaluations when an ultrasound curriculum is integrated into the first-year of undergraduate medical education. In addition, students felt that ultrasound improved their overall medical school experience. We will examine the performance of the class of 2012 in their second year to determine if there is a trend for improvement in cardiovascular pharmacology and other areas involving elements of cardiac physiology.

State of Ultrasound in Undergraduate Medical Education: A National Survey of Medical School Curricula

Nelson A. Royall[1], David P. Bahner, Teresa Y. Liu, David Way, Ellen Goldman
[1]Orlando Health, The Ohio State University, George Washington University

OBJECTIVE: Medical school education of focused ultrasound has rapidly increased alongside the emergence of its utilization within medicine. Efforts to implement ultrasound training as a component of the undergraduate medical education curricula have ranged from week-long courses to vertical curricula. The purpose of this study was to determine the current education landscape with regards to ultrasound training implementation within United States medical schools.

METHODS: A 9-item multiple-choice survey was developed and administered to accredited United States medical schools. Medical school deans or faculty responsible for curricula were surveyed to determine the integration of focused ultrasonography training within their respective curricula. Additional items within the questionnaire were designed to determine respondent's opinions on integration of focused ultrasonography within medical education. Appropriate descriptive statistical analyses were performed to evaluate survey responses.

RESULTS: A total of 135 medical schools were identified through the Liaison Committee on Medical Education (LCME). 82 surveys were returned for inclusion in the study for a response rate of 61%. There was a reported overall prevalence of 62% of medical schools with ultrasound training integration within their curricula. Ultrasound training increased from preclinical to clinical years with a reported prevalence 38%, 35%, 46%, and 43% from the first to fourth year respectively. Ultrasound-guided procedures were recognized to improve patient safety in approximately 98% of respondents, with 79% responding that ultrasound training should be integrated into existing undergraduate medical education curricula.

CONCLUSION: Focused ultrasound training is becoming an increasingly prevalent component of medical school curricula. This study demonstrates that there is a large prevalence of training programs in existing United States medical schools with a high variability in integration of ultrasound across curricula. Despite general acceptance of the potential benefit for focused ultrasonography, further efforts will be necessary to define criteria and methods for ultrasound integration into medical school curricula.

Estimation of spleen size with hand carried ultrasound

J Mark Roberts[1], Luke Chen, Silvia Chang, Mitchell Lee, Kevin Eva, Graydon S Meneilly
[1]University of British Columbia, Vancouver, British Columbia, Canada

Detail: Diagnosis of splenomegaly is important in many medical conditions (1). Physical exam can identify massive splenomegaly, but evaluating lesser degrees of splenomegaly is problematic (2). Hand carried ultrasound (HCU) allows rapid bedside assessment of patients. We conducted this study to determine if HCU can reliably assess spleen size. Sixteen patients (age 60 ± 4 yrs, range 39-85, 10M) with varying degrees of splenomegaly were studied. Two sonographers independently measured spleen size in each patient using either a HCU (Vscan, GE) or a conventional ultrasound (CU; Ultrasonix, SonixTOUCH , Richmond, BC), in random order. The sonographer that used either device was varied with each using HC and CU an equal number of times. Images were obtained in supine and right lateral decubitus positions (RLD). Sonographers completed a data collection sheet indicating the adequacy of the image, clinical measurements of enlargement, and confidence in their observations for each scan. Image quality was adequate or better in all scans with CU and 15/16 scans with HCU. With CU, the best image was obtained in the supine position in 7 cases, in the RLD in 7 cases and both positions were equally good in 2 cases. With HCU, supine was best in 9 cases and the RLD was best in 7. The sonographers' judgment of enlargement was exactly the same using HCU as it was using CU in 10 of the 16 cases. Three cases were judged more enlarged using HCU and 3 cases were judged more enlarged using CU. The correlation between these judgments was $r=0.82$ ($p<0.001$). More objectively, the greatest longitudinal measurement recorded was statistically equivalent across ultrasound technique with a mean of 16.4cm (95%CI=14.8-18.0) with CU and 15.8cm (95%CI= 14.1-17.4) with HCU. The correlation between measurement techniques was $r=0.89$ ($p<0.0001$). Sonographers were somewhat or very confident in the outcome of all scans with CU and in 15/16 cases with HCU. In 14/16 cases it took <5 min to use CU. The same was true in 7/16 cases for HCU (8 scans, 5-10 min; 1 scan, 10-15 min). In conclusion, we have shown that HCU can be used at point of care by trained individuals to reliably diagnose splenomegaly. Examination of the spleen is a core competency for our trainees, but the sensitivity and specificity of physical examination is poor (2). Next, we will determine if trained residents can reliably measure spleen size with HCU. If they can, this could significantly impact training standards and make physical examination of the spleen obsolete.

References:

1. Williams Textbook of Hematology, 8th edition, McGraw-Hill, 2012
2. Grover, SA; Barkun, AN; Sackett, DL. Does this patient have splenomegaly? In The Rational Clinical Examination, JAMA Archive and Journals, McGraw-Hill 2009; pp:605-614. 2011; 12:e58-e63

General internist performed point-of-care ultrasound assessment of left ventricular function correlates with formal echocardiography

David Tierney, MD FACP[1], Benjamin Johnson, MD; Terry Rosborough, MD; Kevin Harris, MD; Marc Newell, MD
[1]Abbott Northwestern Hospital, Minneapolis, Minnesota, United States

Background: Cardiac point-of-care ultrasound (POCUS) has previously been studied in the emergency department and intensive care unit with good correlation to formal echocardiography. However, data is limited on its use by internal medicine (IM) physicians. The accuracy of focused cardiac POCUS performed by IM physicians and the training necessary to reach proficiency need to be rigorously evaluated.

Methods: The Internal Medicine Bedside UltraSound (IMBUS) program was started in 2011 within a quaternary care center's IM residency program. Study participants included 10 IM physicians who had completed the IMBUS training course as well as their additional "IMBUS Cardiac Certification." The IM physician's ability to estimate left ventricular systolic function (LVSF) with POCUS as "normal," "mild to moderately decreased," or "severely decreased" was compared to formal cardiologist-interpreted echocardiography done within 48 hours. IM physicians were blinded to the formal echocardiographic findings.

Results: 178 patients were evaluated. The inter-rater agreement between IM physician performed POCUS and formal echocardiography for any LV dysfunction was "good/substantial" with Kappa = 0.77 ($p < 0.001$), 95% CI (0.67,0.87). Sensitivity and specificity of POCUS for any LV dysfunction was 0.91 (95% CI 0.80, 0.97) and 0.88 (95% CI 0.81, 0.93) respectively.

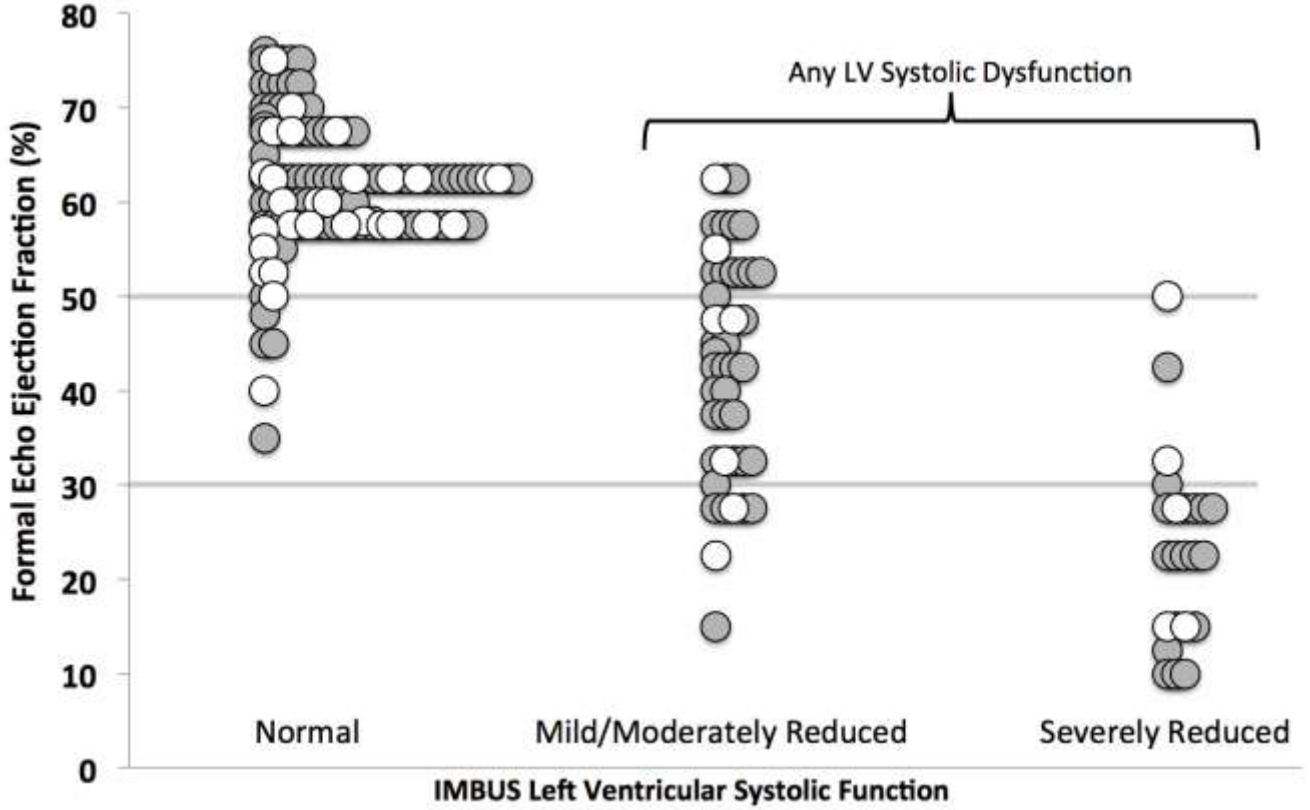

Figure 1. *IM bedside ultrasound qualitative assessment of LVSF compared to formal echocardiography LVEF (n=178). Formal echocardiography LVEF cut-offs (horizontal grey lines) were set as "normal ≥50%," "mild/moderate dysfunction 31-49%," "severe dysfunction ≤30%." White data points represent "technically limited" formal studies per cardiologist interpretation.*

Conclusion: IM physicians using POCUS can identify normal versus decreased LVSF with high sensitivity, specificity, and “good/substantial” inter-rater agreement when compared to formal echocardiography. These results support the role of cardiac POCUS by properly trained IM physicians for discriminating normal from reduced LVSF in hospitalized patients.

Using Ultrasound to Identify Radial Artery Position Prior to Arterial Blood Gasses

Rebecca Corbett[1], Brion Benninger
[1]Western University of Health Sciences, Lebanon, Oregon, United States

INTRODUCTION: Radial artery (RA) is one of two terminal branches of the brachial artery. Arterial blood gasses (ABG) are commonly drawn from the radial artery due to wrist access, safety and modesty. RA location is thought to change during wrist movement. Understanding the orientation, especially the depth from the surface of the wrist, provides confidence to the health care provider (HCP). Proximal (2.5cm) to the distal wrist crease (PDWC), in the neutral position, the radial artery lies deep between brachioradials and flexor carpi radialis, anterior to flexor pollucus longus and pronator quadratus. Objective of this study was to use ultrasound (US) to identify radial artery at PDWC in neutral and extreme hyperextension (NHP). METHODS: Literature search was conducted regarding US and location of radial artery at the PDWC in NHPs. Cadaveric dissection (n=20) was performed to identify RA location at PDWC. US was conducted on 20 live specimens (m:10,f:10) at the PDWC in NHPs . RESULTS: Literature search revealed no studies regarding the use of US to identify RA location for ABG at the PDWC. Cadaveric dissection revealed consistent location of the RA at the PDWC. US revealed the RA relocated anteriorly during neutral to extreme hyperextension positions of the wrist. Surrounding structures were altered. CONCLUSIONS: ABG is an important blood test for both diagnostic and treatment modalities, especially in the critically ill. It requires confidence of the anatomical architecture by the HCP. The needle needs to be introduced at least 0.25 cm, which generally causes anxiety for the HCP. US aids location, provides confidence and possibly accuracy during an ABG procedure. Using US, this study revealed RA and surrounding tissues move during NHPs of the wrist allowing ease of access.

Augmenting physical examination skills with point-of-care ultrasound: Utilizing simulation technology to teach visualization of the abdominal aorta and kidneys to internal medicine residents

Diana Kelm, M.D.[1], Joe Skalski, M.D.; Nabeel Azeem, M.D.; John Ratelle, M.D.; Muhamad Elrashidi, M.D.; Furman McDonald, M.D.; Anjali Bhagra, M.B.B.S.
[1]Mayo Clinic Rochester Minnesota, United States

Background:
Using point-of-care ultrasound has been shown to improve patient safety, especially in central venous catheter placement and thoracentesis, now becoming standard of care. There are multiple roles for the use of ultrasound in internal medicine training programs such as procedures, diagnosis, and physical exam findings. Lack of formal training in point-of-care ultrasound has been identified as a primary barrier to widespread adoption.

Summary of work:
A workshop was created to instruct second and third year internal medicine residents in point-of-care ultrasound imaging of the abdominal aorta and kidneys. The workshop included didactic instruction and hands-on ultrasound practice with standardized patients. The objectives of the workshop were to review ultrasound operation ("knobology") and teach residents to independently obtain ultrasound images of the abdominal aorta and kidneys. Each resident's ability to independently obtain ultrasound images was assessed via a video recording using a skills exam with a standardized patient. Resident knowledge and attitudes towards point-of-care ultrasound were assessed using a pre- and post-test.

Summary of results:
Most (49 of 58) residents were able to independently obtain high-quality images of both the abdominal aorta and kidneys on standardized patients after workshop completion compared to only 9 on the pre-test. There was a statistically significant increase ($p<0.0001$) in both resident self-reported confidence with ultrasound operation and resident likelihood of future use of point-of-care in the post-test compared to the pre-test.

Conclusions:
As based on this focused workshop, a hands-on ultrasound workshop can teach internal medicine residents to perform point-of-care ultrasound while also increasing self-reported likelihood that residents will use ultrasound in their clinical practice.

Future direction:
With the success of this outpatient-focused point-of-care ultrasound workshop, our program has now implemented an inpatient workshop, which will provide education through didactic teaching during morning report and hands-on experience to our internal medicine residents on the evaluation of fluid status by visualization of the inferior vena cava and demonstration of ascites and pleural fluid through "ultrasound rounds." Our goal is to make our internal medicine residents comfortable and proficient in the use of point-of-care ultrasound.

Hocus Pocus or Important Tool? A Point of Care Ultrasound (POCUS) Curriculum in Surgical ICU Fellowship Training Changes Patient Care

Dana Hommel[1], MD, Keith Killu MD, Scott Dulchavsky, MD
[1]Henry Ford Health System, Detroit Michigan, United States

Background: Point of care ultrasound (POCUS) is becoming an integral part of many intensive care units as a bedside tool for patient management. Teaching and implementing POCUS for non-radiologist physicians has been integrated in many academic centers, particularly in emergency medicine programs; however, no standardized curriculum for the ICU is available.

Objective: To implement a POCUS curriculum in a surgical critical care fellowship at a high acuity urban hospital and evaluate the impact of this training on patient diagnosis and management.

Methods: Over a one-year period, a POCUS curriculum was introduced into the surgical ICU fellowship training program at an urban tertiary care center. The curriculum included weekly didactics followed by hands-on workshops and application of these skills during bedside critical care rounds. Instructors were expert ultrasonographers and critical care staff. The fellows then translated their educational experience into clinical practice, using ultrasonography in their diagnosis and management of patients. With each exam they were asked to answer yes or no to whether the POCUS provided a new diagnosis or if it changed their patient management compared to their clinical assessment and plan before the ultrasound. Change in management included: ordering additional tests, giving IV fluid or diuretics and invasive procedures. This data was collected over 12 months and tabulated to evaluate the overall effect of the fellow training program on patient care.

Results: A total of 873 POCUS exams were completed on 197 patients including 379 pulmonary exams, 272 abdominal exams, 203 cardiac exams and 19 miscellaneous exams. Results for each anatomic category are listed in Table 1 and show percentages based on the number of patients examined in each category. Ultrasound was found to be a valuable adjunct to clinical evaluation, providing at least one additional diagnosis in 65.5% of patients examined. It directly impacted patient care and lead to a change in management in 37% of patients. Table 1. Effect of POCUS per Patient Examined

	New Diagnosis	Change in Management
Pulmonary	61.8%	31.4%
Abdominal	41.1%	20.7%
Cardiac	43.9%	25.3%
Total	**65.5%**	**37%**

Conclusions: POCUS is an effective tool that can be incorporated into critical care fellowship training and will in turn, impact patient care. It allows fellows and other physicians to go beyond their clinical assessment and add bedside imaging to guide their diagnosis and management.

References:

1. Neri, L. et al “Toward an ultrasound curriculum for critical care medicine.” Crit Care Med 2007; 35[Suppl.]:S290–S304

2. Mateer, J et al. “Model curriculum for physician training in emergency ultrasonography.” Annals of Emergency Medicine. Volume 23, Issue 1, January 1994, 95–102.

A prospective analysis of single operator sonographic optic nerve sheath diameter measurement for diagnosis of elevated intracranial pressure

Joelle Schlang, MS4[1], Erica Frumin, MD; Mark Rosen, MD, J. Christian Fox, MD; Warren Wiechmann, MD; Stacy Hata, BS; Sasha Rosen, BS; Craig Anderson, PhD, MPH
[1]University of California, Irvine School of Medicine, Irvine California, United States

Background
The accurate diagnosis of elevated intracranial pressure (eICP) in the emergent setting is a critical determination that presents significant challenges. The gold standard, external ventricular device (EVD), is highly invasive. Other means of assessment such as CT or MRI may be contraindicated in unstable patients. There is a need for a non-invasive, rapid exam to detect elevated ICP (eICP). Several studies show correlation of sonographic optic nerve sheath diameter (ONSD) to eICP, while others show high inter-observer variability or marginal performance with less experienced sonographers.

Objective
The objective of our study is to assess the ability of bedside ultrasound measurement of ONSD to identify the presence of eICP when performed by a single experienced sonographer. We hypothesize that ONSD measurement is sensitive and specific for detecting eICP and can be correlated with values obtained by external ventricular device (EVD).

Methods
This was a prospective blinded observational study conducted in a neurocritical care unit of a level 1 trauma center. ONSD measurement was performed on a convenience sample of 27 adult patients who required placement of an invasive intracranial monitor as part of their clinical care. One certified sonographer/physician performed all ultrasounds within 24 hours of placement of EVD. The sonographer was blinded to the ICP recorded by invasive monitor at the time of the scan. A mean ONSD value of ≥5.2 mm was taken as positive.

Results
Twenty-seven ocular ultrasounds were performed on individual patients. Six (22%) of these patients had eICP (EVD measurement of >20 mmHg). Spearman rank correlation coefficient of ONSD and ICP was 0.408 (p=0.03) demonstrating a moderate positive correlation. An ROC curve was created to determine the optimal cut off value to distinguish an eICP greater than 20 mmHg. The area under the ROC curve was 0.8712 (95% confidence interval [CI]=0.67 to 0.96). ONSD ≥5.2 mm was a good predictor of eICP (>20 mmHg) with a sensitivity of 83.3% (95% CI=35.9% to 99.6%) and specificity of 100% (95% CI=84.6% to 100%).

Conclusions
The study suggests ONSD measurements performed by a single skilled operator may be both sensitive and specific for detecting eICP, but confirmation in a much larger sample is needed. Ocular ultrasound may provide additional non-invasive means of assessing eICP.

Ultrasound - Novel Monitoring of CPR

Andy Berglund[1], Brion Benninger
[1]Western University of Health Sciences, Lebanon Oregon, United States

INTRODUCTION: Countless studies have been performed as to the “best” method of Cardiopulmonary Resuscitation (CPR) and its efficacy since its inception in 1954. One common theme throughout is quality chest compressions (QCC). Currently, QCC are monitored through visual depth cues and palpated carotid pulse; this novel study investigated the use of ultrasound (US) as a means of monitoring QCC at the common and internal carotid (CCA and ICA) arteries, bringing CPR into the 21st century. METHODS: Literature search was conducted on journals, specialty journals, and texts for similar studies and Doppler standards for CCA/ICA. Agreement was made between Department of Medical Anatomical Sciences and Willed Body Program for notification and use of recently deceased, unembalmed, donor-cadaver-patients (DCP’s). CPR was performed and monitored utilizing US and Doppler. RESULTS: Literature search revealed no contemporary studies utilizing US at the CCA & ICA for monitoring quality of chest compressions and revealed normal velocity and waveform Doppler for CCA & ICA. While performing CPR novice US users identified CCA & ICA for presence of flow, velocity, and waveform on 5 unembalmed DCP’s ranging from 3 hours to 4 days deceased. CONCLUSIONS: Currently, a palpable pulse is used to assess quality CPR. Movement during CPR often makes palpation difficult to assess. Novice US users were able to rapidly identify structures and assess waveform and velocity utilizing Doppler, implying first responders could perform this technique. Further studies are needed to ensure correlation between waveform/velocity and end-organ perfusion. This study indicates this technique can identify QCC and correct poor compressions, providing better patient outcomes.

The Effects of Positional Change on IVC Diameter in the Euvolemic and Volume Depleted Subject

Max Mam BA[1], Richard Gordon MD, Matt Lyon MD
[1]Medical College of Georgia, Georgia Regents University, Augusta, Georgia, United States

Background: Physicians who engage in resuscitation are routinely faced with the challenging decision between bolused intravenous fluid and vasopressor support. Previous studies have established dynamic ultrasound measurements of the inferior vena cava (IVC) as a rapid, noninvasive, and reliable assessment of a patient's fluid tolerance. However, previous studies focus on the patient in the supine position, which is not always possible in the acute care setting.

Objective: The goals of this study were to investigate the effects of positional change on ultrasound derived IVC diameter measurements in the euvolemic and volume depleted subject.

Methods: In this prospective observational study 26 healthy adults were recruited. In each subject the IVC was imaged via a subcostal window with measurements taken 1cm proximal to the hepatic vein confluence during max inhalation (maxI) and max exhalation (maxE). These measurements were taken in three different positions: supine, recumbent (45 degrees), and standing. After a period of exercise to induce fluid loss, the IVC measurements were repeated. A convenience sample was taken to ensure statistical significance, and the final data analyzed using paired t-tests.

Results: In the pre-exercise subject, there were no significant differences in the maxI and maxE diameters when comparing supine to recumbent and standing positions. In the post-exercise group, there were significant differences in both the maxI and maxE diameters when comparing the supine to the recumbent (maxI *p=0.041*; maxE *p=0.006*) and standing positions (maxI *p=0.005*; maxE *p=0.008*).

Conclusion: These results suggest that a change in position from supine to recumbent or standing has no significant effect on IVC diameter when the subject is euvolemic. However, there is a significant difference in IVC diameter moving from the supine to recumbent or standing position when the subject is volume-depleted.

References:

Akilli B, Bayir A, Kara F, Ak A, Cander B. Inferior vena cava diameter as a marker of early hemorrhagic shock: a comparative study. Ulus Travma Acil Cerrahi Derg. 2010 Mar; 16(2): 113-8.

Lyon M, Blaivas M, Brannam L. Sonographic measurement of the inferior vena cava as a marker of blood loss. Am J Emerg Med. 2005 Jan; 23(1): 45-50.

Rivers E, Nguyen B, et al. Early goal-directed therapy in the treatment of severe sepsis and septic shock. N Engl J Med. 2001 Nov. 8; 345(19): 1368-77.

Sefidbakht S, Assadsangabi R, Abbasi HR, Nabavizadeh A. Sonographic measurement of the inferior vena cava as a predictor of shock in trauma patients. Emerg Radiol. 2007 Jul; 14(3): 181-5.

Yanagawa Y, Nishi K, Sakamoto T, Okada Y. Early diagnosis of hypovolemic shock by sonographic measurement of inferior vena cava in trauma patients. J Trauma. 2005 Apr; 58(4): 825-9.

Enhancing Ultrasound Education through Volunteer Participation in Cardiac Screening

Mason Shieh, MD MBA[1], Suzi Klaus, BS; Carter English, BS; Bassil Aish, MD; Uthara Mohan, MD; John Christian Fox, MD RDMS

[1]University of California, Irvine California, United States

Objective: To develop medical student sonography skills through volunteer involvement in a cardiac screening of local athletes for hypertrophic cardiomyopathy.

Methods: University of California, Irvine medical students were recruited and trained to obtain cardiac ultrasound images to detect hypertrophic cardiomyopathy (HCM) in local high school athletes. HCM ultrasound training involved watching an instructional video and up to two hours of supervised, hands-on ultrasound use. Students had unlimited access to an ultrasound machine for non-supervised practice.

Ten Orange County, California high schools or junior colleges hosted the ultrasound cardiac screening team of 5-12 medical students and 1-3 supervising physicians as part of student athlete physical events. An average of 120 student athletes were scanned during each 4-hour screening.

For each athlete, a medical student obtained 2-second video-clips of parasternal long and parasternal short cardiac views. From the parasternal short view, apical to the mitral valve, the muscular ventricular septum and the left ventricular wall were monitored in motion mode (m-mode) and were measured in systole and diastole on a still m-mode image. The recorded ultrasound videos and images were reviewed by a pediatric cardiologist after the screening. Medical students were asked to complete a brief survey about their participation.

Results: Twenty-five medical student volunteers and five physicians obtained cardiac ultrasound data for 1200 young athletes in Orange County, CA over a four month period. Incidence of findings is pending final review by the research team pediatric cardiologist, who determined 67-74% of student-performed cardiac scans adequate for HCM assessment. Students reported increased confidence in obtaining specific cardiac views quickly, utilizing extensive features of the ultrasound machine, and teaching the screening process to other students.

Conclusion: Student participation in public ultrasound screening provides a public service and enhances student skills and confidence.

Hospitalists' ability to use hand-carried ultrasound for central venous pressure estimation after a brief training intervention: A pilot study

L. David Martin, M.D.[1], Roy C. Ziegelstein, M.D., Eric E. Howell, M.D., Carol Martire R.D.C.S., David B. Hellmann, M.D., Glenn A. Hirsch, M.D., M.H.S.
[1]Johns Hopkins University School of Medicine, Johns Hopkins Bayview Medical Center, Baltimore Maryland, United States

Background: Access to hand-carried ultrasound technology for non-cardiologists has increased significantly, yet development and evaluation of training programs are limited. Estimating central venous pressure (CVP) is key to the care of many patients, but cannot be done accurately by most physicians.[1]

Objective: We studied a focused program to teach image acquisition of inferior vena cava (IVC) diameter and IVC collapsibility index with interpretation of estimated CVP.

Methods: Ten hospitalists completed an online educational module prior to attending a 1-day in-person training session that included supervised IVC imaging on volunteer subjects. Hospitalists were considered "competent" if they correctly measured maximum and minimum IVC diameter and IVC collapsibility on at least 4 of 5 subjects and correctly interpreted at least 8 of 10 pre-recorded IVC images. A follow-up session at least 6 weeks later evaluated these same skills.

Results: Nine of 10 hospitalists demonstrated competence to use hand-carried ultrasound to acquire and interpret IVC images at the end of the initial training session. At 7.4 $\pm$ 0.7 (range, 6.9-8.6) weeks follow-up, all 10 hospitalists were able to accurately acquire and interpret IVC images. Hospitalists were able to accurately determine whether the IVC collapsibility index was more than 50% by qualitative assessment in 180 of 198 attempts (91% of the time).

Conclusions: After a brief training program, hospitalists acquired adequate skills to perform and interpret hand-carried ultrasound IVC images and retained these skills in the near term. Though calculation of the IVC collapsibility index is more accurate, coupling a qualitative assessment with the IVC maximum diameter measurement may be acceptable in aiding bedside estimation of CVP.

Implications: Key clinical outcomes to measure in future work include whether IVC ultrasound assessment can help guide diuresis, limit complications, and ultimately reduce rehospitalizations for heart failure, the most expensive diagnosis for Medicare.[2] Our study, especially the assessment of the hospitalists' ability to retain their skills, adds to what is known about training hospitalists in hand-carried ultrasound and may help inform the Society of Hospital Medicine's deliberation about whether to join other professional societies in defining specialty-specific bedside ultrasound indications and training protocols.[3-4]

References:

1. Badgett RG, Lucey CR, Mulrow CD. Can the clinical examination diagnose left-sided heart failure in adults? JAMA 1997; 277:1712–1719.
2. Jencks SF, Williams MV, Coleman EA. Rehospitalizations among Patients in the Medicare Fee-for-Service Program. N Engl J Med 2009; 360:1418-1428.
3. Lucas BP, Candotti C, Margeta B, et al. Diagnostic accuracy of hospitalist-performed hand-carried ultrasound echocardiography after a brief training program. J Hosp Med. 2009 Jul; 4(6):340-349.
4. Martin LD, Howell EE, Ziegelstein RC, et al. Hospitalist performance of cardiac hand-carried ultrasound after focused training. Am J Med. 2007 Nov; 120(11):1000-1004.

Successful Introduction of an advanced course in ultrasound for senior medical students on a rural placement

Peter Philip McKeown [1], Tatiana Ramage[2], Chris Iwuchukwu[2], Jessamine Faustino[2], James Mattson[2] , Nicole Kiyohara [2], Alan Pedersen[3] , Rod Martin[1], and J. Christian Fox [2]
[1] University of New England, School of Rural Medicine
[2] University of California Irvine, School of Medicine
[3] University of Newcastle
UNIVERSITY OF New England SCHOOL OF RURAL MEDICINE, Armidale, New South Wales, Australia 2351

The University Of New England School Of Rural Medicine (UNE SRM) at Armidale, Australia is part of the Joint Medical Program with the University of Newcastle. UNE SRM is also affiliated with the University of California Irvine School of Medicine (UCI) and has drawn on this affiliation to establish an "Introduction to Ultrasound" course for first year UNE SRM students and now with further support from UCI has introduced an advanced ultrasound course for final year medical students on a rural rotation and for a cohort of second year SRM students who would like to be recognized as student ultrasound tutors.

The advanced course was held over a two day period and included 5 hours of didactic teaching and 8 hours of hands-on skills acquisition. All students were encouraged to do 5 online iTunesU introduction to ultrasound modules (four from UCI and one from University of South Carolina) prior to attending the two day course. Three of the didactic lectures were delivered remotely to Armidale, two by Dr. J. Chris Fox from University of California Irvine and one from a Royal Flying Doctor physician based in North Queensland. In addition to the regular faculty, five UCI student tutors participated in the teaching and assessment. The practical skills sessions used simulated patients, the CAE Mediquip ultrasound simulator and SonoSim. The practical skills stations included: pericardial effusion and tamponade, pneumothorax, ultrasound in abdominal aortic aneurysm, cardiac examination with echo, FAST and RUSH, peripheral intravenous cannulation with ultrasound, foreign body localization and thoracentesis with ultrasound. In addition to an interactive knowledge assessment, participants were assessed on three separate skills stations in an eOSCE (Electronic Objective Structured Clinical Examination) format: 1. Basic ultrasonography 2. FAST protocol and 3. RUSH protocol.

The final year students' scores for the EOSCEs were (mean score for the group /maximum score): Basic Ultrasonography 27.9/29, FAST protocol 13.9/14 and RUSH 12.1/14. One student was considered not satisfactory on initial tests and was offered an additional opportunity to meet criteria for a satisfactory pass.

SUMMARY: The University of New England School of Rural Medicine was able to successfully conduct an intensive two day advanced ultrasound course for final year medical students and second year student tutors using in house resources, members of the Joint Medical Program clinical faculty and five student tutors from the University of California Irvine.

Implementation of a Focused Ultrasound Guided Vascular Access Program for Medical Students

Michael O'Connell, MD[1], Alexandra Dyer, MS4; Lydia M. Sahlani, MD; David P. Bahner, MD, RDMS
[1]The Ohio State University Wexner Medical Center, Columbus Ohio, United States

Introduction:

The ability to obtain vascular access using ultrasound is a critical skill for physicians in training. Novel methods of ultrasound education at UME level have rapidly been developing, and this study assesses the actual and perceived effectiveness of a course developed to train and evaluate medical students in the cannulation of a vessel under ultrasound guidance.

Methods:

Prior to training, 240 second year students were required to: read step-by-step instructions for USGVA, watch a demonstration video, and complete an EMSONO-Carmel Indiana vascular access curriculum. The day of the program, proctors demonstrated the basic principles of ultrasound, demonstrated the skill on a vascular model (Blue Phantom), and then offered students the opportunity to practice the skill. Proctors then evaluated each student and students evaluated the training.

Results:

As assessed by proctors, 96.7% of students could visualize the vessel and needle in the long axis, and 97% of the students could identify the needle and vessel in the short axis. The average number of needle sticks in both the short and long axis was 2 (SD 1.41 for both), suggesting no difference between these methods. Probe grip and stabilization, and image quality ratings both resulted in an average rating of 3.5/5 (SD 2.12), and evaluated dexterity resulted in an average of 4/5 (SD 1.41).

The students strongly agreed that they would recommend ultrasound experiences such as this for future students (84.0% agreement), that they could comfortably recognize the leading edge of an image (90.0% agreement) and that they felt comfortable recognizing a blood vessel in the short and long axis using ultrasound (89.7 % agreement). In addition, over 84.0% strongly agreed that ultrasound-guided vascular access is an important skill that will be encountered by them in the future as a resident or doctor and that this experience was very useful. Possible areas for improvement included the need for more clinical correlation, smaller groups and more time being allotted to the hands-on experience (agreement averages of 73.2%, 69.9%). Many found the hands-on experience to be more helpful than the modules and material required prior to the experience.

Conclusions:

This study demonstrates that the training program was effective and that there was considerable student support for the curriculum. It also presents areas for improvement in future ultrasound curricula. There was no difference in the number of sticks needed for long and short axis techniques. Ultrasound training could be reinforced during 3rd and 4th years and evaluated in clinical scenarios, so that by the end of 4 years, students would have achieved true proficiency. We intend to resurvey all student participants in one year to assess their comfort level with ultrasound and see whether they believe this course assisted them in subsequent clinical work as opposed to different levels of medical school training.

Spatial Abilities and Ultrasonography: Do Differences Between Male and Female Medical Students Matter?

Mark W. Scerbo[1], PhD, Erik Prytz, MS, Rebecca Kennedy, MS, Don Byars, MD, Craig Goodmurphy, PhD, Barry Knapp, MD, Geoff Miller, EMT-P, Frank Lattanzio, PhD, Sarah Shaves, MD, Michael Solhaug, MD, Alex Levitiov, MD, Alfred Abuhamad, MD, F Toreno, MD
[1]Eastern Virginia Medical School/Old Dominion University, Norfolk Virginia, United States

Introduction

Differences between male and female spatial cognitive abilities have been well documented showing an advantage for males on a variety of measures.[1] As ultrasonography places heavy demands on an individual's spatial abilities, we investigated whether males would have an advantage during initial training. Therefore, we tested medical students' spatial ability and correlated their scores with performance on knowledge-based testing requiring spatial discrimination and an observed structured clinical examination (OSCE).

Methods

First-year medical students (MS-I) at Eastern Virginia Medical School (81 males, 64 females) participating in an integrated ultrasonography curriculum were assessed on sonographic knowledge with a 25-item written examination. Student's ability to acquire imagery on GE Logic E ultrasound systems was evaluated during an OSCE using standardized patients. Measures included the ability to select the correct transducer, position it correctly, obtain desired imagery, and image capture time.

Prior to beginning the course, students were administered the Vandenberg and Kuse mental rotations test which requires individuals to distinguish whether 2-dimensional representations of abstract geometric shapes have been shifted in spatial orientation.2 Norms for the test indicate that males perform better than females (56% vs. 37%) and the test has good reliability (K-R 20 = .88, test-retest = .83).[2]

Results

Mean percent correct on mental rotation test for males was 52.6% (sd = 22.8) and 37.2% (sd = 15.2) for females. This difference was statistically significant, $t(143) = 4.85$, $p < .001$. This advantage for males showed up in higher scores on many OSCE measures, but only image acquisition time reached statistical significance. Males were faster (85.2 sec, sd = 5.1) than females (105.2 sec, sd = 8.3) on time needed to acquire images, $F(1,134) = 6.74$, $p < .02$. Also, there was a statistically significant correlation between mental rotation scores and performance on the spatial questions in the post-test, $r = .19$, $p < .025$.

Conclusions

Results from this sample of students confirm that males achieved higher spatial ability scores than females. That advantage did not translate to significantly better performance on the knowledge or OSCE tests, although males were faster at acquiring images. Students with higher mental rotation scores, irrespective of gender, achieved higher scores on post-test questions requiring spatial discrimination. Thus, initial differences in spatial ability were still present upon completion of the course and could differentiate, to some degree, spatial ultrasonography knowledge among medical students.

References:

1. Voyer D, Voyer S, Bryden MP. Magnitude of sex differences in spatial abilities: A meta-analysis and consideration of critical variables. *Psychological Bulletin; 1995;* 117: 250-270.

2. Peters M, Laeng B, Latham K, Jackson M, Zaiyouna R, Richardson C. A redrawn Vandenberg & Kuse mental rotations test: Different versions and factors that affect performance. *Brain and Cognition 1995*; 28:39-58.

Implementation of Bedside Ultrasonography within an Internal Medicine Faculty and Residency Using a "Nidus" Instructor Strategy: The IMBUS Program

David Tierney, MD FACP[1], Benjamin Johnson, MD; Terry Rosborough, MD
[1]Abbott Northwestern Hospital, Minneapolis, Minnesota, United States

Background

Bedside ultrasound has recently secured prominent roles in multiple specialties such as emergency medicine and critical care. Its role for internal medicine (IM) has been described in the arena of procedural guidance, and limited bedside cardiac assessment. However, the feasibility and process of fully integrating bedside ultrasound into the internist's bedside patient assessment has not been described, nor has a process for implementation and certification across an IM residency program.

Objective

Describe in detail and provide rationale for the curriculum, structural details, and successful implementation of an Internal Medicine Bedside Ultrasound program (IMBUS) in an IM residency program its faculty.

Methods

Design: Prospective cohort study in an internal medicine (IM) residency program at a private, academic, 700-bed quaternary care center. **Participants:** 33 residents and 20 full-time faculty members without significant prior ultrasound experience. **Intervention:** 1) Development of an IM ultrasound curriculum to maximize sensitivity/specificity of our routine physical exam as well as critical time sensitive diagnoses; 2) overlap training method using top-down and bottom-up methodologies; 3) 40-hour "boot camp" including didactic, hands-on model-based, and simulator-based training; 4) bedside hands-on training with faculty mentors until trainee meets a pre-specified exam count in each component and is deemed competent in that exam area; 5) ongoing mentored and remotely submitted/reviewed images until adequate technical and interpretive sensitivity/specificity obtained; 6) final test-out using bedside and simulator-based summative evaluation prior to certification; and 7) a robust ongoing quality assurance system. **Measurements:** Comparative effectiveness of multiple implementation strategies utilized. Time to, variation in, and predictive factors of competence in each exam component. Clinical impact of chosen components on patient outcomes. Effect of implementation on resident/faculty workflow, efficiency, and job satisfaction.

Results

We describe in detail and rigorously critique a full bedside ultrasound curriculum and implementation strategy for an IM residency program or other primary care residency program beginning with the common scenario of a single "nidus" instructor. Details include a wireless/mobile certification and exam-recording platform, integration into a resuscitation simulation curriculum, and other unique components that make the IMBUS program successful. 30 IM residents and 20 faculty were trained using the IMBUS program over a 2 year period. Over 4,100 ultrasound examinations have been performed. Early learning curves and competency ranges for each ultrasound exam component within the IMBUS curriculum have been established.

Conclusions

By describing in detail our curriculum, methods, and learning, we hope to help other primary care residency programs implement bedside ultrasound in an efficient, focused, evidence-based, politically aware, and impactful manner with the frequent scenario in primary care training programs of a single "nidus" instructor strategy.

Effectiveness of an institutional faculty development course and barriers to training/education of faculty for integration of ultrasound in medical education

Jongyeol Kim MD[1], Tom Tenner PhD, Peggy Taylor MEd, Raed Alalawi MD, Candy Arentz MD, Aliakbar Arvandi MD, Eric Blackwell MD, Samuel Campbell MD, Robert Casanova MD, Jongpil Cheon EdD, Steven Crooks PhD, Martha Howell MEd, Jennifer Mitchell MD, Thomas Nelius MD, Vaughan Lee PhD, Jeff Paxton MD, Vasum Peiris MD, James Rhea, Dixon Santana MD, Cynthia Smith MD, Simon Williams PhD
[1]Texas Tech University Health Sciences Center School of Medicine, Lubbock Texas, United States

Texas Tech University Health Sciences Center School of Medicine (TTUHSC SOM) began implementing the integration of longitudinal ultrasound into medical education (ILUME) in 2012. The faculty survey on perception and barrier on ILUME revealed many wanted to integrate ultrasound into their specialty but one of the barriers was lack of training and knowledge. We developed an institutional faculty development program on ultrasound (IFDPU). IFDPU consisted of monthly three-hour sessions - basic, intermediate, and advanced - from February through April 2013. We encouraged participants to practice ultrasound at the simulation center outside of sessions. We integrated continuing medical education (CME) into IFDPU for clinical faculty.

To determine whether IFDPU is effective in changing faculty's confidence and gaining knowledge on ultrasound in medical education and barriers to ILUME, pre- and post- IFDPU surveys were conducted for evaluation and self-reporting effectiveness of the program.

Out of 23 participants – 61% clinical faculty at SOM, 22% basic science from SOM - including faculty at School of Nursing, 18 completed the survey. 89% were involved in either undergraduate or graduate medical education. Prior to IFDPU, 33% had moderate to extensive experience with ultrasound and 67% thought their level of understanding of ultrasound as either low or none. IFDPU improved faculty's understanding: upon completion of the program, only 6% described their understanding of ultrasound as low and 89% felt they understood physics and knobology at least more than moderately. All felt the teaching faculty helped them in the understanding and using of ultrasound. 94% considered hands-on sessions with standardized patient as effective in learning use of ultrasound. All reputed they could integrate ultrasound in their teaching of medical students, residents, or faculty (19% very likely; 81% likely and moderately). All saw opportunities for ILUME. 76% felt they would be able to develop a proposal on the integration of ultrasound into their teaching for both clinical and basic sciences. All were interested in following with further training. Only 6% spent time practicing and using ultrasound outside of the sessions. The main obstacle was the lack of time able to be spent practicing. The majority of participants perceived the low availability of machines, finance, and time as the main barriers to application of ultrasound to their teaching.

In conclusion, IFDPU was effective in improving the understanding of ultrasound and awareness of versatility of ultrasound in medical education and willingness to participate in ILUME. Integration of CME and FD is effective in not only increasing clinical faculty participation but changing their perception on ILUME. The main barriers for ILUME and IFDPU included faculty time, availability of machines, and finance.

Attitudes and potential barriers to integration of longitudinal ultrasound to medical education curriculum: A survey of medical school faculty

Jongyeol Kim MD[1], Tom Tenner PhD, Robert Casanova MD, Steven Berk MD
[1]Texas Tech University Health Sciences Center School of Medicine, Lubbock Texas, United States

Background:

Texas Tech University Health Sciences Center School of Medicine (TTUHSC SOM) invited Dr. Hoppmann, Dean of University South Carolina School of Medicine, for Dean's leadership forum on "Integration of ultrasound to medial education" prior to inception of integration of longitudinal ultrasound in medical education (ILUME). The program consisted of multiple small group meetings with various groups of faculty and a Grand Round in March 2013. Knowledge on the attitude of faculty toward using ultrasound as an educational tool and identification of potential barriers to this innovative education were crucial to successful implementation of ILUME.

Purpose:

To investigate potential barriers and attitude by faculty to ILUME.

Methods:

On-line survey with faculty at three campuses of TTUHSC SOM on attitude and knowledge on ultrasound in medical education and perceived barrier to ILUME was performed a few weeks after the symposium.

Results:

Out of 344 clinical faculty, 71 (21%) completed on-line survey. Out of 61 basic sciences faculty, 16 (26%) responded. 83% were aware ultrasound has been taught in other schools as an integrated curriculum. 54% had received training, either formal or informal, of ultrasound. The majority of training was done as postgraduate education during residency and/or fellowship. 46% were using ultrasound in their practice. 74% were interested in receiving additional training. More than half were willing to teach ultrasound to medical students and physicians in training; regarding training other faculty, half expressed their willingness. 61% were interested in developing ultrasound program in their specialty. Even though 87% felt addition of ultrasound to the curriculum the following year was not feasible, 49% were willing to be champions for ultrasound education in their department or specialty.

Regarding barriers, lack of expertise and no support for training faculty, students, and residents were the most significant, followed by lack of time for training and financial constraints. Some concerned the current information on efficacy of ILUME was insufficient. Some felt a strategic plan for accomplishing short and long-term goals was needed.

Conclusions:

In conclusion, the majority of faculty knew that ultrasound has been taught as an integrated curriculum after the leadership forum. Many were willing to develop ultrasound program but majority believed that immediate implementation of ultrasound could not be feasible. Lack of expertise, support, time, and finance were obstacles. Based on this data, TTUHSC SOM put an effort on securing funding and administration support for the successful implementation of ILUME. We also developed institutional faculty development program.

References:

Hoppmann RA et al. An integrated ultrasound curriculum (iUSC) for medical students: 4-year experience. Crit Ultrasound J. 2011 3:1-12.

Evaluating didactic methods for training medical students at The Faculty of Medicine in Transylvania, Romania in the use of bedside ultrasound for clinical practice

Cosmin Florescu, MA, MPH[1], Jeffrey Mullen, Vivian Nguyen, Brooke Sanders, Priscilla Vu
[1]University of California, Irvine School of Medicine, Irvine California, United States

Medical students' time is a precious commodity and learning activities should maximize time efficiency and the amount of useful material that is learned. The purpose of this research project was to help the research team and Dr. Chris Fox from UC Irvine School of Medicine determine whether podcasts or live-class teaching best augments hands-on ultrasound teaching. O'Bannon et al. found that there was no significant difference between using traditional lecture and podcast modalities in the realm of students seeking a teaching credential. The research team wanted to see if this is the case for teaching bedside ultrasonography to medical students (O'Bannon, 2011). The hypothesis was that the best method of teaching ultrasound includes a combination of podcasts describing the anatomy, pathology, and sonography of organ systems and hands-on sessions with the ultrasound machine. The training was done in an international setting at the Faculty of Medicine at Transilvania University of Brasov in Romania. Medical students were randomly assigned to one of three different study groups. Students assigned to the first group watched a 50-minute live lecture and attended a 50-minute hands-on bedside ultrasound training session. Students assigned to the second group watched a podcast that covered the same material as the live lecture and attended a 50-minute hands-on bedside ultrasound training session. Students assigned to the third group did not attend a lecture or watch a podcast but attended a 50-minute bedside ultrasound training session. Each day, a different topic was covered; these were 1) Introduction to ultrasound & knobology, 2) Pulmonary ultrasound, 3) Cardiac ultrasound, 4) Focused Assessment with Sonography for Trauma (FAST) exam, and 5) Hepatobiliary ultrasound. Pre- and post-training evaluations were conducted to compare the three study groups. On the first day of the program, students were randomly assigned an ID number and asked to complete a 20-question pre-training quiz that covered basic ultrasound principles and the FAST exam. At the end of the ultrasound course, the students completed a post-training quiz and the FAST exam for their practical test. Students' pre- to post-training quiz scores in the lecture group increased from 33.6% to 72.6% correct, while those in the podcast group increased from 40.7% to 75.5% correct, and the control group increased from 37.8% to 70%. Data analysis showed that there were no statistically significant differences in quiz score improvement among the three study groups. These results suggest that all three methods are equally effective at improving student comprehension of bedside ultrasound and that faculty have the flexibility to use the one that best suits their institution and student learning style.

References: O'Bannon, B.W., Lubke, J.K., Beard, J.L., and Britt, V.G. (2011), Using podcasts to replace lectures: Effects on student achievement. 57; 1885-1892. Doi:10.1016/j.compedu.2011.04.0 0

Integration of Ultrasound in Academic Medicine: Organizational Trends, Themes, Threads and Transformation in a Philippine Medical School

CAJA, Jocelyn Myra R.[1], MD, MHPED, CALIMAG, Maria Minerva, MD, MSc. PhD; GONZAGA, Peregrina L., MD, MHPED; GONZAGA, Edilberto S. MD; TAN-SALES, Bee Giok, MD
[1]University of Santo Tomas Faculty of Medicine & Surgery, Manila, Republic of the Philippines

Introduction: The evolution of the medical curriculum is dependent on pervading environment and culture through the ages. It must be attentive to the needs of the community and society in general. Recent advancements in modern medicine have made tremendous impact on the changing focus and needs in medical education. The medical schools and training institutions have to respond to these needs to enhance learning and prepare the medical graduates to meet the challenges in the practice of modern medicine. With recent advancements in technology as a whole and the growing demand for better patient care, various medical schools abroad started incorporating ultrasound as a teaching tool in their medical curriculum.

Objective: Anchored on the action research model, this paper portrays the driving and restraining forces that push-pull the pioneering efforts at curricular integration of the ultrasound in Medical Education at a Philippine Medical School.

Method: Action Research

Findings and Discussion: A continuum of curricular change driven by social, political, technological and economic forces was evolved. Milestones of the continuum of change were focused on the initiation, integration, implementation and impact of ultrasound integration in the medical curriculum.
Conclusion: Successful implementation process of change requires that curriculum makers actively engage in this elusive process of supporting implementation while being continuously aware of the various stakeholders and material resources needed so that the push factors overcome the pull factors.

Effectiveness of an Evidence-Based Critical Care Ultrasound Course

Susan Pasnick MD[1], Archana Jayakumar MD, Sarah M Muni MD, and Christopher F Barnett MD
[1]University of California San Francisco, San Francisco California, United States

RATIONALE: Critical care ultrasound (CCUS) refers to focused ultrasound examination performed at the bedside by an intensivist to answer specific clinical questions immediately relevant to patient care. There is growing evidence that CCUS reduces procedural complications, improves patient outcomes, and patient satisfaction. We developed a two-day, evidence-based course, including hands-on skill sessions with standardized patients, to train critical care faculty and fellows in the use of CCUS. Although it has been previously demonstrated that CCUS can be taught during a brief course, the durability of the acquired skills and knowledge is unknown.

OBJECTIVE: To assess the effectiveness of an evidence-based CCUS course.

METHODS: Critical care fellows and faculty from a single institution are invited to attend our two-day evidence-based CCUS course. To date, the course has been offered five times with a total of 75 participants. We developed a survey instrument to assess ultrasound experience, confidence, and knowledge. The survey is administered prior to the course, immediately after the course, and at six months after the course.

RESULTS: 75 participants have attended the course and completed the baseline survey, 37% were critical care faculty and 63% were critical care fellows. At baseline prior to the course, the median self-reported confidence in ultrasound was 'not at all confident' for abdominal and cardiac, and 'not so confident' for lung and vascular ultrasound. Immediately after the course there were significant increases in self-reported confidence in cardiac ('somewhat confident'), abdominal ('somewhat confident'), lung ('somewhat confident') and vascular (‘confident’) ultrasound. After 6 months, there was no decrease in self-reported confidence in cardiac, lung and vascular ultrasound. Self-reported confidence in abdominal ultrasound decreased slightly to ‘not so confident.’ The knowledge assessment showed significant improvement from baseline (median 68% correct) to immediately post-course (median 89%), p value <0.01 (Wilcoxon Signed-Rank Test), with persistence of knowledge at 6 months (median 86%) as compared to baseline, p-value <0.01. At 6 months the proportion of participants who affirmatively responded to the question, "Has an ultrasound performed by you influenced your clinical care?" were 68% for vascular, 68% for cardiac, 54% for lung, and 18% for abdominal ultrasound.

CONCLUSIONS: Our experience suggests that CCUS knowledge and confidence can be acquired during an intensive evidence-based course. Additionally, we showed that this increase in knowledge and confidence in CCUS persists 6 months after the course. Future educational assessments should incorporate bedside ultrasound skill evaluations and patient centered outcomes.

Trained Simulated Ultrasound Patients (TSUP) : Models, Learners and Proctors

Creagh Boulger[1], J Matthew Blickendorf MD, Eric J Adkins MD Msc, David Bahner M.D. RDMS
[1]Wexner Medical Center, The Ohio State University, Columbus Ohio, United States

This project describes an educational paradigm at a large university medical center that uses medical students to fulfill the need for human models to promote passive and active learning. This concept was recently published in Journal of Ultrasound Medicine .[1]Preclinial medical students are often eager to have interactions with faculty, residents and learn clinical skills, this model enables this mentorship and learning in a unique way.

Methods: During the 2012-2013 academic year, medical students from The Ohio State University College of Medicine served as Trained Simulated Ultrasound Patients (TSUP) for hands-on scanning sessions held by the College and many residency programs. The extracurricular program is voluntary and coordinated by medical students with faculty supervision. Students receive a longitudinal didactic and hands-on ultrasound education program as incentive for serving as a TSUP. Following the academic year the TSUPs were given a practical and written exam. The exam covered basic knobology, basic cardiac ultrasound, volume assessment, first trimester pregnancy, and focused assessment of sonography in trauma (FAST). Twenty four students completed the exam that was scored by credentialed ultrasound faculty

Results: The TSUPs scored an average of 77.9 out of 86 on the written exam and scored an average of 43.75 out of 50 on the practical exam.

Examining The Surface and Scanning Within: Point-of-Care Ultrasound Curriculum for First-year Medical Students

Bret P Nelson[1], MD, RDMS, FACEP, Hojsak J, Dei Rossi E, Karani R, Narula J
[1]Icahn School of Medicine at Mount Sinai, New York New York, United States

Background: Although ultrasound use permeates clinical practice across many specialties, very few medical schools offer formal instruction in ultrasound image acquisition and interpretation. This study was designed to assess the impact of adding an ultrasound curriculum to the physical examination course for first year medical students (MS-1).

Methods: A modular curriculum on basic cardiac, lung, gallbladder and aorta ultrasound was incorporated into the MS-1 physical examination course. All students and course faculty were oriented to basic handheld ultrasound machine operation and physics prior to the start of the course. Videos, tutorials, and interactive multiple choice questions were available online prior to each hands-on session. These sessions were incorporated into the relevant standard physical examination small groups. Working with physical examination and ultrasound faculty, students practiced physical examination skills followed by ultrasound visualization of the heart (contractility, pericardial effusion), lungs (A-lines, pleural effusion), gallbladder (stones, sono Murphy sign), and abdominal aorta (diameter measurement). Five additional open practice sessions were arranged. At the start of the course physical examination faculty completed a survey on prior experience and perceptions. A post-course survey was completed by both faculty and students. Student competency in performance and interpretation of basic ultrasound was assessed by ultrasound faculty. For half the students, two independent assessments were made.

Results: The physical examination faculty survey revealed half (13/26) viewed personal gain of skill as the major benefit of the new curriculum; 70% (18/26) noted their own unfamiliarity with ultrasound was the greatest struggle. Sixty-two percent felt MS-1 is the right time to introduce ultrasound skills; 38% thought it too early. Using a Likert scale (1= Agree, 5=Disagree), faculty reported a neutral level of confidence (3.1/5) in their ability to teach this new content. Eighty-two percent agreed that the curriculum would add value to the educational experience. There were no significant differences in these assessments pre- or post-course. Eighty percent of students felt MS-1 was the right time to teach ultrasound; they agreed that it added value to the curriculum (69%) and enhanced knowledge of anatomy (62%). Mean student scores for scanning and identifying anatomy were 80.3% (cardiac), 79.6% (thorax), and 71.2% (abdomen). Their confidence in assessing anatomy was lower: 38% were confident in their ability to visualize the heart, 41% for thorax, 60% for aorta, and 32% for gallbladder.

Conclusion: Students and physical examination faculty supported the timing of the course. Students performed well on competency assessments of their ultrasound skills but were not confident in their abilities at the end of the course. This may be related to learning physical examination and ultrasound at the same time or limited availability of practice time with the machines outside of class.

Assessment of a low-cost pericardiocentesis model

Dorothea Hempel[1], Marco Campo dell' Orto, Agnieszka Starzetz, Raoul Breitkreutz
[1]Medizinische Klinik und Poliklinik, Universitätsmedizin Mainz

Introduction: The use of ultrasound during resuscitation is emphasized in the latest European resuscitation council guidelines of 2013 to identify treatable conditions such as pericardial tamponade [1]. The recommended standard treatment of tamponade in various guidelines is pericardiocentesis. As ultrasound-guidance lowers complication rates and increases patient safety, pericardiocentesis should be performed under ultrasound-guidance [2]. Acute care physicians actually need to train emergency pericardiocentesis.

Methods: We describe in detail a pericardiocentesis ultrasound model that can be assembled in about 2 hours using materials at a cost of about 60 Euros. Materials used were a plastic container, gel wax, a celluloid ball, a balloon, ultrasound gel, colored water and a syringe. During training courses of focused echocardiography n=67 participants tested the phantom and completed a 16-item questionnaire assessing the model using a visual analogue scale (VAS). Three groups of participants were defined: Experience in pericardiocentesis, experience in any kind of puncture (i.e. central line), and no experience at all. Statistical analysis (descriptive statistics) was performed. Scores of the three groups were compared using the Mann-Whitney U-Test in order to identify differences in ratings between the groups.

Results: The model was used for over 60 punctures and stored for over a year without need for major maintenance work. It showed no signs of molding or decline in quality. There was no statistically significant difference between the three groups regarding scores, so that data was pooled. Eleven of fourteen questions were answered with a mean VAS score higher than 60% thus regarded as showing the strengths of the model. Unrealistically outer appearance and heart shape were rated as weakness of the model. A total mean VAS score of all questions of 63% showed that participants gained confidence for further interventions.

Conclusions: Our low-cost pericardiocentesis model, which can be easily constructed, may serve as an effective training tool of ultrasound-guided pericardiocentesis for acute and critical care physicians.

References: 1. Nolan, J.P., et al., *European Resuscitation Council Guidelines for Resuscitation 2010 Section 1. Executive summary.* Resuscitation. **81**(10): p. 1219-76.

2. Lindenberger, M., et al., *Pericardiocentesis guided by 2-D echocardiography: the method of choice for treatment of pericardial effusion.* J Intern Med, 2003. **253**(4): p. 411-7.

A novel cross-departmental pelvic ultrasound training course utilizing a hybrid of live and simulation models improves resident competency

Amy Sanghvi, MD[1], Nelson BP, Pour T
[1]Icahn School of Medicine at Mount Sinai, New York New York, United States

Introduction: Bedside pelvic ultrasound is a standard part of the evaluation by emergency physicians and obstetricians of pregnant and often nonpregnant women who present with abdominal pain, vaginal bleeding, and a host of other complaints. Pelvic ultrasonography performed by emergency physicians or obstetricians can be used to rule out ectopic pregnancy and make other diagnoses in patients with complicated first trimester pregnancies. Teaching pelvic ultrasound can be very resource-intensive and it is rare for different specialties to combine training efforts. In this study a brief, multi-modal training course was introduced for emergency medicine and Ob/Gyn interns.

Methods: A half-day pelvic ultrasound training course for all 23 Emergency Medicine and Ob/Gyn interns was implemented. This was an intensive course beginning with a brief didactic on ultrasound machine use, normal and abnormal anatomy, and an evidence-based pathway for evaluation of ectopic pregnancy in acute care settings. The bulk of the course was hands-on and interactive. Interns rotated through seven stations: four live female models and three simulators. The live models underwent transvaginal scanning of the uterus and ovaries with Sonosite machines and intracavitary probes. The simulators included a Blue Phantom heterotopic pregnancy model (demonstrating both an intrauterine and adnexal pregnancy), a Medaphor ScanTrainer demonstrating several cases of normal anatomy and pathology, and a Simulab SonoMom simulator demonstrating cases of normal anatomy and pathology. EM and OB/Gyn faculty, fellows, and senior residents with significant ultrasound experience provided instruction at each station. At the end of the course, the interns were assessed by faculty with a standardized scanning competency assessment and were asked to complete an online image-based multiple choice examination.

Results: In the practical portion of the exam, all 23 of the residents passed the 13-part practical proficiency exam demonstrating that they could use the machine controls and also obtain adequate views of the uterus (mean score 95%). All residents who completed the online multiple choice examination achieved satisfactory passing scores (mean score 82.8%). Residents completed a survey regarding their experience and unanimously recommended the curriculum be repeated for future classes. They rated both the presentation quality and educational value at 3.7 out of 4.0.

Conclusion: A multimodal, cross-departmental curriculum in acquiring and interpreting point of care sonography can help interns achieve initial competency in this critical skill. Combining specialties allowed for pooling of faculty, space, and equipment resources.

Impact of an EM ultrasound-guided nerve block training course in Porto Alegre, Hospital Pronto Socorro – case series

Daniel Fontana Pedrollo[1], Daniel Fiterman Molinari, Francisco Sanchez, Arun Nagdev, Daniel Mantuani Marcio Rodrigues, Bianca Bertuzzi, Ana Claudia Tonelli
[1]Emergency Department Hospital de Clínicas de Porto Alegre, Emergency Residency Program Hopsital de Pronto Socorro Porto Alegre, Porto Alegre, Brazil

Detail: A 2-day training course in ultrasound-guided nerve blocks (UGNB) was performed by Highlands General US team in Hospital de Clinicas (HCPA), Porto Alegre, Brazil for Emergency Medicine (EM) residents from Hospital Pronto Socorro (HPS). Residents and attending faculty attended the course. The objective was to create a sustainable training program in UGNB.

The two-day UGNB course consisted of didactic and hands-on training on various nerve blocks.

Over the course of 6 months, around 20 UGNB were performed, in the ED in HPS, HCPA, and Maimonides Day Hospital (MDH).

Case 1:

HPS: 50-yo male with a laceration of his right hand. Neurologic examination of affected hand could not be performed due to severe pain despite two doses of intravenous opiates.

Surgical evaluation indicated amputation, but the operation room (OR) had a three-hour delay. An in-plane lateral to medial ultrasound-guided supraclavicular brachial plexus block was performed by a second year EM resident with 20 cc of 0.5% bupivicaine.

Twenty minutes after the procedure, the patient's upper extremity pain was considerably reduced. A detailed examination of the affected hand was performed by the surgical consultation confirming the need for amputation. The patient did not need additional pain control medication in the ED during the three-hour wait for the OR.

Case 2:

MDH: 56-yo male with a mass in left shoulder. Surgery was indicated. An in-plane lateral-to-medial ultrasound-guided interscalene brachial plexus block with lidocaine was performed by the MDH attending emergency physician. Ten minutes after the block, the patients had reduced motor function and complete anesthesia of deltoid area. Surgery was performed with no need for addition local anesthesia or procedural sedation. No pain was reported during surgery. The patient recovered movement and sensation of the left arm 2 hours after block.

Case 3:

HCPA: 55-yo woman with metastatic breast cancer and a mid-shaft femoral fracture. The woman was in pain despite morphine. An ED attending physician performed an in-plane ultrasound-guided femoral nerve block with lidocaine 2% with epinephrine. Pain was reduced significantly, with no need for additional intravenous opioids in under 15 minutes.

Discussion:

UGNB have recently become a novel method for analgesia in the ED. Along with reducing complications and improving success, UGNB are also a teachable skill. After this standardized training program, physicians have been able to integrate its use into clinical practice.

Conclusion:

A short training program consisting of both didactic and hands-on scanning may be an ideal method for training novice sonographers in performing UGNBs. Further training and close evaluation of subsequent cases will help aid in establishing UGNBs as a viable tool for EM physicians internationally. Standard safety protocols must be developed to ensure successful clinical outcomes. (MD et al. 2013; Stone et al. 2008; MS et al. 2010)

References:

Tirado, A. et al., 2013. Ultrasound-Guided Procedures in the Emergency Department-Needle Guidance and Localization. *Emergency Medicine Clinics of NA*, 31(1), pp.87–115.

Beaudoin, F.L. et al., 2010. Ultrasound-guided femoral nerve blocks in elderly patients with hip fractures. *American Journal of Emergency Medicine*, 28(1), pp.76–81.

Stone, M.B., Wang, R. & Price, D.D., 2008. Ultrasound-guided supraclavicular brachial plexus nerve block vs procedural sedation for the treatment of upper extremity emergencies. *The American journal of emergency medicine*, 26(6), pp.706–710.

Confirmation of Endotracheal Tube Placement Utilizing Ultrasound

Brion Benninger[1], Nik Matsler
[1]Western University of Health Sciences, Lebanon, Oregon, United States

Introduction: Confirmation of correct tube placement is paramount following intubation. End title CO_2 ($ETCO_2$) is the preferred confirmation method and is highly accurate in living patients. However, $ETCO_2$ may not be as effective with cardiac arrest. Ultrasound (US) has been used to confirm tube placement through indirect means (i.e. pleural movement). This study investigated if an acoustic window could be found to use US for direct tube placement confirmation. Methods: Literature search was conducted on journals and specialty journals regarding US being used during intubation. 5 unembalmed and 2 embalmed were intubated utilizing direct laryngoscopy with a standard 7.5 tube. US was applied by novice users using vocal cords as an acoustic window to directly confirm tube placement utilizing a long linear, 15-6 MHz transducer. Results: Literature search revealed several studies and techniques for indirect confirmation of tube placement utilizing US or probe placement above suprasternal notch, but none that used vocal cords as an acoustic window. Ultrasound probe was placed just above cricoid cartilage and angled until vocal cords were visible in a transverse plane; all 7 tubes were confirmed within the trachea. Conclusions: Confirmation of tube placement is vital in emergency situations, especially in circumstances where access to advanced imaging techniques or video laryngoscopy is not available. During cardiac arrest, $ETCO_2$ may not be a reliable indicator. Therefore, additional methods of confirmation must be sought, especially for difficult airways. Using the vocal cords as an acoustic window, US was shown to be effective in confirming tube placement by novice users. This study was successful, but further investigation of US for tube placement confirmation is warranted.

Ultrasound Guided Vascular Access on a Phantom: A Training Model for Medical Student Education.

Lydia M. Sahlani[1], MD, Eric J. Adkins, MD; David P. Bahner, MD, RDMS
[1]The Ohio State University Wexner Medical Center, Columbus Ohio, United States

Introduction: Patient safety and prevention of medical errors has been emphasized as an integral part in medical education. Focusing on ultrasound guided vascular access (USGVA) in the medical school curriculum can improve patient safety and prevent errors. We reviewed a cohort of 2nd year medical students (MS2) to assess their proficiency with ultrasound guided vascular access in 2010, 2011, and 2012 focusing on long and short axis cannulation after participation in an asynchronous and synchronous USGVA curriculum.

Methods: This study was an observational cohort study of MS2s during their Introduction to Clinical Medicine (ICM) program during 2010, 2011, and 2012. Students reviewed an online training module from EMSONO.com about USGVA with focus on short and long axis vessel cannulation, completed a quiz, and participated in a proctored didactic session using a blue phantom block gel model.

Students were divided into groups and allowed to practice the skills in the presence of a proctor. After the practice session, they were graded by the proctor using a standardized scoring sheet. The students were evaluated on their ability to visualize the simulated vessel in different planes, perform vascular cannulation in both the short and long axis, the number of needle sticks attempted, and successful cannulation.

Results: A total of 600 MS2s with complete data from 2010-2012 were included. Students were able to cannulate the vessel in long axis with a mean of 1.25 sticks; SD= 0.60, 95% CI= 1.20-1.30. They were able to cannulate the vessel in short axis with a mean of 1.33 sticks; SD= 0.67, 95% CI= 1.27-1.38. A nonparametric test, the Wilcoxon signed rank test, for paired data was used for further analysis. We tested the hypothesis that the median of difference between number of sticks in long and short axis would equal zero. Combined data shows there was a significant difference ($p = 0.0007$) between number of long axis and short axis sticks.

Discussion: A structured ultrasound curriculum can help MS2s learn the psychomotor skills necessary to cannulate a vessel on a phantom using ultrasound guidance. Results indicate there is a significant difference between long and short axis sticks, with short axis requiring more sticks to cannulation. Future studies could focus on improvement of short axis sticks to cannulation and retention of the skill as tested at various intervals of training. Students could also be surveyed regarding whether or not this experience enhanced their understanding and use of USGVA during clinical responsibilities.

Echo-Guided Life support (EGLS) : an algorithmic approach to the patient in shock

Maxime Valois, Jean-Francois Lanctot
Montreal University, Motreal Quebec, Canada

Detail: Point-of-care ultrasound is pertinent to the evaluation of the patient in shock in many ways. For non-experts confusion can arise from the many possibilities available to evaluate a shock patient.

The EGLS approach is designed to standardise and facilitate its use in a potentially stressful situation and to optimise the examination sequence. It is designed to cover the main etiologies of shock and avoid certain pitfalls of ultrasound evaluation. An assessment of core competencies in point-of-care ultrasound is currently being built and aims at evaluating the acquisition, interpretation and clinical integration through a written exam, OSATS (objective structured assessment of technical skills) and CRM (crisis response management).

The training is designed by 2 hour modules on each component of the algorithm : inferior vena cava assessment, focused echocardiography (subcostal, parasternal long and short and apical views) combined with a session on physiology (venous return and cardiac output curves) and ACLS-like case scenarios that allow participants to integrate their learning and easily allows evaluation. All participants have to read prior documentation and viewed online podcast and conferences are being developed.

The course on Echo-guided Life Support has been given to over 300 physicians in Canada. It will be incorporated in undergraduate studies at McGill University. It includes an iPhone application given to the participants that subsequently serves as a reminder and also as a template allowing real-time bedside comparison of the patient’s findings to standardized videos on the application thus allowing in-time teaching and learning.

References: http://link.springer.com/article/10.1007/s13089-011-0083-2

POWERPOINT PRESENTATIONS IN ULTRASOUND TEACHING - STILL APPROPRIATE?

Dorothea Hempel, MD[1], Tanja Stenger, Raoul Breitkreutz
[1]University Hospital Mainz, Germany

BACKGROUND: Ultrasound is gaining importance in medical education both pre- and postgraduate. Certified courses are available for EFAST (extended focused assessment with sonography intrauma) and FEEL (focused echo entry level). Teaching methods used are standardized PowerPoint presentations, pre- and postcourse E-Learning and hands-on training (1). Aim: The primary goal of our study was to evaluate the impact of PowerPoint presentations (PP) used for ultrasound teaching by evaluation the retained knowledge rate (RKR) and the learning load (LL).

METHODS: Our study was conducted during two EFAST and two FEEL courses lasting two days each. Standardized PPs (10-20 min) were presented by experienced trainers. Two presentations were case-based. Trainers were asked to provide keywords, pictures and context of meaning about their presentation that they regarded as most important and assign a score to each. The sum of the scores were divided by the correct responses of the participants giving the RKR. The LL was defined as content per minute of presentation. 11 medical students with no prior ultrasound knowledge and 12 physicians for each presentation were asked to participate. Each group listened to 7 to 8 standard presentations and was asked to answer a questionnaire stating the information and key messages they remembered at 0 and 2.5, 24 hours and 14 days.

RESULTS: The students returned 168 of 176, physicians returned 161 of 202 questionnaires. In the student group the RTR were 32.5%, 15%, 16% and 12% at 0, 2.5, 24 hours and 2 weeks respectively. In the physician group the RKR were 23.%, 20.5% and 22.4% after 0, 2.5 and 24 hours. The LL in the student group was 1.6/minute and 1.2/minute in the physician group. There was no significant difference in RKR when comparing PP with higher and lower LL for both groups ($p=0.99$ and 0.11). For both groups shorter or case-based PP were associated with a significantly higher level of RKR ($p<0.01$).

CONCLUSION: Our study supports the evidence that only a limited amount of information can be processed at a time. Only 12% of knowledge is retained after two weeks. Short presentations and case-based presentations significantly increase the retained knowledge.

REFERENCES:

(1) Röhrig S, et al. DGAI zertifizierte Seminarreihe Anästhesie Fokussierte Sonographie Modul 5: Thorakaoabdominelle Sonographie (EFAST plus). Anaesthesiol Intensivmed Notfallmed Schmerzther, 2011. 46: p. 772-781.

INCORPORATING AN EXTERNAL ASSESSMENT PROGRAM INTO THE EDUCATIONAL CONTINUUM: THE ARDMS PILOT TESTS FOR WINFOCUS CARDIAC ULTRASOUND

R. Eugene Zierler, MD[1], Gabriele Via, MD; Enrico Storti, MD; Elizabeth Langston, CAE; Ellen Julian, PhD
[1]American Registry for Diagnostic Medical Sonography (ARDMS)

DETAIL: The Innovation Task Force (ITF) of the American Registry for Diagnostic Medical Sonography (ARDMS) developed a 3-form (50 items per form) assessment program for the Focused Cardiac Ultrasound course at the 8th WINFOCUS World Congress in Barcelona, Spain, October 20-23, 2012. In contrast to the traditional ARDMS sonography credentialing examinations which contain up to 200 items and are administered once in a secure testing environment on desktop computers, this program was created for delivery on personal computers and tablets as precourse,post-course, and 6-month follow-up assessments. ITF members wrote test items using an outline of the WINFOCUS curriculum. Item types included hot-spots, multiple response, drag-and-drop, drop-down, and fill-in, and many items incorporated still images and videos. All test forms were constructed to have the same level of difficulty and were approved by the WINFOCUS faculty.

Participants completed 23 pre-course and 21 post-course assessments delivered on-line and in-person on 2 testing platforms (Edumatic by Televic and TesTrac by TesTrac.com). A survey was administered between the post-course and 6-month follow-up assessments and was completed by 19 pre-course and 18 post-course participants. Survey data show that the pre-course assessment was considered difficult or very difficult by 52% of participants, while this decreased to 33% for the post-course assessment. All of the 18 post-course participants were physicians, and their specialties included anesthesiology, emergency medicine, and critical care. English-language proficiency was rated as “low” by 33% of the survey respondents. As a result, the 6-month follow-up test form was created with special attention to language. To help maintain a consistent level of difficulty, 72% of the items were taken from previous forms either edited for language or unchanged. The 3rd form was administered online 6-months after the course using the Edumatic platform and was completed by 13 participants. Upon completion of the 3rd form, participants were able to review their results and received explanations of each item.

An analysis of data from participants who completed all 3 assessments showed average test scores (on a 100-point scale) of 70% pre-course, 84% post-course, and 81% at 6-months. An average increase of 14% from the pre-course to the postcourse scores indicates increased knowledge, which appears to be sustained at 6-months. The domain related to ultrasound clinical implementation skills (Use/Effectiveness) consistently underperformed compared to other domains (General Knowledge, Tools/Methodology, Signs/Interpretation), and this suggested to the faculty the need to strengthen post-course education in this important competency area. This experience shows that the integration of external assessments into a point of care ultrasound curriculum and inclusion of assessments along the educational continuum can provide benefits to students, faculty, and test developers. This pilot program documented participant learning while identifying content areas needing emphasis and providing insight into the testing process.

ASSESSMENT OF A NEW E-LEARNING SYSTEM ON THORAX, TRACHEA AND LUNG ULTRASOUND

Dorothea Hempel, MD[1], Colleen Cuca, Magnus Barth, Raoul Breitkreutz

[1] Medizinische Klinik und Poliklinik Universitätsklinik Mainz (Germany)

BACKGROUND: Lung ultrasound has become an emerging tool in acute and critical care medicine. Combined theoretical and hands-on training has been required to teach ultrasound diagnostics. Current computer technology allows for the display, explanation, and animation of information in a remote-learning environment.

OBJECTIVE: Development and assessment of an e-learning program for lung ultrasound and it's comparison to a one-day custom classroom training course.

METHODS: An interactive online tutorial was created. A pre-test was performed in week 1 before the tutorial was available to students for two weeks (weeks 2 and 3). The contents of the tutorial included a total of 21 units, which represent one screen each about basics, pleural effusion, pneumothorax, pulmonary edema, consolidations, trachea, and workflow of a protocol-based lung ultrasound exam with exercises. A prospective learning success study was conducted using a multiple-choice test. Pre-tests (week 1) were compared with post-course tests (in week 4) and sustainability tests (week 7) as well as a pre-and post-test (directly before and after) of a one-day custom classroom training (THOLUUSE) [1, 2].

RESULTS: During the learning success study (n=29 medical students), the increase of correct answers was from 11.7/20 to 17/20 in the post-test and to 16.6/20 in the sustainability test (relative change 45.1%, $p<0.0001$, Wilcoxon matched pairs test). When comparing the students to the THOLUUSE cohort, the mean and median values of the pre-test (e-learning 11.7, 12, THOLUUSE 11.5, 12) as well as the post-test (e-learning 17, 17, THOLUUSE 16.8, 17) and sustainability test (e-learning 17, 15) were almost identical. The average relative improvement in both tests was also very similar with 45.1% (week 4) and 41.81% (week 7) for e-learning and 45.71% for the THOLUUSE cohort.

CONCLUSION: The basics of lung ultrasound can be taught in a highly effective manner and with sustainability using e-learning.

References:

1. Breitkreutz et al. 2013, submitted (unpublished data)

2. Steigerwald, M. (2009) THOLUUSE (Thorax-, Trachea- und Lungensonographie in der Intensiv- und Notfallmedizin): Entwicklung und Überprüfung eines neuen Kurskonzeptes, Med. Dissertation, Fachbereich Medizin, Johann Wolfgang Goethe Universität, Frankfurt am Main

PRE-MEDICAL STUDENT PERCEPTIONS OF AN ULTRASOUND MEDICAL CURRICULUM

Courtney M. Poston[1], Caroline K Powell, MD, MSCR
[1]Clemson University/University of South Carolina School of Medicine

BACKGROUND: Medical schools are embracing innovations in medical education to expand hands-on learning. Ultrasound is among these new initiatives. Adding ultrasound to the curriculum provides a novel method of learning and teaches students a clinical skill. Ultrasound has been shown to add to the learning experience and is positively perceived by pre-clinical and clinical medical students (1-3). Little is known about whether pre-medical students are aware of the use of this technology or how they perceive it would impact their medical school experience (4).

METHODS: Twenty rising senior pre-medical undergraduate students (8 males and 12 females) from 5 universities participated in a four week shadowing experience. Students were selected by pre-medical advisors at their universities based on competitiveness for medical school acceptance. Students participated in clinical shadowing and activities unique to the sponsoring institution's medical school curriculum (ultrasound, simulation, and standardized patient interviews). In the final week of the program, students were sent an electronic survey to assess their perception of ultrasound and relative benefits of ultrasound compared to the other experiences. Students were asked about their perception of the ultrasound curriculum in comparison to unique programs at other medical schools in the state and how ultrasound might influence their learning in medical school. Surveys were completed anonymously and results tabulated in the aggregate and individually.

RESULTS: Nineteen of twenty students completed the survey. Ninety percent of participants rated the ultrasound experience as equally or more influential than other modules offered during the experience. All students perceived an ultrasound curriculum to be equally or more appealing than curricula offered at other regional medical schools, and 95% felt that ultrasound would be equally or more beneficial to their medical education. Ninety-five percent of students felt that ultrasound would enhance their learning of Gross Anatomy and clinical care of patients.

CONCLUSIONS: Pre-medical students perceived the ultrasound curriculum very positively. Just as medical students compete for entry into medical schools, medical schools compete for superior students. An ultrasound curriculum has the potential to assist in recruiting high quality students.

REFERENCES:

Hoppmann RA et al. (2011) An integrated ultrasound curriculum (iUSC) for medical students: 4-year experience. Crit Ultrasound J. 3(1):1-12.

Wittich CM et al. (2002) Teaching cardiovascular anatomy to medical students by using a handheld ultrasound device. JAMA 288(9):1062–1063.

Shapiro RS et al. (2002) A pilot project to study the use of ultrasonography for teaching physical examination to medical students. Comput Biol Med 32(6):403–409.

Adams T et al. (2006) What influences medical school choice? Medical Teacher 28(1):83-85.

ICU ULTRASOUND ROUNDS: A NOVEL METHOD OF EXPOSING STUDENTS TO ULTRASOUND PATHOLOGY

Rebekah Zaiser, BS[1], David Bahner, MD, RDMS, Eric Adkins M.D. MSc
[1]The Ohio State University

INTRODUCTION: The Ohio State University College of Medicine (OSUCOM) has a robust ultrasound education curriculum that spans all four undergraduate years (1). Students learn image acquisition and interpretation through didactic and online modules while they gain practical skills by scanning fellow medical students (2). Our institution has sought to increase students' exposure to real-time pathologic scans and instruction in how these scans direct medical decision-making. ICU ultrasound rounds have been utilized to expose students to pathologic scans reliably found in the ICU setting and to facilitate learning alongside residents, fellows, and attendings from multiple specialties.

METHODS: ICU ultrasound rounds led by the ultrasound faculty are held in the MICU and SICU. Dates and times are distributed to students, housestaff, and attendings on a monthly basis. Critical care fellows and attendings pre-identify interesting and high-yield cases to be reviewed by the group. At the bedside, the group reviews the clinical presentation, indications for the exams, acquisition and interpretation of images, and the use of the exam in medical decision-making (I-AIM, 3). Each student and housestaff member is allowed to perform each scan and identify the pathology.

RESULTS: From October 2009 and June 2011, 52 ICU ultrasound rounds took place. Each session lasted 1-3 hours. Counting each time a student attended, 121 students were present with about 20 students attending multiple sessions. Medical students from all classes participated. Residents, fellows, and attendings from critical care, surgery, emergency medicine, and internal medicine also participated. Students performed bedside scans on patients with pulmonary, cardiac, hepatobiliary, vascular, and ophthalmologic pathologies.

DISCUSSION: ICU ultrasound rounds fills a void in ultrasound training for medical students by providing bedside teaching with supervision of pathologic scans by experienced faculty, structured mentorship at the bedside, and idea sharing. In addition, students refine their application of the I-AIM (3) technique and solidify their understanding of the physiology and pathophysiology of ultrasound findings. ICU ultrasound rounds is a novel method of fostering multidisciplinary teaching of point of care ultrasound in the ICU.

REFERENCES:

(1) Bahner DP, Adkins EJ, Hughes D, Barrie M, Boulger CT, Royall NA. Integrated medical school ultrasound: development of an ultrasound vertical curriculum. Critical Ultrasound Journal. 2013; 5(1):6.
(2) Blickendorf JM, Adkins EJ, Boulger C, Bahner DP. Trained Simulated Ultrasound Patients (TSUP): medical students as models, learners, and teachers. Journal of Ultrasound in Medicine. 2013; Accepted for publication.
(3) Bahner DP, Hughes D, Royall NA. I-AIM: a novel model for teaching and performing focused sonography. Journal of Ultrasound in Medicine. 2012; 31(2):295-300.

MULTIDISCIPLINARY EDUCATIONAL INITIATIVE TRAINING OF REGIONAL ULTRASOUND SPECIALISTS (MENTORS) PROGRAM

Zachary Soucy, DO[1], Alyssa Abo MD, Katherine Willer DO, Jennifer Costello, David Bahner MD
[1]University of California Davis

INTRODUCTION: Mentorship in ultrasound education is underutilized. Coordinating local medical school ultrasound (US) "faculty" is difficult. Working with a national US organization, AIUM, MENTORS was established to connect those regional US experts associated with a finite number of medical schools. We describe a centralized undergraduate medical education (UME) focused mentorship program to address the barriers associated with students looking for US mentorship and US "faculty" searching for local alliances in medical schools across North America.

METHODS: By committee, a multiple choice survey was drafted in an effort to collect national "US Faculty" data. Questions focused on willingness and capacity in which to volunteer, medical school affiliation, time commitment, expectations for compensation, and contact information. Participants were encouraged to write-in activities and offer suggestions.

The governing body for AIUM was approached regarding the objectives of the MENTORS group and dissemination of the survey to its members. A pilot email with the survey attachment was sent to Sacramento and San Francisco area members. Results were collated. At the AIUM 2013 Annual Convention paper versions of the survey were distributed and collected. Pooled data was presented to AIUM leadership and permission was granted for website, Facebook, email, and paper distribution to its national membership. In July 2013 the Ultrasound in Medical Education Portal was launched on the AIUM home page, of which, the MENTORS program is a component with continuous online enrollment.

RESULTS: To date over 50 ultrasound faculty have volunteered from 21 states and 5 countries including Australia, Canada, China, and Lebanon. In the month since the portal went live 575 people who have visited the portal, 140 have entered the MENTORS page. Of those who took the survey 85% are associated with a medical school, 87% will serve as a student mentor, 93% want to teach US with 48% willing to champion or co-champion US UME. The most popular volunteer teaching activity is hands-on instruction at 79% and least popular activity is IT support at 20%.

Arrangements have been made to contact medical school administration to increase US in UME visibility and establish collaborative relationships.

CONCLUSIONS: MENTORS is a feasible construct and may be a method to address the barrier of geographical and regional mentorship. The program has the potential to initiate multidisciplinary alliances creating the institutional critical mass needed to organize and institute UME based US education as part of the standard curriculum.

FEASIBILITY OF ULTRASOUND INTEGRATION INTO MEDICAL EDUCATION IN A LIMITED RESOURCE SETTING IN LEBANON

Reem S. Abu-Rustum, MD[1], Ziad Nehme, MS, Camille Nassar, PhD

[1]Faculty of Medicine University of Balamand

OBJECTIVE: To assess the feasibility of integrating ultrasound into the medical education of the first year medical students in a limited resource setting at the University of Balamand in Lebanon, the first such attempt in the Middle East.

METHODS: This was a combined effort of an obstetrician and a biomedical engineer, with the full support of the Dean of the medical school. There were limited resources available in terms of clinical faculty for the training of the students, machinery and the allocated time in an already packed curriculum. The obstetrician trained with a radiologist and a cardiologist to acquire the basic skills for scanning the various regions. The course included a total of 6 sessions: 2 didactic sessions and 4 practical labs. The learning modules of the Society of Ultrasound in Medical Education were assigned to the students prior to each of the 4 practical sessions: neck and thyroid, liver and gallbladder, kidneys and spleen and finally the heart. A single ultrasound machine was purchased, and the 68 students were divided into 8 groups for each of the 4 labs carried over four full days. The students served as the models. In addition, there was an "open" lab for the students to practice their skills and a written examination at the completion of the course.

RESULTS: A total of 68 students participated in the course with attendance well over 95% in 5 of the 6 sessions, and 80% in one of the sessions (the day preceding a major examination). The students described this experience as "the highlight of their first year" with much enthusiasm expressed, requests for more training, and clear skill demonstrated during the labs with good assimilation of the basic principles covered in the course. This was exemplified by a mean test score of 69.3 % (range 25-100%) on the written examination at the end of the course.

CONCLUSION: Once a passionate core team is available, despite the limited resources available, it is feasible to introduce ultrasound into the medical curriculum at the first year level. This then acts as the catalyst to secure both the clinical faculty, as well as the technical resources, to further build on this experience and work on integrating ultrasound into all four years of medical education as has been our case at the University of Balamand in Lebanon.

FIRST YEAR MEDICAL STUDENTS' PERCEPTIONS OF THE IMPORTANCE OF ULTRASOUND IN MEDICAL EDUCATION IN LEBANON

Reem S. Abu-Rustum, MD[1], Ziad Nehme, MS, Camille Nassar, PhD
[1]Faculty of Medicine University of Balamand

OBJECTIVE: To evaluate first year medical students' perceptions of the importance of ultrasound in medical education pre- and post-implementation of the first ultrasound course in the Middle East.

METHODS: Responses to pre- and post-course surveys from 68 first year medical at the University of Balamand in Lebanon were collected. The ultrasound course was carried out at the end of the first year of medical education. The students were asked to respond, using a 5-level Likert scale, whether they felt ultrasound: enhanced their understanding of anatomy, physiology, was beneficial and should be integrated into all 4 years. In addition, the students were asked whether they believed they would use ultrasound in the future, whether ultrasound education should be universal, whether the experience was positive and whether they would be willing to become "future instructors" to their juniors in ultrasound training. The data was analyzed using t-test and descriptive statistical approach. $P < 0.05$ was considered statistically significant.

RESULTS: The response rate was 63/68 (92.6%) for the pre- and 64/68 (94.1%) for the post-course surveys. Analyzing the pre- and post-course results demonstrated that of the students, 87.3% pre- and 87.5% post-course agreed/strongly agreed that ultrasound would enhance their understanding of anatomy. However only 57.1% of the students, both pre and post-course, agreed/strongly agreed that ultrasound would enhance their understanding of physiology. There was a statistically significant difference in the students' responses, pre- and post-course, with respect to: ultrasound being beneficial, mean scores of 4.41 pre- and 4.76 post-course ($p=0.002$), the need for ultrasound integration into all 4 years, mean scores of 3.81 pre- and 4.83 post-course ($p=0.000$), the need for universal ultrasound integration, mean scores of 4.3 pre- and 4.83 post-course ($p=0.000$), foreseeing using ultrasound in their future clinical practice, mean scores of 4.48 pre- and 4.68 post-course ($p=0.05$), and rating ultrasound as an overall positive educational experience, mean scores of 4.33 pre- and 4.75 post-course ($p=0.001$). Of note is that out of 63 responding students, 79.7% agreed/strongly agreed to becoming "future instructors" to their juniors in ultrasound training.

CONCLUSION: As our study demonstrates, ultrasound integration into medical education is a most positive experience for the first year medical students serving to enhance their basic knowledge of anatomy. Their strong belief in ultrasound's clinical applicability in their future practice, the need to integrate it at all 4 years of medical education, and the need for its universal implementation, together with their willingness to serve as future instructors to their juniors, provides further evidence in support of the importance of global implementation of ultrasound in medical education.

DEVELOPMENT OF A BEDSIDE ECHOCARDIOGRAM TRAINING PROGRAM IN MBEYA, TANZANIA

Jeffrey Hall, MD[1], Mark Shaffer, MD, Lyochi Iseme, AMO, Peter Kishimbo, MD, Humphrey Kiwelu, MD, Issakwisa Mwakyula, MD, Dilan Ellegala, MD, Joyce Nicholas, PhD
[1]University of South Carolina

INTRODUCTION: Tanzania has a high burden of cardiac disease, both from the impact of the HIV and tuberculosis as well as poorly controlled non-communicable diseases. Due to poor access to diagnostic imaging, many patients are diagnosed empirically based on history and physical alone. One solution to this problem is to train general physicians to perform basic beside echocardiogram using equipment that is relatively inexpensive and portable. The purpose of this project is to develop such a training program at the Mbeya Referral Hospital in Mbeya, Tanzania.

METHODS: The current methodology of echocardiogram at MRH was evaluated and a revised standardized protocol and reporting form developed with the local partners. Two radiologists and two physicians were then selected to undergo an organized training program led by an American family physician with specific training in bedside echocardiography using the GE VScan. The program consisted of a lecture series developed for the site, 75 supervised scans, and a written exam which included sending images electronically for consultation. After completing the program, these physicians are helping teach a second course of 3 additional physicians. All scans are logged, and expected clinical impact is noted. Post-training exam quality is assessed by image review.

RESULTS: Over the first 6 months of the program, the initial 4 trainees performed over 350 echocardiogram exams, of which 53% were felt likely to change clinical management. Trainees can consistently identify common conditions such as pericardial and pleural effusions, dilated cardiomyopathy, rheumatic heart disease, and left ventricular hypertrophy. The ability to send images by email has let to remote consultation to experts in Dar es Salaam as well as the US and Europe. The next trainees have already begun their course, mentored by the new Tanzanian experts.

DISCUSSION: As has been shown in many previous studies, focused bedside echocardiogram with a handheld machine can provide a major clinical impact. Here we have shown that physicians with no ultrasound background can be taught this skill effectively, over the course of their normal clinical duties, resulting in a major impact in care. We aim to further demonstrate the sustainability of such a program in the absence of an on-site guidance from the establishing physician. In the future, such programs may allow even remote sites to have basic cardiac imaging capabilities.

ULTRASOUND AS A DIAGNOSTIC TOOL FOR MALARIA IN MWANZA, TANZANIA

Michelle Zhou[1], Yuanting (Allison) Zha (Lead Author), Bradley Jacobsen, Anjali Hari, Bianca Rivas, Olga Gabriela Ventura, Neha Mitragotri, Janice Boughton, MD, John Christian Fox, MD
[1]UC Irvine School of Medicine

DETAIL: Malaria infection is common in sub-Saharan Africa. Mortality mostly stems from consequential infections and complications that eventually lead to multi-organ system failure. The time required to diagnose malaria via blood smear may delay the initiation of treatment. Ultrasound imaging provides a means to rapidly and non-invasively detect symptoms of malarial infection, including increased intracranial pressure and hepatosplenomegaly. The invention of hand-held ultrasound devices makes diagnostic bedside ultrasound feasible in under-resourced areas.

Building upon a previous study by Murphy et al who performed ultrasound on children with acute malaria in Uganda[1], we examined 40 adult patients (8 male, 32 female) with acute malaria in Mwanza, Tanzania by measuring their liver and spleen dimensions as well as the optic nerve sheath diameter (ONSD) using portable ultrasound devices. Of these 40 patients, 12 had severe malaria, as defined by the World Health Organization as criteria for severe malarial syndromes[2]. A control group (n=16) of patients admitted to the hospital for non-malarial syndromes was obtained.

In patients with severe malaria, liver, spleen, and ONSD enlargement were observed in 50%, 75%, and 8% of the cases, respectively. When compared to the control group, liver and spleen size of the severe malaria patients were found to be significantly larger ($p=0.02$ in both cases), while the ONSD was not statistically significantly larger ($p=0.44$). In the non-severe malaria patients, an enlarged liver, spleen, and ONSD were observed in 35%, 32%, and 4%, respectively. When compared to the control group, liver size of the non-severe malaria patients was found to be significantly larger ($p=0.03$), while the spleen and ONSD were not statistically significantly larger ($p=0.48$, $p=0.36$, respectively). When comparing all malaria patients to the control group, liver size of the malaria patients was found to be significantly larger ($p=0.02$), while the spleen and ONSD were not statistically significantly larger ($p=0.22$, $p=0.42$, respectively).

This study was limited by the small number of subjects. Since subjects were recruited in small clinics or hospitals and since pediatric patients were excluded, we had a limited sample size. The control patients were recruited in these same facilities to maintain subject population homogeneity, but their results may have been skewed owing to their being diagnosed with other conditions. The fact that 80% of subjects were female may have also affected the data. In addition, the study could be expanded to include ultrasound scanning of other areas potentially affected by malaria. Further studies should be done to support the results and to investigate better methods for ultrasonography on malaria patients.

REFERENCES:

1) Murphy S, Cserti-Gazdewich C, Dhabangi A. et al. Ultrasound findings in Plasmodium falciparum malaria: a pilot study. Pediatr Crit Care Med. 2011;12(2):e58-e63.
2) World Health Organization Severe falciparum malaria.Trans R Soc Trop Med Hyg. 2000;94(suppl 1):S1–S90.

ACCURACY OF POINT-OF-CARE CARDIAC ULTRASOUND IN CHAGAS DISEASE BY A NON-CARDIOLOGIST WITH LIMITED TRAINING

Lucas Jordan Kreuser, BS[1], Maria Carmo P Nunes, MD, PhD, Robert Reardon, MD, Antonio L. Ribeiro, MD, PhD

[1]University of Minnesota

BACKGROUND: Chagas disease is a major cause of heart failure in Latin America. Many Chagas disease patients live in rural areas under poor economic conditions with limited access to formal echocardiography. Point-of-care ultrasound is rapidly gaining recognition as a powerful diagnostic tool in such fields as emergency medicine, intensive care, and primary care, but is not commonly utilized in Chagas-endemic regions. In this study we sought to determine the reproducibility of point-of-care cardiac ultrasound performed by a non-cardiologist in Chagas patients.

METHODS: Consecutive patients with Chagas disease receiving regularly-scheduled echocardiograms were recruited at a tertiary care teaching hospital in Brazil. A board-certified cardiologist performed and interpreted an echocardiogram with a conventional full function echocardiography machine (iE33 Philips Medical Systems), and a 4th-year medical student performed and interpreted a cardiac exam with a portable ultrasound machine (Sonosite MicroMaxx). The medical student was blind to clinical and the cardiologist's echocardiographic data. A range of quantitative and visual estimation data were collected and compared between the two exams.

RESULTS: A total of 41 patients (mean age=49.5) were examined, and 16 (39%) had at least mild LV systolic dysfunction per the cardiologist´s exam. Measurements from the two observers were highly correlated (ICC values for Long-axis LVDd=0.958 and LVEF=0.930). Qualitative visual estimation of LV systolic function was highly reproducible (Kappa = 0.76, Observed agreement = 0.854), as was RV systolic function (Kappa = 0.55, Observed agreement 0.900).

CONCLUSION: Point-of-care cardiac ultrasound performed and interpreted by a non-cardiologist with limited ultrasound training is accurate and reproducible for detecting cardiac dysfunction. Point-of-care cardiac ultrasound provides clinically valuable information in patients with Chagas disease and could help clinicians determine management of such patients in a wide variety of care settings.

INTRODUCTION TO ULTRASOUND CURRICULUM ESTABLISHED FOR STUDENTS AT TANDABUI INSTITUTE OF HEALTH SCIENCES AND TECHNOLOGY (MWANZA, TANZANIA)

John Fox, MD[1], Anjali Hari, Bradley Jacobsen, Neha Mitragotri, Bianca Rivas, Gabriela Ventura, Allison Zha, Michelle Zhou

[1]University of California, Irvine

DETAIL: UC Irvine School of Medicine students traveled to Mwanza, Tanzania to establish an Introduction to Ultrasound teaching curriculum at Tandabui Institute of Health Sciences and Technology (TIHEST). Five Sonosite Nanomaxx ultrasound machines and one HKB 0112 ultrasound machine were taken to the community to teach a three-week course that included knobology, cardiac, pulmonary, abdominal, musculoskeletal, emergency FAST exam, and pelvic ultrasound. The curriculum was based on the UC Irvine School of Medicine MS1 curriculum, written by John Fox, M.D., and we designed lecture powerpoints, study guides, and quizzes for each lesson. We had additional training sessions with multiple Registered Diagnostic Medical Sonographers in preparation for teaching the course. Due to fundraising efforts, we were able to donate the HKB 0112 to TIHEST, and our arrival encouraged the purchase of two other machines to be distributed throughout the community hospitals. We were the first exposure to ultrasound technology for the students and community members.

Over the course of three weeks, 10 medical professionals from the community and 124 health professional students participated in the course. 122 (91%) completed the course. An identical pre and post written test were administered on the first and last day. It consisted of two multiple-choice questions from each lecture, for a total of 14 questions. The written test served to assess their knowledge of basic ultrasound concepts. The average of the pre-test was a 23% with a standard deviation of 13%, while the post-test had an average of 74% with a standard deviation of 14%. Additionally there was a practical component to the post-test with an average score of 84% with a standard deviation of 17%. The practical component assessed their ability to correctly locate and identify structures with ultrasound. The average overall score of the course was a 79% with a standard deviation of 11%. A total of 113 (93% of students who completed the course) passed the final exam, and were eligible for a Certificate of Completion.

The students, doctors, and other health professionals responded very well to our course and expressed interest in establishing future courses at TIHEST. We wish to teach the same course to new students, include more medical professionals, and teach an Ultrasound Pathology course for the exceptional students from the introductory course. We also hope to raise funds and donate an ultrasound with Doppler capabilities next summer, which we believe would be of great benefit to the community. In conclusion, with 15 days of teaching and limited ultrasound resources there was a 51% increase in average score in 122 students. This shows that the implementation of a thorough introductory ultrasound course is attainable in underserved populations.

ENHANCING THE TOOLBOX OF MEDICAL STUDENTS WITH BASIC ULTRASOUND SKILLS USING THE "FLIPPED CLASSROOM" APPROACH

Galit Dichterman, MD, Menashe Barzilai, MD, Abigail Barzilai, MD, Moshe Flugelman, MD
Carmel Medical Center, Haifa, Israel

DETAIL: Ultrasound is gradually getting into the clinician's toolbox, becoming a natural extension of the traditional physical examination. Exposing medical students to ultrasound may ensure its optimal use by them as doctors, while strengthening their accumulating medical knowledge.

PURPOSE: Investigating the impact of integrating a training tutorial of basic ultrasound skills, during the first clinical clerkship of medical students in the internal medicine departments, using the "flipped classroom" pedagogical approach.

METHODS: A prospective study has been conducted during the internal medicine clerkship of fourth year medical students of the Technion Rappaport faculty of medicine. 32 students in two university hospitals have constituted equal sized study and control groups. A website for basic ultrasound skills was developed in Moodle, a virtual learning environment, where the students could find video lectures and practical video guides with interactive feedback exercises. Both knowledge test and an attitude questionnaire were taken by the students of both groups at the beginning and at the end of the clinical clerkship. Based on the "flipped classroom" approach, the study group was encouraged to work through the online contents in their free time, as a preparation to a couple of supervised hands-on workshops in the ultrasound unit. The hands-on sessions were video-recorded and analyzed. Personal interviews were taken at the end of the clinical clerkship. Data were analyzed both quantitatively and qualitatively.

RESULTS: Students in the study group significantly improved their achievements in the knowledge questionnaires (p-value of 0.0008), while no statistically significant change was found in the control group. All the students in the study group expressed great satisfaction from their basic ultrasound experience. Their attitude towards the utilization of ultrasound as a valuable clinical tool has changed, so as their confidence in their ability to utilize it. Students from both groups emphasized the importance of integrating ultrasound education into the curriculum of the clinical years.

CONCLUSIONS: Providing basic ultrasound skills to medical students at the very beginning of their clinical experience is both feasible and effective. Students who accepted the challenge of the "flipped classroom" learning model benefited more from the practical experience and expressed their positive attitudes towards this non-traditional teaching approach.

REFERENCES:

1. Christopher L. Moore, Joshua A. Copel. Point-of-Care Ultrasonography. N Engl J Med 2011; 364:749-75.
2. Charles G. Prober, Chip Heath. Lecture Halls without Lectures - A Proposal for Medical Education. N Engl J Med 2012; 366:1657-1659.

INTEGRATING DONOR DISSECTION, SIMULATION AND LIVE ULTRASOUND, OF THE FEMORAL REGION DURING AN ANATOMY LAB COURSE ENABLES FIRST YEAR MEDICAL STUDENTS TO CONDUCT FEMORAL NERVE BLOCKS

Adam Mina, Brion Benninger

Western University of Health Sciences, Lebanon, Oregon

INTRODUCTION: Ultrasound is the visual stethoscope of the future. Globally, ultrasound technology has been integrated into multiple specialties. Clinically, the key to ultrasound success is obtaining depth of anatomical knowledge and regularly practicing manual techniques. To ease the learning curve of ultrasonography, today's healthcare student would greatly benefit from early exposure to performing and interpreting ultrasound imaging. The objective of this study was to integrate an ultrasound simulator during an anatomy lab curriculum including cadaveric and live ultrasonography.

METHODS: Literature research was conducted using contemporary anatomy and ultrasound texts, atlases and journals regarding the use of ultrasound simulation during anatomy lab. Pre and post questionnaires were conducted on 16 first year medical students regarding ultrasound simulation and live ultrasonography during an anatomy course. Initially the femoral triangle was dissected, and didactically a femoral nerve block was taught. A femoral nerve block ultrasound simulation was then facilitated and subsequently used in testing during a first year anatomy course. Cadaveric and live ultrasound was conducted after experience on the simulator.

RESULTS: Literature research revealed no known use of ultrasound simulators during lab to teach anatomy and invasive techniques to first year medical students. The pre-ultrasound questionnaire demonstrated students did not have previous ultrasound experience, but have moderate gaming exposure with regards to multimedia video games. Full body dissection was conducted in parallel with teaching ultrasound on simulators, donor cadavers, and live subjects. Testing using the simulator demonstrated 100% of the anatomy students could locate and introduce a needle to the femoral nerve using ultrasound. Students accurately located and identified the femoral nerve and surrounding structures during femoral nerve block testing. Students reported overwhelming enjoyment and benefit of using the ultrasound simulator while 94% of the class suggested that it be integrated into the anatomy course.

DISCUSSION: In order to develop early ultrasound skills, students need exposure and practice during their first year anatomy course. Students reported that it was easier to locate the femoral nerve on the simulator as opposed to an actual ultrasound, suggesting it is an appropriate medium for teaching femoral nerve block anatomy and technique prior to live ultrasound. By integrating femoral triangle anatomy and the accompanying nerve block simulation, the student is motivated to understand the clinical relevance of the femoral region prior to live ultrasound.

CONCLUSION: This pilot study revealed that the chronologic integration of donor cadaver dissection, ultrasound simulation, and live ultrasound during an anatomy lab course was a successful teaching methodology for femoral triangle anatomy and ultrasound skills.

REFERENCES:

Brion Benninger, Rebecca Corbett, and Taylor Delamarter Teaching a Sonographically Guided Invasive Procedure to First-Year Medical Students Using a Novel Finger Transducer. Journal of Ultrasound Medicine. April 2013 32:659-664.

Benjamin E. Stein, Umasuthan Srikumaran, Eric W. Tan, Michael T. Freehill, John H. Wilckens; Lower-Extremity Peripheral Nerve Blocks in the Perioperative Pain Management of Orthopaedic PatientsAAOS Exhibit Selection. The Journal of Bone & Joint Surgery. November 2012 94(22):e167 1-13.

ADVANCED COMPETENCIES INTERNAL MEDICINE FOCUSED ULTRASOUND AT THE UME LEVEL

Saaid Abdel-Ghani, MD, Chris Esber, MD; David Bahner, MD, RDMS
The Ohio State University

INTRODUCTION: Focused Ultrasonography (FU) is rapidly gaining momentum as a powerful teaching tool at the UME level and has been successfully incorporated into medical student education at programs nationwide. The increasing clinical foot-print of focused ultrasound at the UME level is being met by an overwhelming lack of FU education at the GME level, particularly within the field of Internal Medicine (IM). Students having gone through focused ultrasound training at the UME level are taught general clinical ultrasound competencies, however we propose that those interested in pursuing a career in IM meet specific requirements that would lead to a "certificate of distinction." This would allow graduates of the program to become certified in IM focused ultrasound and in effect become local champions at their respective institutions.

METHODS: Emergency medicine has taken the lead in the implementation of US training programs, integrating UME and GME training. Guidelines have been established by the American College of Emergency Physicians (ACEP), which dictate the core principles and competency requirements for physicians to use focused ultrasound in daily practice. Focused ultrasound is gaining momentum in the IM community and is being introduced into the curriculum at various institutions without set guidelines in place for certification and competency. To help with the transition from UME to GME training and competency evaluation, we propose that additional subspecialty training in IM FU be completed. The additional training would include lecture based didactics, on-line learning modules, clinical research experiences, live model simulation sessions and clinical mentorship.

RESULTS: A pilot study is underway at the UME level for students noted to be planning to go into Internal Medicine. We are establishing a proposed number of studies for core and enriched competencies for IM based on certification criteria from the American Board of Internal Medicine (ABIM). The ABIM guidelines for IM certification require that residents be able to perform venous and arterial puncture as well as place a peripheral venous catheter. For more invasive procedures including CVCs, Thoracentesis, Paracentesis and Arthrocentesis, residents are expected to be competent with regard to their knowledge and understanding. This provides a framework for the number of procedures needed for certification, however changes can be made on an individual basis to achieve clinical competency and to ensure the highest quality of patient care.

CONCLUSION: The development of a certificate of distinction for IM focused ultrasound will allow for a smoother transition from ultrasound education at the UME level to that of the GME level and beyond. The specific core and enriched competency requirements can be developed into IM specific guidelines, using emergency medicine as a model. The development of a certificate of distinction for IM focused ultrasound will allow for a more standardized approach to education and builds the framework for evaluation and maintenance of skills.

REFERENCES:

American Board of Internal Medicine, Policies and Procedures for Certification. January 2013.
American College of Emergency Physicians. Emergency ultrasound guidelines 2008.

DEVELOPMENT OF A NOVEL CLINICAL ULTRASOUND THREAD IN A THIRD YEAR LONGITUDINAL INTEGRATED MEDICAL SCHOOL CURRICULUM AT A SATELLITE CAMPUS

Margaret R. Lewis, MD, Vivek S. Tayal, MD

Carolinas Medical Center, Charlotte, NC

DETAIL: Ultrasound is a part of medical student education at a handful of US medical schools, with an integrated four-year program as a common approach. At the same time, medical school enrollment has increased in many states by increasing the number of satellite campuses for the 3rd and 4th year of medical school. In addition, a longitudinal, integrated curriculum design is gaining popularity as emphasis is placed on following patients through the health care system. We describe a unique effort to implement a multidisciplinary, multiple application ultrasound course for medical students in a satellite campus with a longitudinal integrated 3rd year curriculum.

The Charlotte Branch of the University of North Carolina School of Medicine is a satellite campus for 3rd and 4th year medical students at Carolinas Medical Center. The Charlotte Branch offers both a traditional as well as a new, longitudinal integrated curriculum. The students enrolled in the longitudinal integrated curriculum (CLIC) will have dedicated ultrasound classes (thread) as well as simulation classes. This integrated approach at a branch campus represents a novel model for ultrasound education in medical schools.

The ultrasound thread is a seven-session course with each session lasting four hours. The ultrasound sessions will also complement and reinforce the focus of education through lectures and simulation. Different ultrasound applications will be taught following the student's experience in simulation and lecture to help solidify learning.

Ultrasound topics will include cardiac and lung ultrasound, vasculature, free fluid and abdominal ultrasound, gynecologic ultrasound, and procedural guidance. Students will have a lecture on the given ultrasound application with patient correlation, and then hands-on instruction. Following an ultrasound class, students will have the opportunity to utilize their ultrasound skills during shifts in the emergency department. They will also have the opportunity to use their ultrasounds skills at the discretion of the individual preceptor. The students will have a final written assessment as well as skills application assessment.

REFERENCES:

Kman, Nicholas E. MD, Bernard, Aaron W., MD et al. Advanced Topics in Emergency Medicine: Curriculum Development and Initial Evaluation. *Western Journal of Emergency Medicine.* November 2011 (12), 543-550.

Hoppmann, Richard, Rao, Victor V. et al. An Integrated Ultrasound Curriculum (iUSC) for Medical Students: 4 Year Experience. *Critical Ultrasound Journal.* February 2011 (3), 1-12.

Afonso, Nelia MD, Aponsah, David MD et al. Adding New Tools to the Black Bag – Introduction of Ultrasound into the Physical Diagnosis Course. *Journal of Gen.. Internal Medicine.* August 2010 (11), 1248-1252.

DEVELOPMENT OF AN ADVANCED COMPETENCY CURRICULUM IN FOCUSED ULTRASONOGRAPHY FOR MEDICAL STUDENTS TO ASSIST IN TRANSITION TO GRADUATE MEDICAL EDUCATION

Ashish R. Panchal, MD, Creagh T. Boulger, PhD, David P. Bahner, RDMS

The Ohio State University Wexner Medical Center

BACKGROUND: Physician performed focused ultrasonography has become an essential part of patient care in many medical disciplines. The need for skilled practitioners is rapidly increasing, yet a practical approach to transition focused ultrasonography training from the undergraduate (UME) to the graduate medical education (GME) levels is challenging. Specialty specific training during this transition may be critical in assisting young practitioners in integrating these skills into their future daily patient care activities.

METHODS: An Advanced Competencies (AC) curriculum in ultrasonography was developed as a one month 4th year clinical experience to teach and assist integration of focused ultrasound into clinical practice. This curriculum is a part of the four year longitudinal preclinical/clinical *Lead. Serve. Inspire.* (LSI) curriculum developed at The Ohio State University College of Medicine. The AC curriculum incorporates lecture based didactics, on-line learning modules, clinical research experiences, live model simulation sessions, and clinical mentorship to provide specialty directed training in preparation for their transition to GME. The multiple teaching modalities and leadership from multiple specialty departments allows for self-pacing and individualized achievement of clinical expertise. Additionally, standardized testing of basic science and technical competencies as well as ongoing preceptor-based clinical review from clinical faculty ensures that the participants meet standards consistent with the quality of patient care.

RESULTS: This AC curriculum has been developed and is scheduled to be launched as part of the 2015 LSI curriculum. As part of this curriculum, student level of training with focused ultrasonography will be tracked and their expertise at the end of the program will be assessed. Their use of different educational resources will be followed through their training. Goal being to evaluate learning of focused ultrasonography, in learners of all experience levels, as they transition to GME. Following matriculation, these students will be assessed during their GME experience to assess the impact of a transitions curriculum on ultrasound use and proficiency. The foreseeable limitations of the curriculum include availability of certified practitioners within specialty disciplines to provide specialty specific training and scheduling of clinical experience within the already saturated educational and clinical schedules of medical practitioners.

CONCLUSIONS: Focused ultrasonography has an ever-increasing clinical footprint in many disciplines of medicine. This curriculum will assist young practitioners' transition to multiple different specialties through directed focused ultrasound teaching. Future goals will be to closely track the educational endpoints of the curriculum to assess for methods to improve information transfer.

LEARNER IMPROVEMENT AND APPRECIATION FROM A BLENDED-LEARNING, SIMULATION-ENHANCED ULTRASONOGRAPHY CURRICULUM FOR FIRST-YEAR MEDICAL STUDENTS

Geoffrey T. Miller, BS, EMT-P, Mark W. Scerbo, PhD, Don Byars, MD, Craig Goodmurphy, PhD, Barry Knapp, MD, Sarah Shaves, MD, Frank Lattanzio, MD, Michael Solhaug, MD

Eastern Virginia Medical School/Old Dominion University

BACKGROUND: Eastern Virginia Medical School (EVMS) implemented a blended-learning, simulation-enhanced ultrasonography curriculum for first-year medical students during the 2012-13 academic year, as part of a comprehensive curricular integration of ultrasonography skills across the entire medical education curriculum (M1 -4). Our goal was to assess student knowledge, performance, and satisfaction.

METHODS: A demographic survey and pretest were administered to learners at the outset of the ultrasound program. Upon completion, learners were administered a knowledge-based post-test and satisfaction survey. Learners were also assessed at the end of the course using an Objective Structured Clinical Examination (OSCE) format with standardized patients on their transducer placement and image acquisition abilities.

RESULTS: The demographic data are summarized in Table 1. Specifically, information was collected on student sex, age, video game and musical instrument playing history.

	N	Minimum	Maximum	Mean	Std. Deviation
Age	141	21	46	24.49	3.352
VGameHrs	63	0	30	4.07	5.255
Gender	144	81 (M)	63 (F)		
Musical Inst.	142	77 (Yes)	65 (No)		
Prior US Exp.	142	5 (Yes)	139 (No)		

Table 1. Learner Demographics and Prior Experience.

Data were collected from 122 learners who completed both the pretest and post-test. The mean percent correct on the pretest was 26.8% (sd = 10.2) and on the post-test was 67.9% (sd = 11.7). This difference was evaluated with a paired t test and shown to be statistically significant, $t(120) = 33.52$, $p < .001$. Thus, by the end of the course learners' scores had increased more than twice that of their pretest levels.

The post-course OSCE evaluated the learner's ability to place the transducer in the correct position/orientation, the time to acquire the desired image (Parasternal Long Axis, and Hepatorenal), and quality of the image ("good, acceptable, poor"). Learners had more difficulty on the parasternal long axis view task, but most learners achieved good or acceptable ratings on both tasks (see Table 2).

Task	Successful	Unsuccessful	Time (sec.)
Cardiac	93.5%	6.5%	88.69
Abdomen	90.4%	9.6%	101.97
Image/Quality	**Good**	**Acceptable**	**Poor**

Hepatorenal	82.2%	6.4%	11.2%
Parasternal Long Axis	62.2%	19.7%	18.1%

Table 2. OSCE Results.

Learners indicated high satisfaction (99%), that the educational experience in ultrasonography enhanced their medical education. Further, 91% indicated that incorporating ultrasound into their gross anatomy course enhanced their ability to learn, and 97% responded they would like additional opportunities for ultrasound included in their curricula.

CONCLUSIONS: We successfully implemented a blended-learning, simulation-enhanced model for ultrasonography in the M-1 curriculum. Post-test knowledge of fundamental concepts improved significantly over the pretest and most students demonstrated good or acceptable performance in the OSCE. Moreover, students were enthusiastic in their desire for additional training in ultrasonography, which is currently under development for M2-4 students.

AFFORDABLE, PC-BASED ULTRASOUND TRAINING SIMULATOR

Peder C Pedersen, PhD**,** Li Liu, Jason Kutarnia, Petra Belady, MD
Worcester Polytechnic Institute

DETAIL: Outside formal sonography training, diagnostic ultrasound is often taught in an *ad hoc* fashion, without defined competency standards. Limiting factors are lack of available scanners, instructors and human subjects. An alternative is simulation-based training, which provides a controlled and safe practice environment to promote learning. However, ultrasound training simulators (UTS) have yet to fully achieve their potential due to cost, limited simulator access and performance limitations.

This abstract presents a new UTS with the following features: (i) portable, operates on a laptop/PC, and affordable, permitting the UTS to be personally owned; (ii) essential training of psycho-motor skills by manipulating a sham transducer on a scan surface; (iii) training material as extended ultrasound image volumes acquired from human subjects; (iv) a structured curriculum.

Obstetrics ultrasound was chosen as the demonstration discipline, and the physical scan surface is a thin-walled cylindrical surface segment, overlaid with foam rubber and a skin-like vinyl surface, with dimensions approximating those of an adult abdomen. By imprinting the vinyl surface with the Anoto pattern (a nearly invisible dot pattern) and integrating an Anoto tracking device into the sham transducer, its absolute position on the scan surface is obtained. The 3-axes orientation of the sham transducer is determined from a compact inertial measurement unit. This design of the physical components provides low cost, lightweight and portability and allows training to mimic scanning the maternal abdomen, with the corresponding ultrasound image displayed on the laptop/PC.

The preparation of the image volumes for the UTS is a complex process [1], involving multiple overlapping parallel 3D scans of the human subjects, here pregnant mothers, followed by non-rigidly stitching to correct for tissue motion. The resulting image volume covers a given anatomical region, e.g. abdomen, and thus allows the trainee to scan naturally over an extended body surface.

The UTS display on the PC/laptop has several windows: A *virtual subject* with a *virtual transducer* that moves in concert with the movements of the sham transducer; the ultrasound image derived from the selected image volume and determined by the sham transducer position; an instructional window; a basic ultrasound console.

The training is divided up in a set of lessons, such as clinical observations, identifying landmarks or performing biometric measurements. Each lesson begins with a video demonstration, followed by completion of practice tasks on several images volumes (= human subjects) and concluding with a test.

The UTS has been demonstrated to and evaluated by perinatal sonographers and physicians and by educators at UMASS Medical School, with unanimously positive response. The ultimate goal is to utilize the UTS for training and assessment of learning efficacy.

REFERENCES:

1. Kutarnia and Pedersen, “3D Seam Selection Techniques with Application to Improved Ultrasound Mosaicing.” *SPIE Medical Imaging Conference*, 2013.

Using Balloons, Bullets and Superheroes to Construct a Graded Set of US Gel Trainers for Artifact and Knobology Training

Craig Goodmurphy, PhD, Shariff F. Tanious , J. Keegan Coleman, Ben Honig, Jamie Cline
Eastern Virginia Medical School

INTRODUCTION: Physics and knobology are the first topics in ultrasound training. Commercial trainers are expensive options when teaching large groups. Technical difficulties of ultrasound training are associated with learning the complex relationships between the three-dimensional structures being scanned and their two-dimensional representation on screen. Another difficulty is gaining competency in distinguishing actual structures from the confounding effects of artifacts. The purpose was to investigate whether a graded set of ultrasound trainers could be created to help early learners with two specific goals. The first goal was to reproduce clinically relevant ultrasound artifacts with suitable fidelity and scalability. The second goal was to produce a stepwise progression to the trainers that would advance the skills of the learner towards clinical needs.

METHODS: During the Eastern Virginia Medical School (EVMS) anatomy lab, multiple containers were filled with a modified ballistic gel formulation. Plastic, rubber, glass, and metal objects with familiar shapes were placed within the gel. Items were selected based on their identifiable shapes, their differential densities, and echogenicity. Trainers with four stepwise levels of difficulty were created. Step-1 trainers were labeled artifacts and objects. Step-2 trainers were unlabeled artifacts and objects. Step-3 trainers were unlabeled artifacts hidden in fluid filled balloons. Step-4 trainers were shrapnel embedded in organ tissues and hidden from view. Eighteen ultrasound trained clinical team members were asked to identify the intended artifacts in each trainer and rank them on a 7 point Likert-scale based on task difficulty, trainer suitability and fidelity.

RESULTS: Ultrasound trained clinical team members were able to identify the intended artifact simulation in most of the trainers. They ranked the difficulty of the trainers as Step-1 as easiest 100%, Step-2 in 2nd place 67%, Step-3 in 3rd place 56% and Step-4 as most difficult 50%. The overall accuracy of ranking trainers 1-4 as intended was 44%. The “suitable fidelity” rankings were an average of 5.9 out of 7.

CONCLUSIONS: Educational institutions will be under pressure to appropriately train large groups of students while documenting attained competency standards. When creating trainers several qualities will impact their utility. Trainer development should consider cost, scalability, and stepwise progression and measurability of skills mastery. Clinical training methods may have impacted team difficulty ranking trainers to favor organ tissues scanning as “easier”. This also points to the need to consider the level and type of prior training as factors affecting perceived difficulty.

REFERENCES: Gregory K. W. K. Chung**,** Ruth G. Gyllenhammer, and Eva L. Baker, **The Effects of Practicing With a Virtual Ultrasound Trainer on FAST Window Identification, Acquisition, and Diagnosis**, The National Center for Research on Evaluation, Standards, and Student Testing Report 787, UCLA, Feb 2011.

DEMONSTRATING THE FEASIBILITY OF REMOTE HANDS ON ULTRASOUND SKILLS EDUCATION USING HIGH SPEED MULTIPOINT INTERNET CONNECTIONS - THE UCI – UNE CONNECTION

Peter Philip McKeown, Professor of Surgery[1], Stephen Winn PhD , Amanda Nagle PhD,
J. Christian Fox MD

[1] University of New England School of Rural Medicine, Armidale, New South Wales, Australia

While remote ultrasound diagnosis has been well established using the Internet and web based technologies, the capacity to deliver hands on real time ultrasound skills education has not been well established nor accepted. Using multi point high-speed broadband connections we have now demonstrated the value of this mode of remote teaching of skills using high-speed connections between the University of California, Irvine School of Medicine (UCI) to the School of Rural Medicine, University of New England, (UNESRM), Armidale Australia.

Using simulated patients at both sites and synchronous video and audio feed, a faculty member from the University of California Irvine School of Medicine (Dr. Chris Fox) was delivered specific instructions to first year medical students at the School of Rural Medicine, UNE, Armidale Australia. The methodology includes dual displays of near far end ultrasound images at both sites. Viewing ultrasound images as well as the remote instructor, the student and the instructor were able to compare the images and assist the student to make appropriate adjustments. The connection enables additional video channels to display the placement of the transducer by the instructor as viewed by the student and the student's positioning of the transducer being able to be viewed by the instructor, in real time. The instructor at UCI can advise the student at UNE how to manipulate the probe to get the best and required image. This pilot program has been successfully repeated and demonstrates the feasibility of remote ultrasound education with an emphasis on skills acquisition. This mode of remote teaching ultrasound skills education requires both sites to have stable high speed broadband connections with multipoint, multichannel connections. The objectives of this approach are to utilize international expertise, and high-speed broadband connections to enhance the quality of the medical student attributes without the additional costs of on-site expertise teaching in intensive mode .

CONCLUSION: High Speed, multi point Internet connections can be used to successfully delver sophisticated hands on ultrasound skills acquisition to students at remote sites, thus reducing the disadvantages associated with rural and remote placements.

KITCHEN OR CRIME LAB: COOKING UP KNOX® AND BALLISTIC GELATIN IN THE DEVELOPMENT OF ULTRASOUND TRAINERS FOR MEDICAL EDUCATION

Shariff Tanious, BBA[1], Isabella Zecchini, Nathan Davidson, BS, Craig Goodmurphy, PhD, Jennifer G. Cavin, BS, Douglas Onuscheck, BS

[1]Eastern Virginia Medical School

INTRODUCTION: The creation of highly functional, durable, and low-cost ultrasound training apparatuses is an important part in the development of any ultrasound training program. While ultimately falling short of the gold standard of utilizing standardized patients for training purposes, gelatin trainers are an excellent substitute in the early stages of ultrasound education; however, there are various kinds of gelatin analogues available. This study will look at two popular options: Knox® and Ballistic gelatin, to determine how they fare in durability, cost of preparation, and ease of use. The overall goal of this study is to help ultrasound training programs select the best gelatin preparation for their specific educational needs and resources.

METHODS: Knox® and Ballistic gelatin trainers were prepared from June-July 2013. The “Knox Blox” and standard one part ballistic gelatin to ten parts water by mass recipes were used. The gelatin was allowed to set in a refrigerator overnight, for a minimum of 12 hours. Ultrasound probes were then utilized to compress each gelatin mold to a depth of two centimeters as measured on a standard ultrasound depth gauge. This was repeated until the gelatin showed visual or echogenic signs of cracking and/or splitting. The pricing information was obtained from amazon.com for Knox® gelatin, and from gelatin innovations.com for the ballistic gelatin. Cost analysis was performed using Microsoft Excel, utilizing available prices and recipe amounts.

RESULTS: Ballistic gelatin appears to be a superior preparation, sustaining over 500 compressions of two centimeters with either a linear or curvilinear ultrasound probe. Knox® gelatin sustained 209 and 383 compressions of two centimeters with linear and curvilinear probes respectively before significant cracking diminished ultrasound image quality. However, the increased durability of the ballistic gelatin came at the expense of a higher cost per batch ($5.24 vs. $4.07) when obtaining 10 pounds of ballistic gelatin versus 2 pounds of Knox® gelatin. The ballistic gelatin cost per batch drops to $3.77 when buying the 50-pound container.

CONCLUSIONS: Both Knox® and Ballistic gelatin are adequate analogues in the development of introductory ultrasound trainers. The increased availability of Knox® in grocery stores makes it a more attractive option for programs considering a one-time event or small scale experimentation with gelatin trainers; however, for larger programs that will be making several trainers for many students over the course of a longer period of time, the increased durability and lower cost of the ballistic gelatin in higher quantities is the superior choice when creating gelatin training molds for introductory ultrasound education.

TEACHING AN ULTRASOUND GUIDED INVASIVE PROCEDURE TO FIRST YEAR MEDICAL STUDENTS USING A NOVEL FINGER TRANSDUCER

Rebecca Corbett, DO PGY3, Brion Benninger, MD

Western University of Health Sciences, Lebanon, OR

INTRODUCTION: Ultrasonography (US) is the stethoscope of the future. US transducers have evolved to provide higher resolution imaging for more accurate structural identification, with few improvements in ease of use. This study investigated a novel shaped finger transducer used by first-year medical students (MS1) conducting structural identification and practicing an invasive procedure.

METHODS: Literature search was conducted on texts, specialty journals and websites regarding the anatomy of internal jugular vein (IJV) and subclavian vein (SCV) central line placement with US guidance, and the use of a finger transducer. MS1 performed timed US-guided cannulation on the IJV and SCV on a Blue Phantom torso, and identified the IJV and SCV on a healthy volunteer using a novel US finger transducer and a conventional transducer. After exposure to both US transducers a survey was taken regarding transducer preference.

RESULTS: Literature search revealed no studies comparing finger and classic transducers, nor US-guided central line techniques being conducted by MS1. MS1 identified and cannulated the IJV and SCV using both transducers. Survey results revealed 70% of FMS preferred the finger transducer.

DISCUSSION: US is a safe, non-invasive imaging medium proven successful for invasive procedures. This study demonstrated MS1 could interpret US while conducting a clinical procedure. Finger transducer proved successful in structure identification and was preferred to the classic transducer due to its combined tactile presence.

CONCLUSION: This pilot study of a novel finger US transducer demonstrated the benefits of combining palpatory skills with US technology in teaching MS1 to perform invasive procedures.

CAN ANATOMISTS TEACH LIVING ANATOMY USING ULTRASOUND AS A TEACHING TOOL?

Yiju Teresa Liu, Rosalyn A. Jurjus, Kathryn Dimorier, Kirsten Brown, Hamid Shokoohi, Keith Boniface, Frank Slaby

The George Washington University, School of Medicine and Health Sciences

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 (3 anatomists and 4 clinicians) taught in each session. Prior to each session, anatomists were trained in ultrasound by clinicians. First year medical students enrolling in the Anatomy course (N= 190) were divided into groups, rotated teachers between sessions, and completed evaluation forms consisted of 8 survey question and free-text comments. Quantitative data were analyzed using InStat 3 software and presented using descriptive statistics. Qualitative data were analyzed using Leximancer and presented in a concept map.

Medical students completed a total of 277 questionnaires by the four clinicians and 159 questionnaires conducted by the three anatomists after the three training sessions. The response rate from 190 students averaged 76.3% over three sessions. More than 94% of the students agreed or strongly agreed that the teachers appeared prepared, knowledgeable, communicated effectively, demonstrated professionalism, allowed them enough freedom to use the machines independently, and effectively explained and demonstrated how to use the machines.

In the combined sessions of anatomists versus clinicians, two survey questions statistically separated the two groups: Question 3 "Did the teacher present the information in an organized fashion?" ($p \leq 0.001$); Question 8 "Do you feel that ultrasound is helpful with understanding the anatomy?" ($p \leq 0.001$). An examination of the mean student responses to these questions demonstrated a slight increase in positive student responses as the sessions progressed for both groups (Figure 2). Results from unpaired samples t-tests demonstrated a non-statistically 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.