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Integrating Point-of-Care Ultrasonography Into the Osteopathic Medical School Curriculum

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Point-of-care ultrasonography has been shown to have pervasive clinical and educational utility in medicine. The need to provide medical students with training in point-of-care ultrasonography has been recognized by an increasing number of osteopathic and allopathic medical schools. A 4-year integrated ultrasonography curriculum was implemented at Rocky Vista University College of Osteopathic Medicine in 2015. A review of the curriculum design, content, educational methods, and student feedback are described. Barriers to curriculum implementation and lessons learned, unique to integrating point-of-care ultrasonography into the osteopathic curriculum, are also discussed.

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Point-of-care ultrasonography (POCUS) is increasingly used by clinicians across numerous specialties to aid in both diagnosis and procedural guidance.[1] As portable ultrasound technology continues to advance, it becomes ever more readily available to providers in increasingly diverse clinical settings.[1] In addition to the early acquisition of clinically relevant POCUS skills and techniques, ultrasonography in medical education (USMED) has been shown to improve medical student learning of anatomy, physiology, and physical examination.[1-4] Given the pervasive clinical and educational utility of POCUS, the need for USMED integration into medical school curricula has been recognized and implemented by a growing number of medical schools in the United States and internationally.[4-9] In a 2016 survey of all 173 US medical schools, only 48 schools, 45 allopathic and 3 osteopathic, reported having a required integrated ultrasonography curriculum.[10] Although there is a growing body of literature describing USMED in allopathic education, literature specifically related to USMED in osteopathic education is lacking. Kondrashova et al[3] found that a clinical ultrasonography elective in the second year of osteopathic medical school was effective in providing students with a review of key anatomical concepts. Syperda et al[11] showed that preclinical osteopathic medical students can attain a limited degree of proficiency with POCUS after performing 40 hours of organ-specific scanning spread over 20

weeks. Although several osteopathic medical schools have used USMED in a limited capacity, few have developed an integrated curriculum.[10]

In 2015, Rocky Vista University College of Osteopathic Medicine (RVUCOM) began to integrate USMED into the Gross Anatomy (year 1) and Principles of Clinical Medicine (year 2) courses. The purpose of this article is to describe the first- and second-year USMED curriculum at RVUCOM and the experience gained thus far. To our knowledge, this is the first description of a 4-year vertical USMED curriculum implemented at an osteopathic medical school.

USMED Curriculum

The general medical school curriculum at RVUCOM is systems based. Therefore, effort was made to include the appropriate ultrasonography module during each system block. The general layout of the curriculum is shown in the **Figure**.

First Year[a]
Ultrasound Physics and Introduction
Musculoskeletal Parts I & II
Cardiac Ultrasound
Thoracic and Pulmonary Ultrasound
Abdominal Ultrasound
Head and Neck Ultrasound
Second Year[b]
Ultrasound Physics and Introduction
Cardiovascular Ultrasound
Focused Abdominal Sonography in Trauma Ultrasound
Abdominal Ultrasound
Musculoskeletal Ultrasound
Resuscitative Ultrasound

Figure.
First- and second-year ultrasonography curricula at the Rocky Vista University College of Osteopathic Medicine. [a]6 distinct ultrasonography sessions coordinated with the body system anatomy curriculum. [b]6 distinct sessions coordinated with the Primary Care Medicine curriculum to cover clinical applications for ultrasonography.

Year 1

Six ultrasonography laboratory sessions are synchronized with the anatomy systems blocks in the first-year curriculum. The USMED laboratories were designed to complement the anatomy being covered in the dissection laboratory to reinforce normal anatomical concepts. For example, the laboratories are spaced throughout the year so that students cover musculoskeletal ultrasonography during the musculoskeletal anatomy blocks and cardiac and pulmonary ultrasonography during the thoracic anatomy blocks. Laboratory sessions occur at the beginning of each block so that students have adequate time to integrate the material into their learning. To accommodate all first-year students, each ultrasonography laboratory is split into 2-hour sequential sessions over a 4-hour period, with students split into group A or group B. During each 2-hour session, they receive a short demonstration by the instructor and then spend the remainder of the period scanning each other.

Year 2

Clinical correlations and pathologic findings that complement the Principles of Clinical Medicine course are the focus of the second-year USMED curriculum. The 6 second-year laboratory sessions are spaced equally throughout the year to correlate with Principles of Clinical Medicine topics and are scheduled in 2-hour sequential sessions to accommodate all students in the same fashion as the first-year laboratory sessions. Students first review normal anatomy via ultrasonography of the region being covered and practice scanning the region using each other as models. Students then review the clinical applications related to the area being studied and learn to recognize specific pathologic conditions using recorded clips and images from real patients.

Years 3 and 4

Third-year students are required to participate in an 8-hour ultrasonography and procedure course before their surgical rotation. These sessions are scheduled

the Saturday before each new group of third-year students begin their surgery rotation. This course reviews the FAST (Focused Assessment with Sonography in Trauma) examination and provides education on ultrasound-guided central venous access via a simulation experience. Fourth-year students can participate in clinical ultrasonography rotations based on their selected specialty choice.

Educational Methods

Video Modules

Before each of the 6 required laboratory sessions, students are assigned an e-learning module. These modules were created by ultrasonography instructors at the University of Colorado (CU) School of Medicine and are used in the CU School of Medicine USMED curriculum. These modules were designed to give students exposure to the physics, theory, and probe placement for each examination followed by an introduction to the normal anatomy of the body region being studied and commonly associated pathologic conditions. This flipped classroom model[12] allows efficient presentation of the ultrasonography basics before the laboratory sessions, preserving more time for the hands-on ultrasonography experience. These modules are available to students throughout the course, allowing for flexibility in the curriculum and student ownership of their individual learning.

Laboratory Sessions

The osteopathic manipulation laboratory is used for the USMED laboratory sessions. Each examination table and ultrasound machine accommodates 5 students. At the head of the room are the instructor's examination table and ultrasound machine. The equipment is set up so that the instructor can project a live video feed from her ultrasound machine as well as live video from a camera showing the model, probe placement, and technique on digital displays around the room. Additionally, a third video input allows the instructor to project slides with lecture content and examples of pathologic conditions. In effect, the instructor has the ability to facilitate an ultrasonography session with a large number of students. Faculty and teaching assistants circulate throughout the laboratory to verify correct technique and answer questions. With the lecture portions lasting typically 5 to 10 minutes, the focus of the laboratory is to maximize students' hands-on scanning time.

Complementary Educational Opportunities

Ultrasound Interest Group Skills Nights

The RVUCOM and CU School of Medicine ultrasound interest groups work collaboratively under the collective banner "Colorado Ultrasound Interest Group" to pool resources and increase teamwork. The group offers numerous activities throughout each semester. The goal of the Colorado Ultrasound Interest Group is to have an activity each month that increases exposure, fuels excitement, and actively encourages student involvement in POCUS. The events take various formats, such as structured lectures with ultrasonography faculty and guest speakers or open laboratory sessions. The lectures are hands-on sessions that focus primarily on new techniques or case studies related to POCUS. All activities aim to increase students' time using the ultrasound machines, which both enhances the USMED curriculum and fosters the development of ultrasonography skills.

Ultrafest

Colorado Ultrafest is a free, 1-day annual symposium on POCUS hosted by the Colorado Ultrasound Interest Group. The event is available to medical students from any medical school. The idea for Ultrafest originated at the University of California Irvine School of Medicine in 2012 and has since been adopted at multiple institutions in the United States and internationally.[13] The primary goal of Ultrafest is to develop students' ultrasonography skills through hands-on practice on volunteer models with close clinician instruction. Students

are placed into their choice of 5 of 8 small-group sessions, including musculoskeletal, ocular, FAST, cardiac, pulmonary, vascular access, and SonoSim, Inc, training. Sessions are held in individual classrooms with 6 to 8 stations and run for 45 minutes. Each session begins with a brief instructional video from 5 Min Sono (http://5minsono.com) followed by breakout hands-on learning provided by roaming volunteer physicians and medical student peer instructors. Over the lunch hour, students have the opportunity to participate in a friendly competition similar to Sonogames (Academy of Emergency Ultrasound of SAEM) that tests their ability to recognize pathologic conditions, as well as the speed and accuracy of their ultrasonography techniques.[14]

Assessment of Student Knowledge and Course Evaluations

One of the weaknesses of the initial implementation of USMED at RVUCOM was a lack of measured outcomes. Although students were observed to obtain a limited degree of proficiency with POCUS, individual scanning proficiency was not measured objectively. The students were tested directly in the form of written questions containing ultrasonographic images that were included in their systems tests.

Qualitative feedback regarding the USMED curriculum was obtained from students after each systems course. Some of the course evaluation questions were specific to the new USMED content. Common themes in students' feedback were a desire for smaller work groups to allow increased individual hands-on practice; additional teaching assistants to provide feedback and instruction; an admiration of the early exposure to ultrasonography techniques before clinical training; appreciation for the repetition of concepts resulting from the integration of hands-on ultrasonography with anatomy concurrently covered in the systems courses; and enjoyment of the clinical correlations provided by the instructor.

In the future, more quantitative analysis will be used to continue enacting beneficial changes and will be framed in a more succinct format. Additionally, we hope that as the RVUCOM program grows and finds additional resources, objective evaluation of scanning proficiency will be implemented.

Confronting Barriers

A 2014 survey of US allopathic medical school leaders found a general consensus regarding the need for ultrasonography to be integrated into medical school curriculum.[15] About a quarter of medical schools have integrated ultrasonography into their curriculum since then. Dinh et al[10] found that funding, finding faculty to teach, and scheduling within the current curriculum are the primary barriers to establishing a new ultrasonography curriculum. These barriers may be even more difficult for some osteopathic medical schools given limited access to faculty trained in ultrasonography. In addition, the osteopathic curriculum has unique time constraints, given the need for osteopathic manipulative medicine laboratories along with the general medical school curriculum.

Funding

Medical schools may find success negotiating educational packages with major companies for ultrasound machines; however, RVUCOM began with "off-brand" machines. These machines are used during ultrasonography laboratories only and not in the clinical setting. Imaging quality proved more than sufficient to train medical students while drastically decreasing the per-unit price. This could be a solution for a medical school seeking to start a USMED curriculum with limited funding. Also, instead of using expensive models or hiring standardized patients, medical students scan each other during laboratories, taking turns as ultrasonographer and patient. This approach was well received by students and has been used successfully in other programs.[16]

Faculty and Near-Peer Instructors

Currently, 2 faculty members serve as the primary USMED instructors, supported by other RVUCOM

faculty familiar with ultrasonography. Although not a universal solution, osteopathic medical schools searching for faculty trained in ultrasonography can look to nearby medical schools; emergency medicine programs, especially those with an EM ultrasonography fellowship or faculty trained in ultrasonography; and community emergency medicine groups for additional instructors. There are physician instructors with POCUS experience from almost any specialty.

In addition to faculty instructors, RVUCOM uses the near-peer teaching model to help decrease faculty burden during ultrasonography laboratories. The near-peer teaching model is also used at CU School of Medicine and in a plethora of USMED programs throughout the country.[10,17-20] During the 2015-2016 school year, third- and fourth-year medical students familiar with POCUS volunteered as teaching assistants during all of the ultrasonography laboratories. These students served as rotating facilitators among groups to help students obtain images, verify correct technique, and answer questions. Student feedback included suggestions to increase the number of rotating instructors and to develop a student program to address this need.

Scheduling

To fit USMED within the already full osteopathic curriculum, strategic scheduling of laboratories is required. A flipped classroom approach that uses web-based lectures, videos, and other electronic resources assigned to students before laboratories maximizes the efficiency and efficacy of the scanning sessions. This approach has been validated and is used commonly in USMED.[21] The combination of short demonstrative lectures during the laboratories has also proved to be time efficient.

Conclusion

The USMED curriculum follows the systems-based curriculum at RVUCOM and changes each year to correlate with the anatomy and pathology of the current block. We hope that this model and our lessons learned can help other medical schools integrate ultrasonography into their curricula.

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