

Integration of Ultrasonography in Obstetrics and Gynecology in Pre-clerkship Medical Education

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ABSTRACT

The use of ultrasonography has been extensively shown to contribute to improved patient care, safety, and satisfaction. Thus, ultrasound (US) instruction and skill development have become a focus of interest in undergraduate medical education (UME) to enhance student preparedness for future training and professional practice. We provide a review of the literature regarding current practices and recommendations for the implementation of US training curricula within pre-clerkship medical education. Finally, we provide an overview of how we have integrated US training in obstetrics and gynecology into the pre-clerkship curriculum at our institution

Keywords: Clerkship, Medical education, Obstetrics and gynecology, Pre-clerkship, Ultrasound.

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INTRODUCTION

Ultrasonography is a useful tool in patient care that allows physicians and trainees to obtain valuable information at the bedside and enhance procedural effectiveness.^{1,2} The implementation of hands-on ultrasound (US) training in undergraduate medical curricula has become a major focus of many medical schools. Most programs have used this strategy to improve readiness for clinical practice and to enhance traditional learning of anatomy, physiology, and physical examination skills.³ While a growing body of evidence supports the integration of US education into the medical curriculum,⁴ questions remain as to what is the most effective paradigm.^{2,5} On the contrary, multiple studies have shown that not only do students enjoy this type of instruction, but benefit greatly in terms of skills and knowledge acquisition.¹ The goal of this report is to review the most current evidence from the literature supporting the integration of US training during the pre-clerkship phase of undergraduate medical education (UME) and provide a brief description of our experience.

ROLE OF ULTRASONOGRAPHY IN UNDERGRADUATE MEDICAL EDUCATION: A REVIEW OF THE LITERATURE

Ultrasonography has become an essential imaging tool in most medical disciplines. Its value as a diagnostic tool is complemented by its versatility and relative affordability.⁴ The integration of the US into postgraduate medical education is now an established competency expectation for multiple specialties such as emergency medicine,⁶ surgery,⁷ obstetrics, and gynecology.⁸ For these reasons and the many clinical applications and benefits to the use of this imaging modality, it has become a highly desirable addition to UME.^{3,4} Early exposure to technical skills and training is thought to promote the development of core competencies in medical education⁹; thus, there is great interest and support for the implementation of curricular strategies.^{3,10} A consensus statement, issued by multiple US societies from around the world, was recently published to formulate specific suggestions on how to integrate US teaching into the preclinical and clinical phases

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of the UME curricula.³ Here we present a brief synopsis of current approaches and best practices for the integration of US into UME in all medical specialties. Subsequently, we will focus on the most up-to-date literature documenting the integration of the US into obstetrics and gynecology teaching during the preclinical phase of medical education.

The major challenge is to determine not only the ideal stage within the pre-clerkship medical curriculum at which to integrate US training but the specific way to do it. Here we present a review of the most used parameters and strategies that have been evaluated and published.

CURRICULAR IMPLEMENTATION

The strategies to integrate US training into UME vary widely across institutions.³ The impact of these strategies has been particularly evident in helping to enhance traditional learning in the fields of anatomy, physiology, and clinical skills. Most studies report

success in helping to reinforce foundational concepts and helping to reduce the fading of knowledge that was acquired during the pre-clerkship stage of UME.⁵ Thus, most programs have focused on enhancing teaching in these basic science and clinical skills courses, whereas others have targeted specific medical specialties such as emergency medicine, surgery, and obstetrics to provide this type of training.⁵ Specific attempts have been made to provide longitudinal curricula that span the full 4-year education program.¹ Recently published scoping and systematic reviews on this subject, provide a glimpse into the UME US curricula at multiple different institutions.^{1,4,5,10}

INSTRUCTIONAL METHODS

A multimodal approach to instruction is frequently implemented to teach the US and different methods of content delivery are used within the same program.¹ The most common methods of instruction include didactics, demonstrations, and hands-on experiences. The length of each of these programs varies from single 1-hour sessions to full integration throughout the 4-year curriculum.⁵ Most commonly, peer students or healthy volunteers serve as subjects for hands-on experiences and some programs use simulation models and phantoms. In some settings, training is done as part of required clerkship rotations. A small percentage of programs use cadavers.^{4,10} Methods of content delivery include web-based learning modules, open-access podcast lectures, video assignments, and traditional didactic lectures.⁴ The most common instructional format is a “flipped classroom” approach that leverages the content delivery methods listed above.¹ US skills are most commonly taught using hands-on sessions, small and large group scanning demonstrations, and workshops. Clinical applications are frequently reinforced by using case-based learning. In some institutions, opportunities are provided for independent scanning and the development of a digital portfolio is required in some cases.^{1,4,5,11}

Instruction and skills development sessions are led by not only dedicated faculty and staff but peer tutors. Dedicated programs have been implemented to standardize teaching and to train and develop peer tutors, who after an evaluation and certification process function as primary instructors for both hands-on and didactic sessions.^{1,12,13} Furthermore, peer teaching has been documented to be very well received by learners and just as effective as faculty-led training.¹⁴⁻¹⁶

Among the innovative approaches to engage and encourage students to learn and acquire the necessary knowledge and skills required to use US effectively, some institutions have implemented competitions and student-led teaching symposia.¹⁷⁻¹⁹ The overall goal is to help students to be familiar with the equipment and technical aspects of this imaging modality as well as the relevant anatomy, physiology, and pathology that informs the use of point-of-care US in clinical decision making.

Discipline Integration and Longitudinal Curricula

The most common approach to integrating US training, and in particular, point-of-care US, is by providing brief targeted sessions within the existing curriculum. Primarily in the fields of anatomy, physiology, and physical examination, this strategy helps to solidify concepts and enhances the understanding of the clinical applications and limitations of this imaging modality.⁴ Focused sessions are frequently taught as single or series of sessions that last from 1–2 hours, including didactics and live demonstrations.

Some programs provide an opportunity for students to scan and observe peer subjects.²⁰⁻²²

On the contrary, US curricula have been implemented as longer duration threads within the medical curriculum or as stand-alone longitudinal approaches.^{1,4} Different instructional strategies such as weekly didactics, case-based learning sessions, and hands-on opportunities are utilized along with self-directed practice and scanning of actual patients.⁵ Longitudinal curricula span the duration of the medical school program and are incorporated into anatomy, physiology, pathology, and clinical skills courses.^{1,4} For a detailed table summarizing the topics/sessions and objectives/skills most commonly featured in published 4-year integrated point-of-care UME US curricula, please refer to the recent systematic review of the subject by Tarique et al.⁴

ASSESSMENT OF LEARNING

To determine the effectiveness of these different approaches, US curricula have been evaluated using several strategies. Among the most frequent are self-assessment of knowledge and skills, and students' attitudes and perceptions. Surveys, interviews, and questionnaires have been used to determine learners' level of confidence with the use of this imaging modality and the perception of its role in medical education.^{1,4} Assessment of technical skills frequently involves objective structured clinical examinations (OSCEs) on standardized patients and in some instances through the use of simulators. Assessment of knowledge is most frequently performed through multiple choice questions, image-based, or case-based questions. As mentioned above, some programs have incorporated digital portfolios of US images and videos, which students use to demonstrate acquisition skills and competence.¹¹ And a few programs require their trainees to demonstrate the ability to identify pathologic conditions and diagnostic accuracy in a clinical context as part of their assessment of competency. Finally, some studies have included faculty surveys assessing attitudes toward the development and implementation of these types of courses. Most published studies report a high level of satisfaction and increase in knowledge and US skills, regardless of the method of assessment used.^{4,5} Although several studies quantify the level of success of their program, due to the inherent heterogeneity of these reports it is difficult to establish an accurate comparison between the different curricula.

COST AND RESOURCES

While most studies that have been published on this subject provide very little information on the specific cost of implementation of US training, the most common barriers alluded to in these and other reports are the lack of time within the curriculum and scarce financial support.^{2,5} Two particular areas of investment are of notable importance when setting up this type of instructional strategy, namely physical resources (i.e., US machines, transducers, and facilities) and human resources (i.e., time and effort by faculty and staff). Some of these challenges have been alleviated by internal and industry funding to purchase equipment and the allocation of physical spaces to provide dedicated teaching venues. Furthermore, the development of low-cost hand-held devices and the substantial decrease of the cost of US machines and ancillary tools in the last few years is a promising step toward wider implementation of this type of instructional strategy.²³ The recent challenges and disruption caused by

the COVID-19 pandemic, led to the development of innovative approaches using video-conferencing platforms to deliver global point-of-care US instructional support to local and remote areas.²⁴ Thus, new opportunities, to minimize costs and leverage existent resources, have been realized that could be readily used to provide US education and training, ultimately helping to improve patient care. To tackle the labor-intensive aspect of US training, creative strategies have been devised to involve peer-teaching and independent learning opportunities. These approaches are highly welcomed by learners and in the case of peer-teaching just as effective as faculty/staff-led instruction.¹

INTEGRATION OF US TEACHING IN OBSTETRICS AND GYNECOLOGY UNDERGRADUATE MEDICAL EDUCATION

Despite the development of multiple US teaching and training strategies within several components of the UME curricula, an area that remains largely unexplored is the integration into the preclinical foundational sciences applicable to the practice of obstetrics and gynecology.^{12,25} Medical students are exposed to obstetrics and gynecology US education mostly during their clinical rotation and the opportunities for practical experience are very limited.³ Some programs have attempted to bridge this gap by introducing the use of US to teach reproductive system physical examination skills and pelvic anatomy to second-year medical students. Parikh et al, demonstrate that implementation of this strategy is supported by the finding that students acquire competency and confidence in the clinical skills required by integrating the US into the curriculum.²⁶ On the contrary, a recent study by Hamza et al. reports on the effectiveness of implementing student tutor-based basic obstetrical US screening during the clerkship phase.¹² In this study, a cohort of peer-student instructors was trained to work under the supervision of teaching staff to teach undergraduate medical students by following a previously developed curriculum. In this 3-week training program student tutors completed online and in-person theoretical and practical sessions covering basic obstetrical US knowledge and skills. At the end of this intensive training course, the candidate tutors were required to demonstrate their newly acquired skills by performing an OSCE in a clinical setting. Theoretical knowledge was assessed by using a multiple choice question exam. Successful completion of all requirements of the course was needed for certification as tutor. Outcome measures and student evaluations of this course reported a positive effect and experience.¹² This study demonstrated that senior medical students may serve as instructors in an integrated US and clinical skills obstetrics curriculum, and thus opening the door to the possibility of using this strategy during the preclinical phase of UME.

Among the different strategies that have been reported for US teaching didactic lectures, online learning modules, simulation models, and pelvic phantoms are the most frequently used.^{1,10}

ROLE OF ULTRASONOGRAPHY IN AN INTEGRATED MEDICAL CURRICULUM: TTUHSC-EL PASO EXPERIENCE

The Paul L. Foster School of Medicine delivers a highly integrated, clinically orientated, clinical presentation and organ system-based curriculum. The clinical schemes covered during the first 2 years of

medical school will be carried on into the clinical clerkships in the third and fourth years of medical school.

The Paul L. Foster School of Medicine currently designed OB-GYN US education is delivered in each of the two phases of the UME curriculum:

- Pre-clerkship phase: Teaching with OB-GYN US images in a clinical case-based presentation during the reproductive unit of the second year curriculum.
- Clerkship phase: One-on-one hands-on OB-GYN US training using high-fidelity US simulators in the fourth year (obstetric elective rotation).

Part of the goal of an integrated program is to expose students to various aspects of OB-GYN early in their training. During our pre-clerkship curriculum, our second-year medical students are introduced to pelvic US through a reading assignment and lecture that covers image construction, the typical appearance of normal tissue, and other information pertinent to the basics of pelvic US. These readings are reinforced during the first medical skills session of the reproductive unit, in which students participate in an US jeopardy game. The basics of gynecological US as it correlates to pelvic anatomy are reviewed. Echogenicity, location, orientation, and the various US modalities used are also discussed.

The following medical skills session then focuses on applying this foundational knowledge to image interpretation. Students are provided clinical cases with pelvic US images to work on before a small group session with an OB-GYN faculty member. The focus of this session is to correlate a case presentation with written pelvic examination findings and US pictures to generate a differential diagnosis and workup plan for the case. This reinforces the use of US images as a problem-solving tool in the diagnosis of reproductive system pathology.

The third medical skills session focuses on correlating US findings to what would be found on the pelvic examination. Students are given a clinical scenario with US images and then have to perform a bimanual exam on high-fidelity pelvic models. At this stage of the curriculum, students are expected to correlate findings on the exam to those presented on US images.

Simultaneous with the medical skills sessions, students participate in small group discussions throughout the reproductive unit. During these activities, students are instructed as a group to work through case examples. These case examples require students to integrate US findings, operative pictures, and histopathological slides to interpret a clinical scenario. These sessions are facilitated by a clinical faculty member who guides the students as they apply these tools to formulate a differential diagnosis, work-up, and treatment plan.

At the end of the unit, students undergo an OSCE. This experience tests the students' clinical thinking by ensuring that the correct differential diagnosis requires the student to order the transvaginal US, interpret the results, and decide appropriate management. As a whole this final exam allows us to evaluate how well the students have learned the basics of gynecological ultrasonography and its clinical applications.

CHALLENGES AND OPPORTUNITIES

The design and development of the OB-GYN US pre-clerkship curriculum imposes challenges that are inherent to the classroom setting. To overcome those challenges, currently, no hands-on pelvic US session occurs with our pre-clerkship students. Limited

resources (i.e., space, equipment, standardized patient volunteers, and trained faculty and staff) and insufficient time within the curriculum to accommodate all pre-clerkship students are the main barriers to delivering hands-on OB-GYN US training during the pre-clerkship phase. Due to those challenges, hands-on OB-GYN US training is provided during the clerkship phase through an OB-GYN elective rotation that is available for those students interested in acquiring the relevant visuomotor skills.

We believe the early introduction of OB-GYN US education in the pre-clerkship curriculum is an effective modality to enhance and retain the student learning experience in reproductive anatomy, embryology, physiology, pathology, diagnostic, and clinical decision-making skills. OB-GYN US education offers a safe and noninvasive way to visualize and learn the basic reproductive anatomy, physiology, and pathology. The dynamic view of reproductive organs as they change during menstruation, fetal development, and fetal circulation can be learned more easily using 3-D and 4-D US imaging.^{27,28} In our opinion, the pre-clerkship curriculum can be modified to extend OB-GYN US education to enhance anatomy teaching, embryology, and physiology. This can be accomplished by incorporating the use of US simulators or virtual online interactive learning modules, mobile apps, or videos. Furthermore, we support the teaching of US imaging and US-guided procedures on fresh cadavers as an innovative approach to teach anatomy as well as procedure skills in a real-live simulated experience during the pre-clerkship year.^{29,30}

CONCLUSION

Integration of US education during the pre-clerkship phase of UME has been gaining momentum in the past few years to help to enhance instructional opportunities in different core disciplines such as anatomy, physiology, and medical skills. Here we present a review of the current practices and strategies that have been published. We report on our current experiences, challenges, and opportunities in regards to the integration of US education relevant to the practice of obstetrics and gynecology.

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