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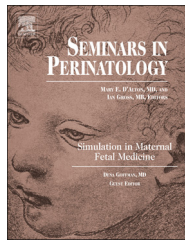

Obstetric ultrasound simulation

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ABSTRACT

Obstetric ultrasound is becoming an increasingly important part of the practice of maternal–fetal medicine. Thus, it is important to develop rigorous and effective training curricula for obstetrics and gynecology residents and maternal–fetal medicine fellows. Traditionally, this training has come almost entirely from exposure to ultrasound in the clinical setting. However, with the increased complexity of modern ultrasound and advent of duty-hour restrictions, a purely clinical training model is no longer viable. With the advent of high-fidelity obstetric ultrasound simulators, a significant amount of training can occur in a non-clinical setting which allows learners to obtain significant skill prior to their first patient ultrasound encounter and obtain proficiency in a shorter period of time. In this manuscript we discuss the available obstetric ultrasound simulators and ways to construct a comprehensive ultrasound training curricula to meet the increasing demands of modern maternal–fetal medicine.

1. Introduction

Ultrasound examination of the fetus is performed and interpreted by members of several different medical fields including radiology, emergency medicine, family medicine, pediatric cardiology, and obstetrics and gynecology (OB–GYN). Although in most of these practices, obstetric imaging makes up only a small portion of their ultrasounds, it often comprises a substantial portion of Maternal–Fetal Medicine (MFM) practices. In fact, obstetrical ultrasound and prenatal diagnosis are now essential parts of nearly every MFM practice. In many centers, MFM specialists are considered the ultimate experts in obstetric ultrasound and serve as the last stop in the referral chain for the fetuses with the most complex arrays of anomalies, making ultrasound training a crucial part of any fellowship. Although the vast majority of hands-on scanning is performed by certified obstetric sonographers, the task of putting the findings together into a coherent diagnosis falls to the supervising physician. In many cases, arriving at the correct diagnosis requires the physician to perform parts and sometimes all of an ultrasound examination. Thus, not only must trainees acquire the skills required to properly read an ultrasound examination, there is also great benefit in obtaining the skills required to actually perform the examination. Unfortunately, it is unclear as to what is the best and most efficient way to train practitioners in obstetric ultrasound. Although some recommendations exist for graduating OB–GYN residents, no clear guidelines exist as to what level of ultrasound training is appropriate for graduating MFM fellows. However, one must assume they would be more vigorous than those performing ultrasound examinations as part of a general OB–GYN practice.

Several professional oversight bodies have provided guidance on the requirements deemed necessary to effectively perform and interpret obstetric ultrasound examinations. The American Institute of Ultrasound in Medicine (AIUM) in conjunction with the American Congress of Obstetrics and

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Gynecology (ACOG) has published training guidelines for physicians who evaluate and interpret ultrasound examinations.[1] These guidelines state that physicians performing ultrasound examinations should have completed an accredited residency or fellowship program (OB–GYN residency or MFM fellowship in the case of obstetric and gynecologic ultrasound) that includes at least 3 months of dedicated ultrasound training in which the trainee interprets or performs at least 300 sonograms. The American Registry for Diagnostic Medical Sonography (ARDMS) has also laid out requirements necessary to become certified as a Registered Diagnostic Medical Sonographer (RDMS) and to further specialize in obstetric and gynecologic ultrasound.[2] The ARDMS requires applicants for an RDMS to complete either a 4-year bachelor degree or a 2-year allied health program with at least 12 months of full-time clinical ultrasound experience. No specific procedure numbers are provided for these applicants. Physicians are also eligible for the RDMS credentialing, provided they have completed an accredited residency or fellowship program which has at least 12 months of full-time clinical ultrasound training or exposes the trainee to at least 800 studies.[2]

Similar guidelines have been laid out in Europe. For certification, the European Board and College of Obstetrics and Gynecology (EBCOG) requires each trainee to maintain a logbook containing at least 200 obstetric scans.[3] In addition, the European Federation of Societies for Ultrasound in Medicine and Biology (EFSUMB) recommends that obtaining a basic level of competency in obstetric ultrasound requires 500 examinations under supervision and 30 h of theoretical instruction; whereas for more advanced ultrasound techniques such as the evaluation of fetal anomalies, 800 examinations are recommended.[4] Furthermore, the International Society of Ultrasound in Obstetrics and Gynecology (ISUOG) Education Committee has also proposed minimum standards for residents in OB/GYN recommending a minimum of 200 obstetric scans.[5] This has not led to uniformity in the training of OB–GYN specialist in Europe as the requirements vary considerably across countries.[6] The minimum requirement for obstetric scans is 80 in Denmark, 500 in Germany, 250 in Norway, and 400 in Switzerland. There is no specified minimum number of scans performed for OB–GYN specialty training in France, Italy, or Sweden.[2] The Royal College of Obstetrics and Gynecology (RCOG) in the United Kingdom has a well-established didactic and practical ultrasound curriculum that is competency based rather than focusing on a minimum number of procedures.[7]

As the above mentioned guidelines do not reference empiric studies investigating the number of procedures required to obtain proficiency, they appear to be based mostly on expert opinion. However, there is some data available on which to base minimum procedure guidelines. Studies involving the training of family medicine physicians in basic obstetric ultrasound skills such as first trimester dating via crown-rump length, second trimester biometry, and organ system screening for major anomalies suggest that after 25–50 scans trainees are able to obtain scans of acceptable quality as defined by experienced physicians.[8,9] A study of 300 ultrasound assessments of fetal weight performed by OB–GYN residents compared to actual birthweight showed significant improvement with more experience.[8] The authors concluded that 24 months of scanning time was required to achieve the goal of obtaining an estimated weight within 10% of the actual birthweight in 70% of the cases. Unfortunately, the total number of scans performed by each group of residents prior to the study was not provided, so the minimum number of scans required for proficiency cannot be determined.

More recent investigation of this issue is focused around a statistical analysis known as cumulative summation (CUSUM) that is an established quality-control measure used in several different fields of medicine.[10–13] Although a complete discussion of CUSUM is beyond the scope of this article, the method graphically represents performance adequacy on a case-by-case basis by testing whether the procedure in question (in this case the obstetric ultrasound) is being done properly, i.e., a success, or if significant deviation from a predefined metric or gold standard has occurred, i.e., a failure.[14] In obstetric ultrasound, possible gold standards include birthweight, mean biometric measurements based on gestational age, or biometric measurements performed by a senior sonographer. Successes result in a decrease in the CUSUM score, and failures result in increase in the CUSUM score. When the CUSUM score decreases below a predetermined cutoff the, learner is considered competent, and when it increases above a predetermined cutoff, remediation is necessary. Two studies have employed CUSUM to assess trainee competency in fetal biometry.[15,16] One study comparing the biometric estimates of fetal weight of three inexperienced ultrasound trainees compared to actual neonatal birthweight revealed that 107, 166, and 177 scans were required to achieve competency in fetal weight assessment.[15] Another study of the individual biometric measurements (i.e., BPD, HC, AC, and FL) performed by three primary healthcare doctors with no prior ultrasound experience compared to the biometric measurements of an experienced physician revealed a more complicated path to competency.[16] All three trainees achieved competence in BPD and HC measurements in 30 attempts or less. However, competency in AC and FL measurement was more difficult to obtain requiring over 60 attempts, and one trainee did not maintain competency in measurement in either parameter throughout the 100 scans performed in the study.

As the number of trainees involved in these studies is small, their results do not justify changing the minimum numbers of procedures suggested by AIUM, EBCOG, EFSUMB, or ISUOG. Moreover, none of the studies discussed thus far involved any significant number of abnormal fetuses, limiting their ability to make conclusions about the number of scans needed to reliably recognize fetal anomalies, a task which is the focus of ultrasound in MFM. Thus, the significantly larger numbers of scans proposed by the AIUM, ARDMS, and other regulating bodies in Europe are reasonable for those providers that care for high-risk obstetric populations.

Although the number of trainees in these studies is too small to draw strong conclusions about the number of scans required to obtain proficiency, they do illustrate the significant variation in skill acquisition among trainees. For example, in the study comparing estimated fetal weight to actual birth rate,[15] there was a difference of 70 examinations needed to obtain proficiency between the fastest and slowest learner in the study. In addition, in the study of proficiency in