

## Teaching Prenatal Ultrasound to Family Medicine Residents

Lee T. Dresang, MD; Wm. MacMillan Rodney, MD; Jason Dees, DO

*Prenatal ultrasound is a powerful diagnostic tool, but there has been little research on how to teach ultrasound to family physicians. The available evidence supports teaching through didactics followed by supervised scanning. Didactic topics include physics and machine usage, indications, fetal biometry, anatomic survey, practice management, ethical issues, and resources. Supervised scanning reinforces the didactic components of training. A "hand-on-hand" supervised scanning technique is recommended for the transmission of psychomotor skills in these sessions. Curricula for teaching ultrasound should include information on which residents will be taught prenatal ultrasound, who will teach them, how to create time for learning ultrasound skills, and how to test for competency. The literature suggests that competency can be achieved within 25–50 supervised scans. Measures of competency include examination and qualitative analysis of scanning. Competency-based testing needs further development because no uniform standards have been established.*

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Most family physicians do not use prenatal ultrasound in their practice. Low rates of using prenatal ultrasound may be due to a lack of understanding of technology availability, lack of awareness among ultrasound manufacturers that family physicians might use such equipment, or lack of training programs for family physicians. In addition, inter-specialty conflicts among family physicians, radiologists, and obstetrician-gynecologists may play a role in family physicians not using prenatal ultrasound.<sup>1</sup>

Nevertheless, family medicine residency directors indicate a strong interest in offering a prenatal ultrasound curriculum. In one survey, 87% of residency directors said they were willing to send faculty to a week-long training course and regularly use prenatal ultrasound in their residency practice. Fifty-four percent said they were willing to purchase a \$20,000–\$30,000 ultrasound machine.<sup>2</sup> The benefits and disadvantages of teaching prenatal ultrasound in a residency program are shown in Table 1.

This article focuses on how to assist family physicians in training to acquire the skills necessary to perform ultrasound examinations in their post-residency practices. Relevant literature is reviewed, and recommendations are made using US Preventive Services Task Force (USPSTF) guidelines.<sup>3</sup> This article does not attempt to present a detailed prenatal ultrasound curriculum but, instead, outlines a method of didactic instruction followed by supervised scanning. Details of implementation are discussed, including who teaches ultrasound, how to allocate time to teach, and how to evaluate learners. The key recommendations are shown in Table 2.

### Curriculum Model: An Overview

Various approaches are used for teaching prenatal ultrasound to family medicine residents. These approaches range from a combination of lectures followed by supervised scanning, to instruction in scanning alone.<sup>2</sup> The most commonly used training method involves didactics followed by supervised scanning<sup>4–11</sup> (Table 2). The type and extent of didactics and the length of supervised scanning have varied in published reports, but the basic model has been the same. Competency-based testing in the cited studies indicates that this basic training model is effective. However, these studies do not compare the variations of this model nor do they compare this teaching model with other models.

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From the Department of Family Medicine, University of Wisconsin (Dr Dresang); and the Department of Family and Community Medicine, Meharry Medical College/Vanderbilt University (Drs Rodney and Dees). Dr Dees is now in private practice in rural Mississippi.



### Didactics

Based on published reports, didactics should cover ultrasound physics, machine usage, indications, fetal biometry, the anatomic survey, practice management, and ethical issues. Consideration may be given to teaching non-obstetric ultrasound.

### Physics and Machine Usage

"Any course of study should begin with the basics of physics, instrumentation, and image orientation . . . The person doing the scanning must understand how the images are generated and processed to produce an optimal study."<sup>12</sup> For example, learners should understand that a 3.5 MHz transducer will allow more penetration but less definition than a 5.0 MHz transducer. In addition, learners should be familiar with the variety of controls offered on ultrasound units so they will be able to use any machine they encounter.

### Indications

Learners should know the indications for prenatal ultrasound examination. These are listed in Table 3.

### Fetal Biometry

Teaching fetal biometry will allow learners to calculate estimated gestational age (EGA) and estimated fetal weight (EFW). Formulas should be taught to avoid reliance on software packages. Two important formulas are those for calculating crown-rump length and biparietal diameter (BPD). Whether or not they per-

form their own ultrasounds, family physicians should also understand how to calculate the estimated due date (EDD) using the last menstrual period (LMP) and the first ultrasound examination.

The accuracy of fetal measurements at different gestational ages should be understood. For example, the BPD is generally the most accurate measurement in the early second trimester and the least accurate measurement in the late third trimester.

### Anatomic Survey

Both normal and abnormal anatomy are important topics within the didactic component. Discussion should cover common variations of normal anatomy, which may be confused with abnormal anatomy. Although no sonographer can learn every anatomic abnormality and syndrome, sonographers should learn to distinguish normal from abnormal and what to do when they encounter abnormalities. Every ultrasound report should document whether the organs listed in Table 4 are normal, abnormal, or not well visualized.

### Practice Management

Practice management is an important part of prenatal ultrasound education. Appropriate *International Classification of Diseases, Ninth Edition* (ICD-9) codes (Table 5) and *Current Procedural Terminology* (CPT) codes (Table 6) should be taught, so that family physicians will know how to bill for the services they provide. Ultrasound exams are billed according to their CPT codes, but all must have an ICD-9 code for the medical indication or they will not be reimbursed. "Pregnancy" is not an accepted ICD-9 justification for reimbursement. New CPT codes were created in 2004. Revised collection data will not be available until 2005, at the earliest. One change is a new CPT code for pregnant transvaginal ultrasound, to differentiate it from gynecologic transvaginal ultrasound.

Students and residents should receive honest information on costs of equipment and associated expenses, such as malpractice issues, involved in performing ul-

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Table 3

#### Indications for Prenatal Ultrasound<sup>13</sup>

1. Estimation of gestational age for patients with uncertain dates or who are to undergo scheduled elective repeat cesarean delivery, indicated induction of labor, or other elective termination of pregnancy
  2. Evaluation of fetal growth
  3. Determination of fetal presentation
  4. Suspected multiple gestation
  5. Adjunct to amniocentesis
  6. Significant uterine size/dates discrepancy
  7. Suspected pelvic mass
  8. Suspected hydatidiform mole
  9. Adjunct to procedures such as amniocentesis and external cephalic version
  10. Suspected ectopic pregnancy
  11. Suspected fetal death
  12. Intrauterine contraceptive device localization
  13. Biophysical evaluation for fetal well-being
  14. Estimation of fetal weight and/or presentation in premature rupture of membranes and/or premature labor
  15. Abnormal triple screen
  16. Follow-up observation of identified fetal, placental, uterine, or ovarian abnormality
  17. Follow-up evaluation of placenta location for identified placenta previa
  18. History of previous congenital anomaly
  19. Evaluation of fetal condition in late registrants for prenatal care
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Table 4

#### Structures to Examine With Each Anatomic Survey<sup>14</sup>

- Cerebral ventricles
  - Posterior fossa (including cerebellar hemispheres and cisterna magna)
  - Four-chamber view of the heart (including its position within the thorax)
  - Spine
  - Stomach
  - Renal region (kidneys)
  - Urinary bladder
  - Fetal umbilical cord insertion site and intactness of anterior abdominal wall
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Table 5  
Prenatal Ultrasound ICD-9 Codes

ICD-9 Code	Description
656.63	Large for dates
V28.4	Uncertain dates
656.5	Small for dates
641.93	Vaginal bleed
789.00	Abdominal pain
652.23	Breech presentation
656.33	Fetal distress
658.03	Oligohydraminos
V23.7	Late prenatal care
634.10	Sp Ab with hemorrhage
640.03	Threatened abortion

ICD-9—International Classification of Diseases, Ninth Edition

trasound as well as other procedures, because students routinely overestimated family medicine insurance costs by 200% to 400%.<sup>16</sup> False perceptions about costs may keep students and residents from providing ultrasound examinations. In reality, in a study describing annual revenues and expenses within an urban family practice, OB ultrasound produced \$68,250 in additional revenues for a practice. This revenue was derived from primarily Medicaid patients and would be higher in many communities and for patients insured by carriers other than Medicaid. Revenues from ultrasound studies more than paid for the equipment and associated overhead while providing important diagnostic information for the patients and the physicians.<sup>17</sup>

*Ethical Issues*

Resident education also involves grappling with the ethical issues raised by ultrasound use. Prenatal ultra-

Table 6  
Prenatal Ultrasound CPT Codes

CPT Code	Description of Exam	Medicare Tech Fee	Medicare Professional Fee	Medicare Global Fee	Non-Medicare Tech Fee	Non-Medicare Professional Fee	Non-Medicare Global Fee
76805	Ultrasonography (ultrasound examination), pregnant uterus, B-scan and/or real time with image documentation; complete (complete fetal and maternal evaluation)	\$73	\$46	\$121	\$190 to \$226	\$140 to \$169	\$330 to \$395
76810	Complete (complete fetal and maternal evaluation), multiple gestation, after first trimester	\$145	\$87	\$143	\$250 to \$311	\$297 to \$343	\$546 to \$653
76813	Limited (fetal size, heart beat, placental location, fetal position, or emergency in the delivery room)	\$49	\$32	\$81	\$114 to \$137	\$101 to \$121	\$215 to \$258
76816	Follow-up or repeat	\$39	\$23	\$67	\$88 to \$103	\$81 to \$98	\$169 to \$201
76818	Fetal biophysical profile	\$76	\$52	\$108	\$158 to \$184	\$121 to \$147	\$339 to \$331
76830	Ultrasonography (ultrasound examination), transvaginal	\$53	\$33	\$86	\$176 to \$210	\$113 to \$136	\$289 to \$345

*CPT Current Procedural Terminology*

The above figures are multiplied by a geographic adjustment factor (GAF), which ranges from .84 to 1.20, depending on where the ultrasound is performed.

sound ethical issues can be divided into those commonly encountered by family physicians and those occasionally encountered, the latter most often handled in collaboration with a perinatologist. Common ethical issues include whether to offer all pregnant patients a routine scan(s), whether to use the term *fetus* or *baby*, and how to use ultrasound in relation to abortion counseling. Uncommon prenatal ultrasound ethical issues include ultrasound use in infertility treatment, selective reduction of multiple pregnancies, and management of fetal anomalies. Perinatologists usually perform ultrasounds for these unusual, high-risk sonographic applications, and they may offer guidance in addressing the ethical issues that arise. In addition to discussing specific issues in the residents' didactic sessions, strategies for working through ethical issues in general can be developed.

#### *Teaching Non-Prenatal Ultrasound*

Consideration can be given to teaching ultrasound skills beyond those needed for pregnancy-related examinations. A 2-year multi-center study of diagnostic ultrasound found four areas of potential ultrasound use by family physicians.

The first is pelvic imaging for gynecologic problems such as uterine bleeding, fibroids, IUD localization, retained products of conception, blighted ovum, ectopic pregnancy, and ovarian cysts. The second is detection of intra-abdominal diagnoses, such as abdominal aortic aneurysms, gallstones, cholecystitis with obstruction, intra-abdominal solid and cystic masses, ascites, and hemoperitoneum. One study found that adding a scan of the gallbladder to a standard prenatal ultrasound only required 2 extra minutes per scan.<sup>18</sup> Intra-abdominal diagnosis also includes using ultrasound as an adjunctive procedure to paracentesis and culdocentesis. A CD-ROM is now available for teaching abdominal ultrasound techniques.<sup>19</sup> The third non-prenatal use is detection of emergency cardiac diagnoses, such as pericardial tamponade, pericardial effusion, and hemopericardium. The fourth is "small-parts imaging." This involves imaging superficial solid and cystic masses, hydroceles, spermatoceles, and thyroid masses.<sup>1</sup>

#### *Resources*

Resources (Tables 7 and 8) and lectures provide support for the didactic component in ultrasound training. CD-ROMs may provide an excellent transition from didactics to scanning—providing still images and videos of normal and abnormal anatomy and giving the user practice placing calipers on those images (Table 8).

Workshops are another important method of delivering didactic material. The ultrasound workshop of the Advanced Life Support in Obstetrics (ALSO) course teaches participants to use ultrasound to assess fetal

number, fetal presentation, fetal viability, placental location, and amniotic fluid index. A number of other organizations offer longer, 2- to 4-day workshops, which provide a more in-depth study of prenatal ultrasound techniques.

#### *Supervised Scanning*

After developing a cognitive understanding of prenatal ultrasound, learners benefit from supervised scanning until competency is achieved.

#### *The "Hand-on-Hand" Technique*

The "hand-on-hand" technique is a method of teaching prenatal ultrasound that has not yet been described in the literature. With this technique, the learner's hand, while still on the ultrasound probe, can be guided by the instructor's hand to obtain the desired image. This develops the learner's psychomotor skills in a way that observation, CD-ROM practice, and verbal instruction cannot. Hand-on-hand training is less necessary as the learner becomes more adept, but it is still useful for acquiring advanced ultrasound skills. For example, even experienced ultrasonographers may need some tactile guidance to identify certain anatomic structures, like the cardiac outflow tracts. Though not well studied, anecdotally, the hand-on-hand technique appears to be an accelerator of learning.

#### *Adapting Teaching to Learners' Needs*

Supervised scanning allows instructors to adapt the content and method of teaching to the needs of the learners. As beginners, learners may be asked to focus on a single image or organ system per patient or be given a time limit to use the ultrasound equipment on a single patient. Complete scans are reserved for later, after skills and speed have improved. Residents are encouraged to use images as they are located and not be too rigid about the order in which they identify structures. If one hand is always on the freeze button, images can be captured quickly. Leaving the transducer in the same place between biometry measurements can reduce time relocating images.

#### *Images Encountered During Supervised Scanning*

Figures 1 through 4 demonstrate normal anatomical structures visualized as part of the standard exam. Other images, including abnormalities such as fetal hydro-nephrosis or gastroschisis, may occasionally be encountered.

#### *Number of Scans Needed To Achieve Competency*

The number of supervised scans needed for competency in prenatal ultrasound is controversial, and perhaps the number of scans is not the best measure of competency. Nonetheless, a 1993 task force from the American Institute of Ultrasound in Medicine (AIUM),

Table 7  
Prenatal Ultrasound References

Category	Reference	Description	Price
General	Bowerman RA. An atlas of normal fetal ultrasonographic anatomy, second edition. Year Book Medical Publishers, Inc, 1992.	338 pages, reference book	\$49.95
	Cullen PW. Ultrasonography in obstetrics and gynecology, fourth edition. W.B. Saunders, 2000.	1,078 pages, reference book with color illustrations, classic textbooks with recent revision and update	\$69
	DFWT Clinical obstetrical ultrasound. John Wiley & Sons, Inc, 1999.	392 pages, comes with CD-ROM, live ultrasound findings with physiology and clinical relevance	\$179
	Sanders JL. Clinical sonography: a practical guide, third edition. Lippincott, Brown and Company, 1998.	613 pages, teaching techniques, clinical correlation, more than 200 illustrations	\$71.95
Anomalies	Benison of BE. Ultrasound of fetal syndromes. W.B. Saunders, 1996.	467 pages, reference for determining prenatal diagnosis of syndromes with clinical and sonographic correlation	\$145
	Blaser KA, Kahn AN, Thomas NB, McHugh JM. Differential diagnosis in obstetric and gynecologic ultrasound, second ed. Lea, W.B. Saunders, 2002.	576 pages, pocket reference guide of prenatal ultrasonography with summary of sonographic and clinical findings	\$79.95
	Nyberg DA, Eisenberg RL, Ting G. Diagnostic ultrasound of fetal anomalies, second edition. Lippincott: Williams and Wilkins Publishers, 2002.	1,102 pages, reference guide to detect and diagnose fetal anomalies; clinical correlation	\$175
	Twinzig P, McHugh JM, Pelling LW. Textbook of fetal abnormalities. Churchill Livingstone, 2000	572 pages, detection, interpretation, and management of fetal abnormalities. Includes algorithms and illustrations	\$224
Emergency room	Heller M, Jaffe D. Ultrasound in emergency medicine. W.B. Saunders, 1995.	236 pages, principles of ultrasound and applications to emergency room	\$67.77
Transvaginal	Fleischer AC, Kepple DM. Transvaginal sonography: a clinical atlas, second edition, Lippincott Williams & Wilkins, 1995.	426 pages, discussion of fetal anatomy and anomalies. Photos and color images	\$125

Table 8  
Prenatal Ultrasound CD-ROMs

CD ROM	Content	Ordering Information	Price
American College of Gynecology and Obstetrics (ACOG). Fetal Ultrasound Simulation. 1998.	ACOG screening guidelines and reference library with more than 28 fetal anomalies.	ACOG Distribution Center PO Box 4500 Kearneysville, WV 25430-4500 800-762-2264, ext. 277	Non-ACOG members: \$189 ACOG members: \$150 Institutional price: \$395
Deutschman ME, Toquet P. Diagnostic Ultrasound of Fetal Anomalies. Principles and Techniques. Silver Platter Education. 1999.	Comprehensive instruction in normal and abnormal fetal anatomy and biometry. Includes interactive exercises. Two CD-ROM set.	mark.deutschman@ucsb.edu	\$98/set
Deutschman ME. Abdominal Ultrasound: Principles and Techniques. Healthstream. 1997.	Physics, image orientation, hepatic, biliary, renal and aorta ultrasound. One CD-ROM. Does not run on Windows 2000.	mark.deutschman@ucsb.edu	\$89
Deutschman ME. Obstetric Ultrasound: Principles and Techniques. Healthstream, 2001.	Normal fetal anatomy and biometry including interactive exercises. One CD-ROM. Does not run on Windows 2000.	mark.deutschman@ucsb.edu	\$89
Kendall J, Deutschman ME. Ultrasound in Emergency Medicine and Trauma. Healthstream, 2001.	Comprehensive instruction in the sonographic exam for abdominal trauma, emergency cardiac indications, and first-trimester pregnancy applications. Also covers physics and image orientation. Two CD-ROM set.	mark.deutschman@ucsb.edu	\$146/set
Nyberg DA, Kapur BD. Pediatric DSA. Ultrasound of Fetal Anomalies-Disk and User's Guide. Mosby, 1995.	Textbook and disk of fetal anomalies.	www.amazon.com	1790
Old WT. Clinical Obstetrical Ultrasound. John Wiley & Sons, Inc, 1999.	Illustrations, narrated videos, tables, and graphs from companion book.	www.amazon.com	\$179

the American College of Obstetricians and Gynecologists (ACOG), and the American College of Radiology (ACR) recommended that learners complete 200 scans over 3 years to achieve competency. This contrasts with studies by family physicians that document competency after 50 scans,<sup>4</sup> 25 scans,<sup>8</sup> 40 scans,<sup>9</sup> and 40–50 scans.<sup>20</sup> According to Connors, the “task force guidelines were not supported by outcome and performance studies; the studies conducted by family physicians did include outcome and performance measures.”<sup>22</sup>

Maintaining and improving ultrasound competency continues beyond the initial training. “Learning diagnostic ultrasonography is a longitudinal effort that requires continual reading and practice, as well as building a reference library.”<sup>12</sup> Ultrasound skills should improve with level of experience, and experience should help maintain skills already acquired.

#### Implementation of Ultrasound Curriculum

To implement an ultrasound curriculum, residency programs must decide which residents will be taught

Figure 1

Normal Umbilical Cord Insertion



Figure 2

Normal Four-chambered Heart



Figure 3

Normal Sagittal Spine

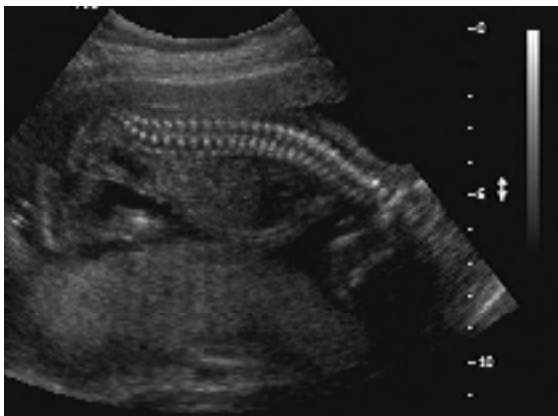


Figure 4

Biparietal Diameter



prenatal ultrasound, who will teach the residents, how this will fit into the rest of their residency curriculum, and how to assess competency.

#### *Which Residents Will Be Taught Prenatal Ultrasound*

Because all family medicine residents receive training in prenatal care, and because basic labor and delivery ultrasound skills can be lifesaving, patient care might benefit if all family physicians attending deliveries could perform basic labor and delivery ultrasound examinations. To this end, time can be set aside during the internship year, or at least prior to obstetric rotations, for residents to take an ALSO course that includes optional instruction in basic ultrasound skills. This can be followed by supervised scanning on the labor and delivery unit and in the clinic.

Because acquiring the skills to perform a full standard prenatal ultrasound examination requires additional effort and time commitment, it remains an open question as to which residents should be taught to perform a complete standard exam. Factors such as resident plans for delivering babies after residency might be considered when choosing who should learn the standard exam, but the same could be said for other experiences that are part of all residents' training (eg, an ICU rotation). We recommend that residents learn these basic skills much as one would recommend learning basic computer keyboard skills.

#### *Who Will Teach the Residents*

Who does the teaching may vary. Ideally, a residency program would have enough family physicians performing prenatal ultrasounds to teach its own residents.

If not, consideration can be given to training more faculty to perform and teach complete prenatal scans. Radiologists, ultrasound technicians, and obstetricians may be involved in ultrasound training.

#### *Finding Time for Residents to Learn Ultrasound*

One of the main challenges to learning the standard exam within a 3-year family medicine residency is the structured curriculum. Residents may be overextended, and learning prenatal ultrasound requires time. Unless time is blocked for learning the skill, time constraints will likely deter even interested and motivated residents from pursuing this goal.

One aspect of "procedural skill atrophy has been an overworked and understaffed residency faculty."<sup>21</sup> Teaching prenatal ultrasound should not become a burden by adding it to already-busy resident and faculty schedules. Instead, time should be blocked within normal schedules for teaching and learning this skill. For example, a program in Memphis took time away from less-relevant inpatient gynecology and surgery rotations and created a mandatory outpatient procedural rotation, during which residents developed skills in ambulatory gynecology and ambulatory surgery, including ultrasound. In addition, a continuity procedural session was provided to third-year residents so they could provide procedural services for their own patients.<sup>22</sup> Time may be set aside to learn prenatal ultrasound on both a longitudinal basis and during block rotations.

#### *Competency-based Testing*

Competency-based testing is an area in need of more research. To date, there is no standard mechanism for documenting competency. The acquisition of prenatal ultrasound skills has been tested by "direct examination of scanning capabilities, written tests, objective measurements of acquired basic data, compared patient outcomes, and matching family physicians to other practitioners."<sup>23</sup> Testing for competency has the potential to motivate learners, provide quality assurance, and overcome interspecialty conflict. Studies can help determine if certain methods of competency-based testing are linked to improved outcomes.

#### *Conclusions*

Although evidence for the best method of teaching prenatal ultrasound is sparse, the basic method of didactics followed by supervised scanning is supported by the literature. Whether and how to implement this model will need to be adapted to individual settings. Future research on specific techniques, such as the hand-on-hand technique, and on general tools such as competency-based testing, can help refine and standardize teaching techniques. An evidence-based approach to teaching prenatal ultrasound will help family physicians increase access to high-quality prenatal ultrasound services.

#### *Summary of Recommendations*

*Category A (There is good evidence to support the recommendation)*

(1) Didactics followed by supervised scanning is an effective method for teaching fetal biometry to family physicians.<sup>4-11</sup>

(2) Family physicians can learn to perform adequate complete studies in less than 50 scans.<sup>4,8,9,20</sup>

*Category B (There is fair evidence to support the recommendation)*

(1) Didactics followed by supervised scanning is an effective method for teaching anatomic surveys to family physicians.<sup>4-6,9</sup>

(2) Practice management should be taught as part of prenatal ultrasound didactics. When it is not taught, residents tend to overestimate the costs of malpractice and refrain from including ultrasound in their postgraduate practice.<sup>16</sup>

*Category C (There is insufficient evidence to support the recommendation, but these recommendations conform to common or standard practice)*

(1) Didactics should cover ultrasound physics, machine usage, indications, fetal biometry, the anatomic survey, practice management, and ethical issues.

(2) CD-ROMs are an effective tool allowing active learning and a transition from didactic learning to practice with live patients.

(3) The hand-on-hand technique is an effective method for teaching the psychomotor skills of prenatal ultrasound.

(4) Training faculty in prenatal ultrasound skills is a first step in developing a program for training residents.<sup>2</sup>

(5) Time should be set aside for residents to learn prenatal ultrasound longitudinally and in block rotations.<sup>22</sup>

*Corresponding Author:* Address correspondence to Dr Dresang, Johnston Community Health Center, 1230 W. Grant Street, Milwaukee, WI 53215. 414-286-8892. Fax: 414-384-5578. ldresang@fammed.wisc.edu.

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