

## Obstetric Ultrasound Training for Family Physicians

### Results from a Multi-Site Study

Ricardo G. Hahn, MD; Larry D. Roi, PhD; Steve M. Ornstein, MD; Wm. MacMillan Rodney, MD; David R. Garr, MD; Terence C. Davies, MD; Walter Morgan, MD; John M. O'Brien, MD; Richard D. McLeary, MD; James F. Peggs, MD; Magdalena Bugarin-Viera, MD; Sam Ho, MD; Robert Reinhardt, MD; Tomie Timon, RDMS; Kent J. Sheets, PhD; John Hood, MD; John Langlois, MD; and Hiram B. Curry, MD

*A practical program to train family physicians in obstetric ultrasound was tested with 13 family physicians. Each physician completed 6.5 days of course work and ultrasound laboratory apprenticeship prior to beginning a clinical preceptorship of approximately 14 months' duration. During the clinical preceptorship the physicians performed ultrasound studies in their own offices. All studies were reviewed by a local consultant radiologist utilizing examination data sheets and videotapes. At the conclusion of the training program, the physicians took a combined practical and written proficiency examination administered by an independent sonographer.*

*Eight physicians completed the training, performing during the preceptorship an average of 78 examinations. The rated performance of the physicians improved markedly over the course of the preceptorship. During the last segment of the preceptorship the radiologist preceptors rated 94 percent of the ultrasound studies as acceptable, compared with 79 percent rated acceptable at the beginning of the preceptorship. Seven of the eight physicians completing the protocol took the proficiency examination: all passed.*

*This study can provide a blueprint for an individual family physician to design his own training, or it can guide an academic department of family medicine in developing and evaluating ultrasound training programs for residents and practicing physicians.*

**P**rimarily care physicians are using diagnostic obstetric ultrasound in their offices with increasing frequency as ultrasound equipment becomes easier to use, more

compact, and less expensive.<sup>1-6</sup> In 1983 an estimated 34 percent of pregnant women seeing an office-based obstetrician underwent at least one ultrasound examination; more than 30 percent of North American obstetricians now perform ultrasound examinations in their offices.<sup>7,8</sup> There is also evidence that family physicians are increasing their use of obstetric ultrasound.

Despite the growing use of obstetric ultrasound, there are no training standards for primary care physicians. In 1984 the National Institutes of Health (NIH) Consensus Development Conference on Diagnostic Ultrasound Imaging in Pregnancy<sup>9</sup> recommended that minimum training requirements and uniform credentialing be established for physicians performing obstetric ultrasound, but no action has yet been taken on this recommendation.

This study was undertaken to design and implement a validated obstetric ultrasound training protocol tailored

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From the Department of Family Practice, University of Michigan, Ann Arbor, Michigan (Drs. Hahn, Roi, Davies, O'Brien, McLeary, Peggs, Reinhardt, and Sheets); the Division of Family and Community Medicine, University of California at San Francisco (Drs. Hahn and Ho), and the Pacific Family Practice, San Francisco, California (Drs. Hahn and Bugarin-Viera); the Department of Family Medicine, Medical University of South Carolina, Charleston, South Carolina (Drs. Ornstein, Garr, and Curry); the Department of Family Medicine, San Bernardino County Medical Center—University of California at Irvine, San Bernardino, California (Drs. Rodney and Morgan); the Department of Radiology, St. Joseph Mercy Hospital, Ann Arbor, Michigan (Dr. McLeary); Auburn Faith Community Hospital, Auburn, California (Mr. Timon); the Radiology Associates of Charleston, Charleston, South Carolina (Dr. Hood); and the Little River Medical Center, Little River, South Carolina (Dr. Langlois). Requests for reprints should be addressed to Mary Anne Hartness, Department of Family Practice, University of Michigan, 1018 Fuller St, Ann Arbor, MI 48109-0708.

for the family physician. The training program developed in this study incorporates specific guidelines for training, sets minimum standards for competency, and defines an appropriate method to assess proficiency.

**METHODS**

**Trainees**

Thirteen family physicians at four sites participated in the training program. The sites were located in Michigan, South Carolina, and California.<sup>2</sup> The physicians included three physicians in private practice, one resident, and nine practicing physician faculty. At each site a local board-certified radiologist, the site sonologist, provided consultation and served as preceptor. A board-certified radiologist served as the coordinating sonologist.

**Equipment**

All ultrasound examinations were performed using an ADR 4000 Sector/Linear ultrasound scanner with 3.0 and 5.0 MHz transducers (Applied Technology Laboratories, Bothell, Washington) and attached videotape recorder.

**Educational Protocol**

The educational protocol consisted of two phases: an introductory training phase and a clinical practice and preceptorship phase (Table 1). In the introductory training phase, the physicians completed three segments: a two-day, on-site introductory course; a three-day formal continuing medical education (CME) course; and three half-days of apprenticeship in a local ultrasound laboratory. Professional education personnel from the equipment manufacturer, applications technicians, and practicing certified sonographers conducted the two-day on-site training. This combination session of didactic and practical training covered the following:

1. Ultrasound theory, physics, safety, limitations
2. Clinical indications for scanning
3. Anatomy, scanning technique
4. Standardized performance of studies
5. Preparation of patients, pitfalls
6. Imaging format for patient and videotape records
7. Familiarization with the equipment
8. Practical, hands-on experience with obstetric patients
9. Practice completing examination data sheets

The three-day formal CME course (provided by two obstetricians specializing in obstetrical ultrasound) consisted

**TABLE 1. STUDY PROTOCOL FOR ULTRASOUND EXAMINATIONS**

<b>Initial introduction to obstetric ultrasound</b>
Introduction to theory and practice—2-day on-site course
Formal continuing medical education course in obstetric ultrasound—3-day off-site course
Obstetric ultrasound laboratory training—3 half-day apprenticeship in a radiology-ultrasound laboratory
<b>Clinical practice/preceptorship (14 months)</b>
Ultrasound studies performed and videotaped in the family physician's office
Minimum completion of 70 studies by each physician with at least 10 first-trimester and 20 second- and third-trimester studies
Regular sessions with consultant site sonologist to review and critique videotapes
<b>Evaluation</b>
Administration of comprehensive proficiency examination testing ultrasound technical and interpretation skills

of theoretical and practical instruction in obstetric ultrasound, with an emphasis on linear imaging techniques. Now in the eighth year of regular presentation, these courses are specifically geared to primary care obstetricians and family physicians.\*

In the clinical practice and preceptorship phase, each family physician performed and videotaped ultrasound studies in his or her own office. All studies were reviewed with the site sonologist. Patients who required more immediate attention had their studies reviewed sooner or, when appropriate, were referred to a sonologist for further examination.

**Patient Population**

Patients were drawn from the clinical practice population of each site. Patients were eligible if they gave written informed consent and presented with one or more of the indications given in Table 2. These 12 indications are a subset of the 27 obstetric indications given by the NIH Consensus Development Conference on Diagnostic Ultrasound Imaging During Pregnancy.<sup>9</sup> The indications were selected because they are suitable for a family practice patient population and consistent with the level of training provided in this protocol.

**Data Collection**

For each ultrasound examination the family physician recorded patient clinical data and examination results on

*\* Since completion of this project the authors have designed and implemented their own, five-day obstetric and gynecologic ultrasound course designed for family physicians and taught by family physicians and certified sonographers.*

**TABLE 2. OBSTETRICAL INDICATIONS FOR ULTRASOUND EXAMINATION**

1. Estimation or verification of gestational age
2. Discrepant uterine size and clinical dates
3. Vaginal bleeding of undetermined etiology
4. Suspected multiple gestation
5. Evaluation of fetal condition in late registrants for prenatal care
6. Determination of fetal presentation
7. Suspected fetal death
8. Suspected polyhydramnios or oligohydramnios
9. Pelvic mass detected clinically
10. Suspected hydatidiform mole
11. Suspected ectopic pregnancy
12. Estimation of fetal weight or presentation in premature rupture of membranes or premature labor

a worksheet tailored to the pregnancy trimester. The physician also videotaped and narrated a three- to five-minute summary scan. Additionally, each ultrasound measurement was documented by videotaping the stopped image.

During the precepting session, the site sonologist filled out a critique worksheet based on the videotape record and the family physician's examination worksheet. The critique provided the data for two evaluations of the family physician's performance of an individual examination. The first, the global assessment, recorded the preceptor's judgment that the ultrasound study was either acceptable or unacceptable. The preceptor's global judgment was based on the content outline listed in Table 3. The second measure, termed the multifactor criteria, was based on the physician correctly performing essential components of the examination (Table 4). The essential components were chosen based on advice of radiologist consultants. For example, for a first-trimester examination these basic criteria included correctly identifying fetal number, cardiac activity, and any uterine pathology as well as correctly placing the calipers and determining the measurement plane for the measurements taken. If the preceptor passed the family physician on all of the basic criteria, then this measure was recorded as a pass. These selected criteria were not regarded as being sufficient for a complete examination, but they provided preceptors with evidence that basic anatomic and physiologic indicators had been looked at.

**Proficiency Evaluation**

At the completion of the clinical practice and preceptorship phase, the physicians took a proficiency examination composed of a practical and a written component.

In the practical examination, the physician scanned a second-trimester obstetric patient under the observation of an examiner (T.T.), an independent sonographer not

**TABLE 3. PRACTICAL EXAMINATION CHECKLIST CONTENT OUTLINE**

- Preparation**
  - Patient identification
  - Patient informed, indications reviewed
  - Scanner properly adjusted, study identified
- Data collection**
  - Vagina, cervix, bladder, uterus, uterine wall, lower uterine segment, adnexae, pelvis surveyed
  - Placental location and grade. Three umbilical vessels
  - Aminotic fluid amount
  - Fetal number and lie
  - Cardiac and body activity
  - Intracranial survey—Image at level of lateral ventricles, thalamus and septum cavum pellucidum, mid-brain and brain stem
  - Vertebral column in sagittal and axial views (multiple)
  - Four-chamber cardiac view, stomach, kidney, bladder, liver, umbilical vein, abdominal wall, four limbs
- Measurements**
  - Biparietal diameter
  - Occipital frontal diameter
  - Anteroposterior and transverse diameters of the abdomen
  - Femur measurements
- Calculations**
  - Head circumference
  - Abdominal circumference
  - Cephalic index
  - Femur-biparietal diameter ratio
  - Head circumference-abdominal circumference ratio
  - Gestational age
  - Fetal weight
  - Percentile growth
- Interpretation**
  - Appropriate for gestational age
  - Large for gestational age
  - Small for gestational age
  - Intrauterine growth retardation (symmetrical and asymmetrical)
  - Hydrocephaly
  - Macrosomia

otherwise connected with the study. Immediately prior to the start of the practical examination and before the physician entered the room, the sonographer scanned the patient. The administering sonographer rated 21 separate performance areas on a 1- to 5-point rating scale. A passing average item score was defined to be 3.5. The sonographer also made a global assessment of whether the ultrasound study was acceptable or unacceptable. The checklist used in administering the practical examination is outlined in Table 3.

The written examination, which tested didactic knowledge and image recognition, was obtained by special arrangement from the American Registry of Diagnostic Medical Sonographers (ARDMS).<sup>10</sup> The ARDMS designs, validates, and administers examinations for all areas of diagnostic ultrasonography including cardiology, peripheral vascular, and abdominal. The American Institute of

**TABLE 4. MULTIFACTOR CRITERIA FOR PASSING FAMILY PHYSICIAN TRAINEE BASED ON REVIEW BY PRECEPTING SONOLOGIST**

Passing requires scoring agreement between family physician (FP) and reference sonologist (RS) on all listed factors.

**First trimester**

- Pregnancy (yes or no)
- Pregnancy location
- Fetal number (or gestational sac number, if appropriate)
- Cardiac activity
- Uterine pathology
- Second opinion referral (disagreement only if FP does not refer and RS considers referral appropriate)
- Caliper placements correct
- All measurement planes correct

**Second and third trimester**

- Fetal number (twins graded only on the basis of fetal number agreement)
- Fetal presentation ( $\geq 34$  weeks)
- Placenta previa (yes or no)
- Cardiac activity
- Stomach and bladder seen ( $\geq 18$  weeks)
- Kidney(s) seen ( $\geq 20$  weeks)
- Abnormal fetal anatomy (disagreement only if FP does not check seen or suspected and RS does)
- Second opinion referral (disagreement only if FP does not refer and RS considers referral appropriate)
- All caliper placements correct
- All measurement planes correct

**TABLE 5. CLINICAL INDICATIONS FOR ULTRASOUND EXAMINATIONS (n + 685\*)**

Indication	Number	Percent
Estimation of gestational age	449	66
Discrepant uterine size and clinical dates	145	21
Vaginal bleeding	51	7
Suspected multiple gestation	35	5
Evaluation of fetal conditions in late registrants	27	4
Determination of fetal presentation	18	3
Other	51	7

Note: The cumulative percent adds up to more than 100% because some patients had multiple indications (14%)

\* Includes patients from 13 study physicians

Ultrasound in Medicine (AIUM) is the parent body to the ARDMS and represents the central, scholarly association for all specialties involved in diagnostic ultrasonography. This three-hour examination was a slightly modified version of the obstetrics-gynecology examination offered by the ARDMS as part of its voluntary certification program in diagnostic medical sonography. Passing was based on the passing level used by the ARDMS at the last regular administration of the examination (October 1985).

**TABLE 6. PRECEPTOR GLOBAL ASSESSMENT OF SECOND- AND THIRD-TRIMESTER STUDIES: PERCENTAGE RATED ACCEPTABLE**

Study Number	Number	Percent Rated Acceptable
<11	77	79
11 to 25	129	84
26 to 50	186	91
>50	86	94
Total	478*	88

\* Includes patients from eight trainees completing the protocol

The examination is an extensively validated test recognized as the current standard leading to registration.

**RESULTS**

Eight of the 13 physicians completed the protocol. (Four physicians at one site were withdrawn because of inadequate accrual of patients, and one physician withdrew because of a job change.) The eight physicians performed a total of 621 precepted ultrasound examinations, of which 23 percent (144) were first-trimester examinations. The physicians averaged 78 examinations each, ranging from 49 to 114 studies completed. They averaged 18 first-trimester examinations, ranging from 7 to 38.

Patients most often underwent ultrasound examination for estimation of gestational age (66 percent), for discrepant uterine size and clinical dates (21 percent), or for vaginal bleeding (7 percent) (Table 5). Fourteen percent of patients had multiple indications.

The preceptors' global assessment of examination acceptability as a function of the number of examinations completed is given in Table 6. Second- and third-trimester studies are tabulated, since these patients are more difficult to scan. Seventy-nine percent of the early studies (first ten studies) were judged acceptable; this rate increased to more than 94 percent after 50 studies. When the multifactor criteria were applied, 15 percent of the earliest (second and third trimester) studies met all criteria; this rate increased to 74 percent after 50 studies (Table 7).

Seven of the eight physicians completing the protocol took the proficiency examination. (One physician, R.G.H., helped design the proficiency examination and therefore did not take the examination.) The written examination scores ranged from 150 to 166, with a mean of 159. The ARDMS passing score for this examination, after adjusting for omitted items, is 143. The average item score on the practical examination ranged from 3.6 to 4.0 with a mean of 3.8; all physicians were rated acceptable on the global assessment. Thus, all of the physicians passed

**TABLE 7. PRECEPTOR EVALUATION OF SECOND- AND THIRD-TRIMESTER STUDIES: PERCENTAGE PASSED BY MULTIFACTOR CRITERIA**

Study Number	Number	Percent Passed By Multifactor Criteria
<11	71	15
11 to 25	101	32
26 to 50	138	63
>50	66	74
Total	376*	47

\* Includes patients from eight trainees completing the protocol

both written and practical components of the proficiency examination.

## DISCUSSION

Existing training options for family physicians in obstetric ultrasound are either difficult for a practicing physician to schedule or are of untested efficacy. Available courses range from seminars of several days' duration to 12-month fellowships.<sup>11</sup> Previous recommendations for training<sup>12,13</sup> have not been evaluated for efficacy and have not incorporated mechanisms for testing physicians' skills at completion of the training.

The training regimen followed in this study addresses the above limitations and validates a realistic training protocol. At the end of the study, the radiologist preceptors rated 94 percent of the ultrasound scans as acceptable. (This figure is comparable to accuracy ratings given to experienced physicians in a study of the ultrasound diagnosis of obstructive jaundice.<sup>14</sup>) All family physicians who completed the study and took the proficiency examination passed both the practical and written portions of the examination, supporting the high ratings given by the radiologist preceptors.

The success of this training program is attributable to the following features:

1. The training regimen can be incorporated into the practicing physician's schedule.
2. The five days of initial course work provide a strong foundation for the later clinical phases.
3. Requiring extensive documentation of each ultrasound examination for the precepting sessions assures that a complete examination and a thorough review by the preceptor are performed for each patient.
4. Using videotape in precepting allows studies to be

precepted in batches, which provides scheduling and time efficiency for the family physician and the radiologist.

5. The number of required examinations is large enough to ensure that adequate proficiency is developed.

6. The formal evaluation component allows the proficiency of the family physicians to be assessed at the end of the training.

While the results of this initial study are very positive, the number of physicians evaluated is small, and this set of physicians may have been particularly highly motivated. Further research is needed to replicate this study and to explore variations to the training program.

One potential drawback in using a family practice population for ultrasound training is that it is difficult to gain sufficient experience with rare pathologic problems. Such problems were addressed through review of teaching slides and video documents and were also tested for in the final ARDMS examination. As technology evolves, however, two-dimensional video simulators may be used to mimic uncommon problems while the trainee examines a three-dimensional model.

Intraobserver variability among radiologists was a concern in this study, since ultrasound practice styles vary widely. Some radiologists are expert in the technical and interpretative aspects of obstetric ultrasound; others rely heavily on the skills of an ultrasound technician and read only static examples of a real-time video document. All reference radiologists were skilled in all areas of ultrasound and had a wide range of clinical experience. Their teaching styles emphasized rigorous evaluation of fetal and maternal physiology by a complete ultrasound examination rather than just identifying anatomic abnormalities, which rarely result in a change in management.

To address these concerns, a small study was conducted to evaluate preceptor interobserver variability. Two of the preceptors (R.D.M. and J.H.) independently critiqued 13 ultrasound scans, based on the audio-videotape documentation. The two preceptors' global assessment agreement was 85 percent (11/13). They agreed (pass or no pass) using the multifactor criteria on 77 percent (10/13) of the cases. A careful case-by-case review of the evaluations showed the two radiologists to be in broad agreement, with the discrepancies being the result of variation in clinical emphasis and differing standards for completeness of an ultrasound scan.

The protocol used for this study is a potential blueprint for the family physician designing his or her own training program in obstetric ultrasound. The physician will need to arrange precepting with a local sonologist and to have available a sufficient number of obstetric patients to gain the required scanning experience and retain skills. In a group practice it may be preferable to designate one family physician to perform all obstetric scans for the practice.

This study can also provide guidance for academic departments of family medicine in designing ultrasound training programs for family physicians. Mechanisms for ongoing review and consultation after the trainees return to their own clinical practices would need to be developed. This might require faculty to develop expertise in these subject areas and to set up a system of audio-video communication with geographically distant trainees. Regional centers for consultation could be established throughout the United States once sufficient faculty have been trained.

Finally, the model described in this paper could be used to develop training and evaluation protocols for other applications of ultrasound in primary care, including the sonographic evaluation of gynecologic, abdominal, and peripheral tissues.

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#### **References**

1. Smith CB: Diagnostic ultrasound. *Am Fam Physician* 1985; 31:22-32
2. Smith CB: Birthweights of fetuses exposed to diagnostic ultrasound. *J Ultrasound Med* 1984; 3:395-396
3. Davies TC, Hahn RG, Rodney WM, Curry HB: The use of ob/gyn ultrasound by family physicians. *Cont Educ Fam Physicians* 1986; 21:335-338
4. Norman LA, Karp LE: Biophysical profile for antepartum fetal assessment. *Am Fam Physician* 1986; 34:83-89
5. Smith GN, Fry KA, Johnson TRB: Assessing gestational age. *Am Fam Physician* 1986; 33:215-220
6. Prislun MD: Assessing the fetal-placental unit. *West J Med* 1986; 145:679
7. Institute of Medicine: A Manpower Policy of Primary Health Care. Washington, DC, National Academy of Sciences, May 1978
8. New data in on ultrasonography use in ob/gyn offices. *ACOG Newslett*, June 5, 1983, pp 1-2
9. Consensus Development Conference: The use of diagnostic ultrasound imaging during pregnancy. *JAMA* 1984; 252:669-672
10. Early LA: Update on the American Registry of Diagnostic Medicine Sonographers. *Med Ultrasound* 1984; 8:81-85
11. Katerndahl DA: The primary care physician as ultrasonographer. *Postgrad Med* 1982; 5:191-196
12. Joint Task Group on Training for Diagnosis in Obstetrical and Gynecological Ultrasound, American Institute of Ultrasound in Medicine: Guidelines for minimum post-residency training in obstetrical and gynecological ultrasound. *J Ultrasound Med* 1982; 1:R40
13. Bartrum RJ: Instruction in abdominal and obstetrical ultrasound. *AJR* 1979; 133:765-766
14. Taylor KJW, Rosenfield AT, de Graaff CS, et al: Factors affecting the recognition of the dilated biliary tree in the jaundiced patient. In White DN (ed): *Ultrasound in Medicine*. New York, Plenum Press, 1978, pp 125-133