Family Practice Obstetric Ultrasound in an Urban Community Health Center

Birth Outcomes and Examination Accuracy of the Initial 227 Cases

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The initial 227 consecutive prenatal ultrasound examinations by two family physicians in an urban community health center were compared with actual birth outcomes. Of 186 examinations for which follow-up information was available, 162 infants were represented. The sampling rate was 81%. No serious anomalies were noted by ultrasound. One placenta previa, one fetal death, and two unsuspected cases of twins were detected by ultrasound.

These data represent one of the first detailed reports of outcomes reflecting family physicians' psychomotor and cognitive skill in the use of obstetric ultrasound. The high accuracy (92% to 96%) of correct ultrasound dating suggests that a short postgraduate continuing medical education course was effective for these two family physicians. The accuracy rate compares favorably to more rigorous training. This structured format utilizing the average of four direct measurements for ultrasound-estimated gestational age and three anatomy ratios for assessing proper imaging relationships or growth symmetry may be useful as other family physicians develop educational methods and quality-assurance protocols in this area. **J Fam Pract 1990; 30:163-168.**

Availability of obstetric ultrasound imaging in the office may be of benefit in risk management while providing an opportunity for needed role model involvement by family physician-educators.[1–3] Morgan et al[4] described some of the important psychosocial benefits of family physicians utilizing obstetric ultrasound in the office. These benefits included defragmentation of care, improved patient education, opportunities for early family bonding, and others.

Recently, several family physician investigators have related training experiences with the outcomes of prenatal ultrasound by family physicians in the office. Hahn et al[5] studied over 600 ultrasound examinations by family physicians who received 6 days of didactic and hands-on training. This training was supplemented by a series of 50 to 70 examinations that were videotaped, narrated, and then evaluated by a blinded referee. After approximately 12 to 25 examinations, 84% of these ultrasound studies were rated as acceptable by the referee. Interobserver agreement among experts has been measured at 85% to 89% when similar comparisons are sought in the diagnostic imaging literature.[6–8] Data therefore suggested that these trained groups of family physicians could reach skills that define an "acceptable standard of care." These investigators noted the need for additional studies.

This paper describes the initial 227 consecutive prenatal ultrasound examinations by two family physicians providing care in an urban health center. This study grew from the observation that many patients for whom prenatal ultrasound was requested did not receive these examinations. These patients had been referred for the ultrasound studies to the University Medical Center, where they

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would ultimately give birth. Although some had described such patient behavior as failing to keep appointments as "noncompliant," many could not receive the services because of a combination of psychosocial issues, including language barriers, financial barriers, transportation barriers, and other issues known to fragment the care of the poor and non-English-speaking patients.[9] As a result, an ultrasound examination performed by family physicians on site was made available. The physicians were supported by a departmental allotment of additional clinical research and attending time for this activity.

A priori assumptions included the following: Complete ultrasound examination data and birth outcome data could be obtained so that a complete follow-up analysis could be performed on at least 65% of the sample. In these follow-up data, family physician ultrasound diagnoses would be correct at a rate equal to or greater than the 84% to 94% acceptability rate described in previous studies. Agreement could be reached regarding the clinically significant diagnostic outcomes of this ultrasound service, as follows: (1) redating the estimated gestational age (EGA) when appropriate, (2) detecting multiple gestation, (3) detecting a nonviable fetus or lack of intrauterine pregnancy, (4) detecting placenta previa, (5) detecting major fetal anomalies, (6) detecting asymmetrical intrauterine growth retardation, and (7) referring for consultation when appropriate. Anatomy ratios (ie, biparietal diameter/occipitofrontal diameter, femur length/biparietal diameter, and head circumference/abdominal circumference) would be appropriate in at least 94% of cases.

Furthermore, it was assumed the quality of examination of the two family physician sonographers would be similar. This study examined these assumptions.

METHODS

All cases were collected at a southern California urban health center that has approximately 32,000 ambulatory patient visits per year. Approximately 10,000 of these visits are prenatal visits by 1100 pregnant patients who are primarily Hispanic. Continuity, although encouraged, is not always possible. Nevertheless, records are kept in a thorough and accurate fashion by faculty and family practice residents. This paper describes data collected in a prospective fashion regarding the first 227 ultrasound examinations by two family physicians.

The patient selection and data collection method was previously described in a national multisite study.[5] Patient selection was based on consensus standards for prenatal ultrasound examination from the National Institutes of Health Conference. Demographic and examination outcome data fields were preprinted on a sheet that was filled out by the physician sonographer at the time of the examination.

TABLE 1. FAMILY PRACTICE ULTRASOUND EXAMINATION DATA

Presentation, fetal number
Fetal anatomy scan for anomalies
Biparietal diameter (BPD)
Occipitofrontal diameter (OFD)
Head circumference (HC)
Abdominal circumference (AC)
Femur length (FL)
Validity ratios (BPD/OFD, FL/BPD, HC/AC)
Estimated gestational age based on ultrasound examination
Estimated gestational age based on last menstrual period
Presence of uterine mass
Presence of adnexal mass
Amniotic fluid volume
When the examination was a first-trimester examination, the crown-rump length was noted in place of the other measurements
Was consultation requested?
Others

This protocol for prenatal ultrasound examination was discussed and agreed upon by clinic providers and staff. A blinded assignment of patients to the two physicians was made on the basis of appointment availability and patient convenience. Neither family physician sonographer had primary care responsibilities for the patients examined.

All cases were sequentially registered in a log book. A uniform, preprinted, one-page description of ultrasound findings was completed for each examination (Table 1). An original copy was placed in the medical record, and another copy was kept by each investigator. Additional indirect data were obtained by calculating ratios for (1) biparietal diameter/occipitofrontal diameter, (2) femur length/biparietal diameter, and (3) head circumference/abdominal circumference.[10–12] Estimated gestational age by ultrasound was derived from correlational standards for biparietal diameter, head circumference, femur length, and abdominal circumference. Estimated gestational age using last menstrual period was measured to the nearest week using a calendar wheel. When the estimated gestational age by ultrasound and by last menstrual period differed by 4 weeks or more, the estimated delivery date was redated using the ultrasound-determined gestational age as the accurate measure.

Approximately 12 months after the study was initiated, a systematic investigation of follow-up outcomes was conducted. Dependent variables included date of delivery, delivery mode, fetal number, fetal presentation, perinatal complications, and fetal anomalies. The delivery date was compared with the predicted delivery date, and all cases in which patients gave birth more than 2 weeks from the predicted time were noted. An additional analysis utilized a sliding confidence interval of plus or minus 1 week for

first-trimester examinations, plus or minus 2 weeks for second-trimester examinations, and plus or minus 3 weeks for third-trimester examinations. Delivery and infant data were collected by review of hospital medical records of the mother and infant when available. If questions were not answered satisfactorily by this approach, patients were contacted by telephone, by letter, through the primary care provider, or by health center chart review.

All data were assembled and entered on computer using dBase III+. Statistical analysis was performed using Abstat[13] software, which allowed calculation of means and standard deviations for continuous variables. Fisher's exact test or chi-square analysis was used for comparison of categorical variables. Student's *t* test was used for continuous variables. Using a variant of the Bonferroni correction for the analysis of multiple variables, significance was set at $P = .005$. The data were also examined for significance at $P = .05$.

RESULTS

Medical records for the first 227 consecutive cases entered in the family health center obstetric ultrasound log were sought. Of 227 examinations analyzed, there were 124 third-trimester examinations, 75 second-trimester examinations, and 28 first-trimester examinations. Demographic and independent variables are described in Table 2. Four cases represented two pairs of twins and 18 mothers underwent a second ultrasound examination. Therefore, 227 cases represent 207 women. No mother received more than two ultrasound examinations. Six women did not have a viable pregnancy. Forty-one examinations were performed on mothers who transferred care or could not be located for delivery confirmation. Delivery data were obtained for 162 infants (81% of the total population). There was no statistically significant difference between the follow-up group and the group that was lost to follow-up. No serious anomalies were noted by ultrasound, although one case of tracheoesophageal fistula was noted at delivery. At delivery, one infant had webbed second and third toes bilaterally. One additional infant was noted to have bilateral hydroceles. Two unsuspected cases of twins and an early fetal death were detected by ultrasound. One case of placenta previa was accurately detected.

The sonographers accurately found no viable pregnancy in five of six first-trimester examinations. Findings on one examination were ambiguous, and a requested consultation confirmed no viable fetus. All 18 remaining patients having first-trimester examinations were dated correctly, and four were lost to follow-up. Of 75 patients undergoing second-trimester examinations, 17 were lost to follow-up. Using a plus or minus 2-week confidence interval for delivery date comparison, redating was performed correctly in 32 of 33 cases. Six consultations were requested among the patients having second-trimester examinations. In four of 58 cases (7%), the infant was delivered more than 2 weeks from the predicted estimated date of confinement.

TABLE 2. DEMOGRAPHIC CHARACTERISTICS OF PATIENTS EXAMINED

	Total Number	Percent
Average age of mother (years)	25.2 ± 6.0	
Ethnic origin		
Hispanic	206	91
White	15	7
Black	2	1
Asian	3	1
Other (include unknown)	1	—
Primipara	69	30
More than gravida 3	61	27
Estimated gestational age at the time of examination		
0–13 weeks	28	12
14–27 weeks	75	33
27+ weeks	124	55
Indications for examination		
Size-dates discrepancy	125	55
Unknown dates	41	18
Vaginal bleeding	20	9
Confirm viable intrauterine pregnancy	13	6
Suspected malpresentation	10	4
Suspected twins	6	3
Other	12	5

NOTE: Although 18 maternal-infant pairs received an additional examination (ie, a repeat ultrasound examination), each examination was tabulated as an independent event. Members of twin-pairs were tabulated as independent events.

Of 124 patients having third-trimester examinations, 20 were lost to follow-up. Of 104 confirmed deliveries, 34 of 40 were redated correctly using the 2-week confidence interval. Six consultations were requested among patients having third-trimester examinations, and in 11 cases infants were delivered more than 2 weeks from the predicted estimated date of confinement (11%). In only three third-trimester cases were infants delivered more than 3 weeks from the predicted delivery date (3%).

Confirmatory Dubowitz scores and delivery outcomes were obtained from hospital records for 140 cases. For 46 additional cases delivery data were obtained from the clinic medical record or telephone follow-up with the family. These 186 cases represent 162 infants, 18 repeat-examination infants, and 6 nonviable pregnancies. There was no significant difference in the group for whom Dubowitz evaluation data were available when compared with the group for whom the data were not available.

TABLE 3. PATIENT AND ULTRASOUND DATA AND OUTCOME: A COMPARISON OF PHYSICIAN A WITH PHYSICIAN B

	A No. (%)	B No. (%)
	118 (52)*	109 (48%)
Ethnic origin of mother		
Hispanic	109 (92)	97 (89)
White	6 (5)	9 (8)
Other	3 (3)	3 (3)
Redating frequency	51 (43)	25 (23)†
Examinations by trimester		
First trimester	16 (14)	12 (11)
Second trimester	38 (32)	37 (34)
Third trimester	64 (54)	60 (55)
Number of cases with follow-up data	94 (80)	92 (84)
Delivery dates more than 2 weeks from predicted	7 (8)	8 (9)
Delivery dates more than 3 weeks from predicted	1 (1)	2 (2)
Delivery dates off from predicted using sliding scale‡	4 (4)	3 (3)*

Raw numbers are displayed with percentages of total in parentheses.
†Redating frequency of physician A vs physician B by chi-square, P = .0036.
‡Sliding scale adjusts to ±1 week for first trimester, ±2 weeks for second trimester, and ±3 weeks for third trimester.

Thus, the overall consultation request rate was 16 of 227, or 7%. With a Dubowitz correction for preterm labors, 15 normal infants were delivered more than 2 weeks from the predicted estimated date of confinement (15/186, 8%). When standards were stratified by time of examination, however (mothers having a first-trimester ultrasound examination and who gave birth more than 1 week from the predicted due date, mothers having a second-trimester examination and, who gave birth more than 2 weeks from the predicted due date, and mothers having a third-trimester examination and who gave birth more than 3 weeks from the predicted due date), only seven infants exceeded the boundaries of these predictions (7/186 = 4%). Accuracy of dating using these stratified confidence intervals was accordingly 179/186 or 96%.

A comparison of characteristics of patients examined by the two physician sonographers (physician A and physician B) is shown in Table 3. Except for the redating frequency, the comparison yields no significant differences among the various characteristics. Indications for examination (Table 2) were similar for both physician sonographers.

The cephalic index and the femur length/biparietal diameter index were compared with widely accepted 95% confidence intervals.[10–12] In addition, the head circumference/abdominal circumference ratio was measured in all cases. When both indices were considered simultaneously, 80% of cases in which there was a third-trimester ultrasound examination were within accepted confidence

TABLE 4. BIPARIETAL DIAMETER (BPD)/OCCIPITOFRONTAL DIAMETER (OFD) AND FEMUR LENGTH (FL)/BIPARIETAL DIAMETER (BPD) RATIOS WITHIN BOUNDS: THIRD TRIMESTER CASES

Comparison by Sonographer	Number	Both Ranges Met
Physician A	64	49 (77%)
Physician B	60	50 (83%)

NOTE: Analysis used the standardized criteria of Hadlock[11] and Hohler and Quetel[12]:

Normal Range
(Mean ±2 SD)
BPD/OFD 70–87 (78.3 ± 8.8)
FL/BPD 71–87 (79 ± 8)

intervals (Tables 4 and 5). Outliers were examined for abnormality as noted in the hospital delivery record, and no correlations were found. Complications and anomalies were noted among the 162 infants for whom delivery data were available. This process did not reveal any diagnoses missed by sonography. There was no perinatal mortality.

DISCUSSION

Two large studies with compelling data for the potential improvement of maternal-child health by using prenatal ultrasound have been published. Kramer et al[14] pointed out that only 12% of pregnancies that had been labeled as "postterm" by last menstrual period were truly postterm by ultrasound dating and delivery evaluation of the infant. A randomized, controlled study discovered a 33% reduction in pregnancy inductions among those mothers who had received ultrasound dating.[15] Skills in obstetric ultrasound are likely to become increasingly important as part of the training curriculum for those who deliver babies.

TABLE 5. ANATOMY RATIOS WITHIN RANGE: SECOND TRIMESTER EXAMINATIONS

Sonographers	Number of Cases	Biparietal Diameter (BPD)/ Occipitofrontal Diameter (OFD) No. (%)	Femur Length (FL)/ Biparietal Diameter (BPD) No. (%)
Physician A	36	36 (100)	24 (67)
Physician B	37	37 (100)	24 (65)
Total cases	73	73 (100)	48 (66)

NOTE: Study measurements were compared with published ranges from large series (mean ±2 standard deviations).
BPD/OFD range = 70–87
FL/BPD range = 71–87

Ultrasound assessment skills may provide some liability protection by reducing inappropriate inductions and enhancing diagnostic power.

When diagnostic services are provided by physicians who acquire these skills after residency, monitoring of outcomes is desirable. This study differs from the previous study by Hahn et al in several important ways. First, the training for these examiners was shorter than the protocol described by Hahn et al. Both examiners had completed between 15 and 25 supervised hands-on examinations at a 3-day continuing medical education course. Both were board-certified family physicians with an average experience of 9 years in providing obstetric services within a residency training program practice. Photodocumentation of caliper placement was obtained on each case, but videotapes were not evaluated by a referee, as was done in the Hahn et al study. This study sought to monitor outcomes by following up on delivery information and by rigorously documenting well-established validity measurements.

These data represent some of the first detailed reports reflecting family physicians' psychomotor and cognitive skill in the use of obstetric ultrasound. The high accuracy in estimating delivery date (92% to 96%) suggests that 3 days of training was effective for these two family physicians, and this accuracy rate compares favorably to physicians who have received more training. The structured format utilizing the average of four direct measurements for estimated gestational age by ultrasound and three internal validity ratios for assessing the proper anatomical relationships may be useful as other family physician-educators develop educational methods and quality-assurance protocols in this area.

Selection bias is a definite issue, and the results may not be generalizable to all settings. The population studied had special ethnic and psychosocial characteristics that have been reported. Reporting bias was examined by noting interobserver audit agreement of 99% on the same cases. Data entry reliability was monitored and found to have an error rate of less than 1%.

Nonresponse (lost to follow-up) bias was not apparent or detectable. Those patients for whom more complete medical records were available did not differ statistically from those in whom Dubowitz data could be obtained. A statistically significant difference was noted in the frequency with which physician A redated cases as compared with physician B (Table 3). This observation highlights the individual variation that can accompany complicated diagnostic tasks. Grauer et al[16] have noted 20% to 30% individual variations when electrocardiograms are interpreted by experts in the field. Nevertheless, this awareness allows the involved physicians to recognize that a discussion of this variance would be in order.

The interphysician redating difference may reflect a statistical artifact or it may reflect the opportunity for these two physician-educators to develop a consistent and accurate approach to teaching ultrasound examination to family practice residents. The major contribution of this article may be in describing this aspect of objectively striving to improve the training message that is sent in an educational environment. Training is not well described in the literature of obstetrics, radiology, or family practice.

During an early phase of the study, some residents requested immediate privileges with the ultrasound equipment. They claimed a substantial ultrasound experience during their labor and delivery rotation. None of these physicians could demonstrate rudimentary knowledge of most of the items required in the protocol report. The use of equipment was restricted to the two trained investigators. The large percentage of requests for third-trimester examinations may reflect a combination of physician education and patient population issues.

An indirect benefit of the study was a candid assessment of basic knowledge and development of appropriate educational prescriptions. The use of the ultrasound examination by family physician sonographers allowed educational feedback. This feedback is usually lost when patients are referred to out of practice facilities. A "see-one, do-one, teach-one" approach is seductively misleading for this diagnostic skill, and physician educators should be wary of unmonitored examinations.

Radiologists, obstetricians, family physicians, and nurses frequently do not share common insights into the life of the patient. The family physician's ability to measure and understand the effect of fragmentation on the psychosocial aspects of health care delivery requires further work.[17,18] A randomized study whereby patients were allocated to two separate ultrasound services with equally adequate technical quality could and should be a future direction for this type of research.

Repeat scans could have created a bias leading to a falsely elevated accuracy rate. Only a few mothers received a second scan, and examiners performed second examinations independent of previous examinations. A falsely elevated accuracy rate resulting from repeat scan bias is unlikely.

This study may be biased by the relatively small number of cases when measured against the low prevalence rate of fetal abnormalities (type II error). These data, however, add one more layer of reassurance to the few published studies by family physicians. Although indices of risk were not formally described, the women served by urban health care centers are acknowledged to be generally at a higher risk. Furthermore, financial barriers and language barriers complicate their care. This study, therefore, was initiated as a prototype that, if successful, would lead to the initiation of a more refined, longer term study

to examine a larger number of cases. Selection occurs in this setting, with recognized high-risk patients frequently being referred to specialist care. All study patients initially were felt to be low risk, and they were all under the care of a family physician.

Despite the handicaps of discontinuity and poverty, patients in this study appeared to receive accurate dating as a result of the ultrasound service initiated at this urban health center. This study represents one of the first detailed reports of outcomes describing family physicians' psychomotor and cognitive skill in the use of obstetric ultrasound. The high accuracy suggests that short-course continuing medical education was effective for these two family physicians, and this accuracy rate for dating compares favorably with more rigorous training. The structured format utilizing the average of four direct measurements for estimated gestational age by ultrasound and three internal validity ratios for assessing proper anatomical relationships or fetal growth symmetry may be useful as other family physician-educators develop educational methods and quality assurance protocols in this area.

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