

# Cost-Effectiveness Of Office Obstetrical Ultrasound In Family Practice: Preliminary Considerations

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**Abstract:** This study reports costs incurred over a nine-and-one-half-month period following the introduction of obstetrical ultrasound into a group family practice serving primarily prepaid health plan patients. During this introductory period, 248 examinations were performed by family physicians and refereed by a radiologist for accuracy. The estimated cost to the practice was \$95 per examination. This figure includes physician training expenses, profes-

sional fees, personnel, equipment and maintenance costs, costs for exams repeated due to technical error, and costs for additional consultation by a radiologist. Previously, all exams were referred to other consultants, and the charge was \$185 per exam. Thus, in-office ultrasound exams performed by family physicians can provide cost savings while maintaining high standards of obstetric care. (JABFP 1988; 1: 33-8.)

The use of diagnostic ultrasound by family physicians is increasing, and it can be expected to accelerate.<sup>1,2</sup> Obstetric ultrasound imaging allows earlier diagnosis and treatment of potentially dangerous medical conditions.<sup>3,4</sup> In addition to considering the quality of care provided, family physicians contemplating the use of diagnostic ultrasound must also consider the cost. Hohler conducted a survey of obstetrics and gynecology practices and concluded that in-office ultrasound is economically feasible.<sup>5</sup> We could find no similar data regarding cost considerations of office ultrasound in family practice. This study provides an initial examination of the economic aspects of introducing obstetric ultrasound into a group practice with a prepaid, health plan. The economic analysis presented may be useful for all physicians providing obstetrical care.

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## Methods

From March 15, 1985, through December 31, 1985, 248 in-office ultrasound examinations were performed on obstetric patients in San Francisco who participated in a family-practice-based, prepaid health plan. Three family physicians in the practice performed all of the examinations. The examinations were given as part of the clinical practice/preceptorship phase of a four-site national study designed to test a protocol for training family physicians in obstetric ultrasound.<sup>6</sup> Before beginning the preceptorship, each family physician completed five days of lecture and hands-on coursework in obstetric ultrasound and three half-days of apprenticeship in an ultrasound laboratory. Table 1 provides an outline of the complete educational protocol used in this study.

Twelve indications were used to select patients for ultrasound examination (see Appendix). These 12 indications were chosen from the 27 obstetric indications given by the National Institutes of Health Consensus Conference on "The Use of Diagnostic Ultrasound Imaging During Pregnancy" as an appropriate subset for family practice.<sup>7</sup> The family physicians produced a summary videotape of each ultrasound examination and recorded the examination results in a standardized, written format. A board-certified radiologist subsequently reviewed and critiqued the videotape and written record with the family phy-

**Table 1. Educational Protocol.**

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Initial introduction to obstetric ultrasound
Introduction to theory and practice—16 hours
on-site training (lecture and hands-on teaching)
Formal CME course in obstetric ultrasound—three-day off-site course
Obstetric ultrasound laboratory training—three half-days in a local radiology/ultrasound department
Obstetric ultrasound clinical practice/preceptorship
Ultrasound studies performed and videotaped in the family physician's office
Regular review and critique of videotapes with local consultant radiologist
Minimum completion of 70 studies by each physician with at least 10 first trimester and 20 second trimester studies
Evaluation
Comprehensive proficiency examination testing ultrasound technical and interpretation skills administered at completion of training protocol

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sician. All ultrasound studies were performed on an ADR 4000 sector/linear ultrasound unit (Advanced Technology Laboratories, Inc., Bothell, Washington).

## Results

Twenty-nine percent of the examinations were performed on patients during the first trimester. Ninety-eight percent of the examinations were performed on prepaid health plan patients. Table 2 summarizes the primary medical indications corresponding to the examinations. Seventy-four percent of the examinations were for uncertain gestational age, and 12 percent were due to clinical discrepancies with dates. Eight percent of the patients were examined due to vaginal bleeding of uncertain etiology.

Two hundred and fourteen studies (86 percent) were judged acceptable on videotape review by the radiologist preceptor. It was necessary to repeat 26 studies (10 percent) to correct technical errors such as poorly filled maternal bladder, incomplete videotape survey, or accidental videotape erasure. After repeat examination by the family physicians, all 26 studies were reviewed and judged acceptable. In total, 240 examinations (97 percent) were judged acceptable.

Eight examinations (three percent) were judged by the radiologist preceptor to be unacceptable due to incorrect diagnoses. These patients were immediately referred to a tertiary care ultrasound

laboratory. Twenty-one (8.5 percent) of the acceptable studies were referred to a tertiary care ultrasound laboratory for a second examination to confirm the diagnosis (Table 3).

Table 4 gives the cost breakdown of the ultrasound examinations performed by the family physicians. The equipment purchase cost was based on the nine-and-one-half-month proportion of the five-year depreciation of the \$23,000 purchase price. This is a conservative estimate since no tax deduction savings were included in this computation. Equipment maintenance was based on an estimated yearly maintenance cost of \$600. Including all expenses, the total cost of the examinations was \$23,510 or \$95 per examination. The precepting component (radiologist's fee) of this cost was \$5,700. The cost per examination excluding this training-related component was \$72 per examination.

Previously, ultrasound examinations were performed at a hospital-based laboratory at a cost of \$185 per study. If the 248 examinations had been performed exclusively at that laboratory, costs would have totaled \$45,880. The difference is \$22,370, or \$90 per study, which is a reduction in cost of 49 percent.

## Discussion

The calculated cost reduction of nearly 50 percent per ultrasound examination was larger than

**Table 2. Primary Medical Indications for Ultrasound Studies.**

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Indications	Number	Percent
Uncertain gestational age	182	73.4
Vaginal bleeding, unknown etiology	19	7.7
Discrepant uterine size with clinical dates	18	7.3
Suspected multiple gestation	11	4.4
Suspected ectopic pregnancy	6	2.4
Late registrants for prenatal care	5	2.0
Suspected polyhydramnios or oligohydramnios	3	1.2
Uncertain fetal presentation late in pregnancy	2	0.8
Failure to detect fetal heart tone with Doppler	1	0.4
Premature rupture of membranes	1	0.4
Total	248	100.0

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**Table 3.** *Studies Referred to Confirm Diagnosis.*

Diagnosis	Number
Possible ectopic pregnancy	10
Twin gestation	5
Possible intrauterine growth retardation	5
Fetal demise	1
Total	21

expected, particularly considering the ongoing training costs over the study period. Reductions in costs on such a scale through the transference of this technology into the primary care setting would allow prepaid health plans to broaden the scope of their benefit packages to their subscribers. In a fee-for-service setting, this reduction could provide direct cost savings to the patient or the patient's insurance plan.

With the completion of preceptorship training, costs will be further reduced as the supervisory role of the radiologist is converted into that of a consultant. Also, the rate of referral to a second laboratory should decrease as greater proficiency and confidence are attained by the family physicians. Professional liability insurance premiums have not increased as a result of performing ultrasound studies.

Additional costs due to increased utilization of readily available on-site ultrasound may be offset by decreased costs due to the earlier diagnosis of serious medical conditions. There may have been an increase in ultrasound utilization, although past data were not available to permit compari-

son. Investigation of the possible cost benefits due to earlier diagnosis would require an elaborate study design beyond the scope of this study, although we comment on our impressions below.

Our clinical experience confirms that the quality of care is improved by having such an accessible means of diagnosis. Ultrasound proved to be essential in distinguishing between the differential diagnoses associated with abdominal pain and vaginal bleeding (such as acute salpingitis, ectopic pregnancy, incomplete spontaneous abortion, and ruptured physiologic ovarian cyst). In one case, we were able to make an early office diagnosis of a ruptured or oozing ovarian cyst with minimal hemorrhage and avoided costly hospitalization. We managed the patient conservatively with serial physical examinations and ultrasound monitoring.

With early diagnosis, we were able to manage more efficiently cases of anencephaly, coexisting uterine pregnancy with an intrauterine contraceptive device, a nonruptured ectopic pregnancy, and a blighted ovum. As our diagnostic capabilities improved, we were better able to choose appropriate treatment modalities, thus often preventing or decreasing the need for patients to be hospitalized.

## Conclusion

Family physicians can achieve significant cost savings by using diagnostic ultrasound in the office practice of obstetrics. Our assumption, based on preliminary evidence from a four-site national study, is that family physicians can be trained to

**Table 4.** *Ultrasound Cost Comparison: In-Office versus Outside Referral.*

Costs of examinations performed by family physicians	
Family physician fees (@ \$35 per hour × 124 hours =	\$4,340
Support staff/facility costs (@ \$25 per hour × 124 hours =	3,100
Videocassette tapes (@ \$6 per tape × 18 tapes =	108
Radiologist preceptor fees (@ \$600 per month =	5,700
Costs of second opinion exams: 29 exams × \$185 per exam =	5,365
Costs of repeat in-office exams: 26 exams	
Fam. phys. fees (@ \$35 per hour × 13 hours =	455
Sup. staff/facil. costs (@ \$25 per hour × 13 hours =	325
Equipment purchase and maintenance	4,117
Total	\$23,510
Costs of examinations if performed at referral laboratory	
248 exams × \$185 per exam =	\$45,880
Savings	
\$45,880 - \$23,510 = \$22,370 = \$90 per study	

perform ultrasound examinations with consistent accuracy.<sup>6</sup> Side benefits of on-site ultrasound are more rapid diagnosis and treatment and improved convenience for the patient. Faster diagnosis leading to more timely treatment and intervention in clinically difficult situations is likely to realize further medical care cost savings. Longer term studies with larger numbers of patients will be needed to support these preliminary conclusions.

## References

1. Davies TC, Hahn RG, Rodney WM, Curry HB. The use of ob/gyn ultrasound by family physicians. *Cont Ed Fam Physician* 1986; 21:335-8.
2. Acton CM, Oats JN. Should an ultrasound scan be a routine in the obstetric patient? *Australas Radiol* 1984; 28:257-61.
3. Quinlan RW, Cruz AC, Martin M. Hydramnios: ultrasound diagnosis and its impact on perinatal management and pregnancy outcome. *Am J Obstet Gynecol* 1983; 145:306-11.
4. Neumann CH, Carroll BA. Fetal biometry and intrauterine growth retardation. *Current concepts*. *West J Med* 1984; 140:414-20.
5. Hohler CW. Private practice use of real-time B scan ultrasound in obstetrics and gynecology. *J Clin Ultrasound* 1978; 6:241-3.
6. Roi LD, Reinhardt R, Garr D, et al. Training family physicians in obstetrical ultrasound: early results from a multi-site study. Presented at the North American Primary Care Research Group Annual Meeting, April 13-16, 1986, Baltimore, Maryland.
7. Consensus Conference. The use of diagnostic ultrasound imaging during pregnancy. *JAMA* 1984; 252:669-72.

## Appendix

### *Obstetric Indications for Ultrasonography*

1. Estimation of gestational age for patients with uncertain clinical dates, or verification of dates for patients who are to undergo scheduled elective repeated cesarean delivery, indicated induction of labor, or other elective termination of pregnancy.
2. Vaginal bleeding of undetermined etiology during pregnancy.
3. Determination of fetal presentation when the presenting part cannot be adequately determined in labor or the fetal presentation is variable in late pregnancy.
4. Suspected multiple gestation based on detection of more than one fetal heartbeat pattern, or fundal height larger than expected for dates, and/or prior use of fertility drugs.
5. Significant discrepancy of uterine size compared with clinical dates.

6. Pelvic mass detected clinically.
7. Suspected hydatidiform mole on the bases of clinical signs of hypertension, proteinuria, and/or the presence of ovarian cysts felt on pelvic examination, or failure to detect fetal heart tones with Doppler ultrasound device after 12 weeks' gestation.
8. Suspected ectopic pregnancy or pregnancy occurring after tuboplasty or prior ectopic gestation.
9. Suspected fetal death.
10. Suspected polyhydramnios or oligohydramnios.
11. Estimation of fetal weight and/or presentation in premature rupture of membranes and/or premature labor.
12. Evaluation of fetal condition in late registrants for prenatal care.

## Editorial Comment

"Cost Effectiveness of Office Obstetrical Ultrasound in Family Practice" has been reviewed by three reviewers who feel this is an important and timely topic and that the proposal is an interesting one. However, the analysis is felt to contain some flaws. The reviewers note that a number of radiology practices are now utilizing quite sophisticated equipment for ultrasound examination, and the cost of these systems is significantly more than the ADR system described. This article seems to be based on the assumption that there are such things as level one and level two examinations. The American Institute of Ultrasound and Medicine has recently gotten away from such designations. The problem appears to lie in the potential medical/legal liability circumstance; the concern is that if one utilizes ultrasound as a diagnostic tool, then one may be liable for any potential diagnostic clues that may be uncovered. Another concern is that most ultrasonographers would not accept a three percent error rate in the diagnosis, for the cost of defending such an incorrect diagnosis could outweigh potential cost benefits from the proposed savings.

In addition, the reviewers feel that the discussion regarding appropriate training and experience prior to the utilization is a problematic one. They agree that the object of the article in regard to reducing the cost for ultrasound is a meritorious one. The question might be raised if one were to accept the other assumptions, why not utilize



lower-paid technicians to do the procedure and reduce the cost even more?

### Authors' Comment

We have carefully reviewed the editorial comments regarding our manuscript entitled "Cost Effectiveness in Office Obstetrical Ultrasound in Family Practice" and offer the following reactions:

1. The ADR ultrasound system is the portable system most widely used today by office-based obstetricians. It is the system used by both the Schlichting course in San Jose, California, and the J. Crane course in St. Louis. It is also the most frequently used system by radiologists in mobile units. Its imaging quality is as good in obstetrical ultrasound as any unit available. While it lacks transducer versatility, Doppler, annular array, automated printout capability, and advanced software capability, these deficiencies do not compromise its essential usefulness or reliability. All the systems used in our training program have audiovisual capability, and trainees are required to document according to an established protocol each and every aspect of their examination. In summary, the ADR 4000 system still remains the most widely used workhorse in obstetrical ultrasound.
2. The assumption that the trainees were performing level one examinations is incorrect. We have tried meticulously to stay away from such a classification. The completeness, advanced technical quality, and rigorous methodology employed by the trainees are comparable to those performed in any radiological ultrasound laboratory. In fact, our mechanism of documentation is far more extensive than that performed by our colleagues at our tertiary care referral center. Our tapes are frequently used as an example of what constitutes a complete document, and they have been shown at various national meetings to demonstrate different pathologic states.
3. The medical/legal issues to which the reviewers allude have been discussed at length in various articles published over the last few years. Each and every patient who is examined is given to understand the nature and reason for the examination. It is the opinion of the authors as well as of our consulting radiologists and obstetricians that the service provided is equal in every way to that provided by obstetricians and radiologists, and we offer another important advantage. As the patient's physician and examiner, we provide a whole new spectrum in the understanding of the physiology of the fetal-maternal axis for both the physician and patient and the bond established between patient and physician during the ongoing pregnancy.
4. We are surprised at the comments regarding a three percent error rate, considering the fact that ultrasonography is such a variable technical skill subject to a great number of interpretations in any given study. Published studies have in the past revealed a much higher rate of inter-observer error. In fact, our own inter-observer statistics, which are in the process of being included for publication in our master study article, are approximating five to seven percent. It is also important to recognize that these errors were primarily due to incomplete studies, and in only two occasions were they due to nonidentification of subtle pathologies. We are acutely aware of the controversy that exists currently among the American College of Obstetrics and Gynecology, the American College of Radiology, the American Institute of Ultrasound and Medicine, and the American Society of Diagnostic Medical Sonographers. Nobody seems to be able to agree on what constitutes proper training and minimum standards of competence. We feel that we have to date given this issue the best effort and think that the competence of our trainees after 18 months of intensive training is no longer in question. In summary, we do not believe that the technical competence of our trainees who have completed the protocol is inferior to that of other specialties doing obstetrical ultrasound, and we do not feel that they are putting themselves at risk of increased medical liability, an issue worthy of another full article.
5. Our training protocol and the results of our training program are in the process of being submitted for publication. It has taken us a total of three years to complete the training, validate the protocol, and analyze the results. We feel that this is the first serious attempt at such a training program and hope that it will serve as a blueprint for further training. The results of this training program were presented at the annual Scientific Assembly of the

American Academy of Family Physicians in September 1986, and the scientific exhibit received the outstanding award after critical evaluation by a number of judges.

6. It is our opinion that the enhanced physiologic and anatomic perspective obtained by ultrasound examination by the attending physician is such that it merits the time and effort invested. We have had technicians working along side us as technical experts in the evaluation of these examinations, and they do provide a significant service. However, we do not

agree that they would be more cost effective, since today they command a fairly high salary and would require a group of physicians to establish an ultrasound capability available on a continuing basis. Obstetrical ultrasound is also a uniquely desirable skill and technique to have available when an urgent problem is confronted by the office-based physician. Major delays experienced when a patient has to be referred elsewhere or a technician has to be called have frequently resulted in adverse consequences for patients.

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