The Use of Ultrasonography to Scan the Abdomen of Patients Presenting for Routine Physical Examinations

Thomas C. Rosenthal, MD; Timothy Siepel, MD; Jennifer Zubler; and Mary Horwitz, MA
Buffalo, New York

Background. Ultrasonography has become an increasingly important diagnostic tool, producing high-quality images at a low cost. However, except in obstetrics, ultrasonography has not been used for screening purposes in asymptomatic persons.

Methods. This prospective study included 189 patients on whom an abdominal ultrasound scan was performed by a family physician as part of a routine physical examination. During the 2-year follow-up period, the screening was evaluated by determining whether the ultrasound findings contributed to the patient's health care management.

Results. Forty-two of the patients (22%) were found to have previously undiagnosed conditions. The most common findings were gallstones, urinary retention, and renal cysts. Six patients (3%) received treatment for the condition detected by the screening, but three of these patients received treatment only after they developed symptoms during the 2-year follow-up period. One patient developed symptoms for gallstones that may have been missed by the screening ultrasound. The internal and external reliability rates for the screening examination were 96% and 82%, respectively.

Conclusions. Ultrasound findings altered the treatment plan for 3% of the screened patients but was the sole factor leading to treatment in only 1.6%. Abdominal ultrasound can be performed accurately and at a reasonable cost by generalist physicians. Patient acceptance was high, and many reported feeling reassured by the ultrasound screening.

Key words. Ultrasonography; ultrasonography, interventional; primary health care; abdomen; physical examination; preventive health services; preventive medicine.
(*J Fam Pract 1994; 38:380-385*)

Family physicians are appropriately cautious about introducing new technology into their practices. They await a demonstration of the technology's effectiveness and applicability to the primary care patient as well as proof that a generalist can develop the skill necessary to assure reliable results. Use of scanning ultrasound is one of the new technologies that is becoming part of the generalist armamentarium. Although studies of obstetrical ultrasound use by family physicians indicate a proficiency equivalent to that acquired by ultrasound technicians, little is known about other uses of ultrasound to evaluate patients in the primary care setting.[1,2] This study evaluated the use of scanning abdominal ultrasound by a family physician as a supplement to the routine physical examination of asymptomatic adults.

The Western New York Rural Research Network consists of 47 family physicians in the six rural counties surrounding Buffalo, New York. When one participating physician introduced ultrasonography into his practice, other Network members suggested a formal evaluation of the impact this modality would have on patient care. The study physician agreed to participate in an in-depth,

Submitted, revised, November 20, 1993.

From the Department of Family Medicine, School of Medicine and Biomedical Sciences, State University of New York at Buffalo. Requests for reprints should be addressed to Thomas C. Rosenthal, MD, Department of Family Medicine, State University of New York at Buffalo, 462 Grider St, Buffalo, NY 14215.

ISSN 0094-3509

open study of outcomes related to his use of abdominal ultrasound in patients presenting for routine physical examinations.

Methods

The study practice is a solo family practice that is located in a rural western New York State community and serves approximately 6000 patients. Because of the relative geographic isolation of this practice, the principal investigator purchased a portable real-time ultrasound unit (Scanmate I, Damen Corporation, Needham Heights, Mass) in March 1989. After completing a seminar in sonography supplemented by supervised in-office application and practice over a 3-month period, the study physician began offering ultrasound diagnostic services, including obstetric ultrasound, to his patients.

The study practice encourages all patients over 50 years of age to have an annual physical examination. All patients older than aged 30 years who are new to the practice are encouraged to undergo an intake history and physical examination. The study population included 189 adults presenting between July 1989 and March 1990 for a routine examination consisting of a medical history, physical examination, bloodwork (complete blood count, chemistry screen, and urinalysis), electrocardiogram, stool test for occult blood, and, for women, a pelvic examination and mammogram. A follow-up letter summarizing the results was mailed to each patient. An ultrasound scan of the abdomen was included in the examination at no extra charge. The abdominal scan screened for gallstones, abdominal aortic aneurysms, uterine enlargement, urinary retention, calcified gallbladder, ascites, liver cysts, kidney cysts, and atrophic kidneys.

Two years later, detailed and updated information was obtained on 169 (89%) patients. A medical student used a structured survey instrument to complete a chart review. A telephone interview of each patient (or family member if the patient had died) was completed on 154 (81%) cases. In addition to the ultrasound findings, data were collected on the rest of the physical examination, the review of systems, and laboratory findings. Results from subsequent ultrasounds performed on study patients by the physician, by outside ultrasound services, and by referral were collected. The findings of the ultrasound screening were evaluated by whether they added significantly to the patient's health care management and whether the review of symptoms, physical examination, and laboratory results alone would have provided information that eventually would have led to the same finding as that of the ultrasound.

Results

Between July 1989 and March 1990, 189 patients were seen for routine physical examinations and underwent a screening abdominal ultrasound examination. No patient refused the sonogram, which was presented as an optional but routine part of the examination. The average age of the study participants was 58 years, with a range of 28 to 88 years. Fifty-three percent of the patients were men, 25% were smokers, and 30% exercised on a regular basis. Seventy-three percent were taking one or more medications and 53% were taking two or more medications at the time of the screening. In 1992, 2-year follow-up data were collected for 169 (89%) of these patients from office charts, by telephone, or both when possible. In addition, 154 (81%) of the patients (or their family members if the patient had died) were contacted by telephone. Twenty patients (11%) had not returned to the office and could not be contacted by phone.

The most common complaints found on the review of symptoms included musculoskeletal (46%), cardiovascular (16%), head, eyes, ears, nose, throat (HEENT) (14%), and mental status symptoms (14%). The most common abnormal findings during the physical examination included HEENT (23%), musculoskeletal (19%), and cardiovascular (14%) abnormalities. Sixty-five percent of patients screened had some type of abnormality discovered on further testing, including electrocardiogram (40%), urinalysis (11%), blood counts (7%), fecal occult blood (2%), and ultrasound (22%).

Of the 189 patients, 42 (22%) had sonographic findings that were unsuspected before the examination. Two of these patients had two findings each when screened, yielding a total of 44 findings, including the following: gallstone, 20 (11% of patients screened); urinary retention, 10 (5%); renal cyst, 4 (2%); atrophic kidney, 2 (1%); abdominal aortic aneurysm, 2 (1%); aortic thickening, 1 (0.5%); enlarged nonpregnant uterus, 1 (0.5%); calcified gallbladder, 1 (0.5%); ascites, 1 (0.5%); liver cyst, 1 (0.5%); and fatty mass near the liver, 1 (0.5%) (Table).

Eleven of the 42 (26%) patients with ultrasound findings had a review of systems response (n = 9) or laboratory result (n = 2) that may have suggested the sonogram results. Those with a positive review of systems suggesting the need for further workup for the condition discovered by ultrasound included five cases of gallstone, three cases of urinary retention, and one case of ascites. One case each of urinary retention and renal cyst had laboratory findings that could have aroused suspicion of the diagnosis resulting from ultrasound screening. None of the ultrasound findings were suggested by the physical examination.

Table. Ultrasound Findings and Impact on Patient Health Status in a Study of 189 Adult Patients Presenting to a Primary Care Office for a Routine Physical Examination

Ultrasound Findings	No. of Findings	No. of Findings Accompanied by Symptoms*	No. of Findings Resulting in Treatment†
Gallstones	20	3	1
Urinary retention	10	2	3
Renal cysts	4	1	0
Atrophic kidneys	2	0	0
Abdominal aortic aneurysm	2	0	2
Aortic thickening	1	0	0
Enlarged nonpregnant uterus	1	1	0
Calcified gallbladder	1	0	0
Ascites	1	0	0
Liver cysts	1	0	0
Fatty mass near the liver	1	0	0
Total	44	7	6

**Symptoms were considered significant if they resulted in any related complaint.*
†Change in health status, care plan, surgery or medication use was considered treatment.

Twenty-eight of the 42 (67%) patients with findings revealed by sonogram were sent for further confirmation or consultation. Some patients declined follow-up studies or consultation, and in some cases, no second opinion was recommended because the finding was considered insignificant. In 23 of the 28 referred cases (82%), the second opinion corroborated the original physician's ultrasound findings. All cases of abdominal aortic aneurysm, urinary retention, and liver cysts were confirmed. Eighty-six percent of gallstones and 67% of renal cysts were confirmed.

When possible, the physician repeated ultrasound scans on patients after the initial physical examination. One hundred twenty-seven (67%) patients underwent at least one follow-up abdominal ultrasound by the study physician. There were five studies that were possibly inconsistent with findings on the previous ultrasound, four of which involved cysts or atrophy not seen on follow-up study. In one other study, a liver cyst was not discerned on follow-up study. Therefore, the internal reliability was 96%.

Two-year patient follow-up was obtained for 39 of the 42 patients who had a positive ultrasound finding (93%). Seven of these patients had became symptomatic, including 1 of 4 patients with renal cysts, 2 of 10 with urinary retention, 3 of 20 with gallstones, and 1 with an enlarged uterus. Three patients with positive ultrasound findings did not have a current health status report in their charts and could not be located by telephone. One of these patients had gallstones and two had urinary retention.

Four of the patients (10%) underwent surgery for the condition discovered by ultrasound. One patient had a cholecystectomy for gallstones after developing symptoms, and three patients underwent transurethral resection of the prostate for urinary retention. Two of the three patients with urinary retention had developed symptoms before surgery. The two patients with abdominal aortic aneurysms did not receive treatment but were monitored for any increase in the size of their aneurysms. Overall, six patients with ultrasound findings (14%) received some sort of medical intervention, but three developed symptoms before initiation of the intervention.

Eighty-six of the patients without ultrasound findings (46%) developed conditions for which they requested medical care within the 2-year study period. Only one condition, a case of gallstones 1 year after the screen, had the potential to be detected by ultrasound but was not recorded by the initial ultrasound.

Three patients died during the follow-up period. All three had abnormal findings on initial ultrasound (gallstones, fatty mass near the liver, and urinary retention) but all died of unrelated causes.

One hundred fifty-four patients of the initial 189 patients screened (81%) were contacted by telephone. None of the patients surveyed considered the screening to be significantly time-consuming, stressful, uncomfortable, or embarrassing. One hundred seven patients (69%) reported that they were satisfied or very satisfied with the procedure. Patient comments suggested a perception that ultrasound screening was a form of preventive medicine and detected problems that would otherwise be hidden. Fifty-six percent of patients reported that sonography gave them a sense of security about their health. Sixty-six percent felt that ultrasound screening should be performed during a routine physical examination.

Discussion

Early detection and prevention of disease is a cornerstone of family practice. For the asymptomatic nonpregnant adult of any age, there is little evidence to support the effectiveness of the traditional complete physical examination. Thus, modalities that promise to increase the physician's ability to evaluate well patients are enticing.[3,4] Only three screening procedures have definitely been established as effective. These include a blood pressure reading every 2 years, an annual breast examination by the physician for women over 40, and a Papanicolaou (Pap) test every 3 years after two normal annual smears in women who are sexually active. Other screening procedures that are probably effective are a periodic weight and vision check, one lifetime skin examination to identify patients at high risk for skin cancer, a periodic hearing check, periodic mammograms, and an annual palpation of the abdomen for abdominal aortic aneurysms in men over age 60.[3]

For screening to be effective, the disease being screened for must have significant effect on quality of life or longevity, or an acceptable method of treatment; an asymptomatic period during which treatment will make a significant difference in the outcome; an early treatment that is better than late treatment; an accurate screening test at a reasonable cost; and an incidence of the condition that justifies the cost of the screening.[5]

In the past 20 years, ultrasonography has emerged as a highly accurate and noninvasive diagnostic tool, but it has had limited use as a routine screening test in asymptomatic persons. This study offers a perspective on the routine use of abdominal ultrasound to screen healthy adults who present to a family physician's office.

Gallstones were the most common ultrasound finding in this series. The incidence of gallstone ranges from 1.7% between the ages of 20 and 29, to 31.3% between the ages of 80 and 89.6 Study patients (average age, 58) had an incidence of 11%. Although the complications of gallstones can be serious (acute and chronic cholangitis, obstructive jaundice, pancreatitis, sepsis, perforation, and gallbladder carcinoma), the majority of gallstones do not cause symptoms.[7,8] Other studies have suggested that only 1% or 2% of patients with asymptomatic gallstones become symptomatic each year; however, a somewhat higher rate of 15% in 2 years was observed in this study.[9] Ultrasound is 96% sensitive and nearly 100% specific in detecting gallstones.[10] One study patient is known to have developed cholelithiasis 1 year after a negative sonogram, but none of the repeat sonograms in other previously negative patients revealed gallstones. Eighty-six percent of the study patients who had subsequent diagnostic sonograms had their diagnosis of gallstones confirmed. The United States Preventive Services Task Force makes no recommendation on screening for asymptomatic gallstones.[4]

Adenocarcinoma of the prostate is the second most common cancer in men in the United States.[11,12] Digital rectal examination detects one half of the prostate cancers found on transrectal ultrasound, but transabdominal ultrasound is unreliable in spite of the cancer's typical hypo-echogenic ultrasonic characteristics.[12–14] Urinary retention is an indirect indication of prostatic hypertrophy and, therefore, of prostate enlargement.[12] Urinary retention was found in 10 patients, 3 of whom were referred and treated. None of these patients was noted to have an enlarged prostate on rectal examination, and only one chose referral before the onset of symptoms. It is unclear whether the patients would suffer adverse outcomes if they waited until symptoms developed. The recommendation of the Preventive Services Task Force to perform an annual digital examination in men over the age of 50, although less than ideally sensitive, is not challenged by this series.[4]

Abdominal ultrasound can also find pelvic abnormalities, such as enlarged uterus, early pregnancy, fibroids, and ovarian carcinoma. Unfortunately, there is no evidence that screening ultrasound detects ovarian carcinoma sooner or improves survival as compared with bimanual examination.[3,15] The one patient found to have an enlarged uterus received treatment only after she became symptomatic.

Thirty percent of people over the age of 50 may have abdominal aortic aneurysms, which, if ruptured, have a 50% mortality rate. Elective repair is associated with only a 1.5% to 3% mortality.[16] Whereas physical examination is 20% specific and 22% sensitive and plain radiographs are 50% sensitive, ultrasound and computed tomography scans are 100% sensitive and 100% specific.[17] The incidence of abdominal aortic aneurysm discovered by screening ultrasound in the general population over 65 is 5.3%.[16] Some experts suggest that all patients over 65 should have an annual abdominal examination and that patients with hypertension or atherosclerotic vessel disease should be considered for periodic ultrasound examination.[16] The study population had an incidence of abdominal aortic aneurysm of 1%, all of which were below the 5-cm threshold for elective surgical repair.[18] Patients in this study who were discovered to have abdominal aortic aneurysms had their health care plan altered to include follow-up ultrasounds, but had no change in health status resulting from this finding.

Ultrasound can also be used to screen for conditions such as aortic stenosis, prolapsed mitral valve, and congenital dislocation of hip.[19] Although there are no official recommendations for screening for ascites, renal lesions, or liver abnormalities, these are accurately found by scanning ultrasound and were frequent findings in the study patients.[4] Again, these findings failed to have an impact on the patient's health status or health care management plan.

Ultrasound findings added to the study patients' health status or health care plan in only a limited number of cases. Although 22% of the 189 screened patients had some abnormality, only six patients received medical intervention on the basis of the ultrasound findings and only three before they became symptomatic. For the two patients with abdominal aortic aneurysms, the finding may prove to be important to survival if the aneurysms progress in size. Abdominal aortic aneurysms produce significant morbidity and mortality, can be effectively treated in the asymptomatic phase, and are common enough in some populations to justify screening.[5] The study patients with abdominal aortic aneurysms would have been identified if screening had been performed only on patients who were over 60 and had cardiovascular disease.

One patient with urinary retention requested referral and treatment (transurethral resection of the prostate) on the basis of the ultrasound findings alone. It is reasonable to assume that given time, the patient would have developed symptoms that would have led to the same treatment. This patient and the two patients with abdominal aortic aneurysms are the only ones to have a change in their health care management on the basis of ultrasound findings alone. Therefore, in the study cohort, only 3 of 189 (1.6%) received treatment based solely on the ultrasound findings. The screening productivity would have increased to 10% if a high-risk pool of patients (men over 60 with cardiovascular disease) had been identified for a focused abdominal aortic aneurysms screen. Only this group would have met the criteria for screening developed by Frame.[5]

Patient acceptance of the ultrasound screen was high (70%), and many felt that it should become a routine part of the physical examination (66%). This high acceptance rate may reflect the ease of undergoing abdominal ultrasound, patient intrigue with technology, the confidence and trust patients place in their family physicians, and the office policy of not charging for the study.

A survey of five public and private hospitals in western New York revealed an average charge of $174 for an abdominal ultrasound screening examination. Based on this estimate, the cost per asymptomatic finding in this series (44 out of 189 patients screened) would have been $747. The six findings that resulted in patients receiving some form of medical treatment would have cost $5481 per discovery. A physician investing in an ultrasound unit to use as described in this study would have spent $35,000 in 1993. If used only for the study series, it would represent an investment of $185 per screen, $795 per positive finding, and $5834 per significant finding, excluding the cost of physician time. Ultrasound equipment is typically replaced every 3 to 4 years as new technology becomes available.

This study has several inherent weaknesses that limit its interpretation. It is a descriptive, noncomparative study taking place in the office of a highly motivated and skilled physician. Inclusion of all patients who made an appointment for a routine physical in the study period only partly overcomes this bias. Because of limited resources, only positive results were sent for confirmation or consultation. A randomized study with confirmation of all findings would produce more definitive results.

Ultrasound should not be limited to any specialty group, and as technology improves, the equipment expense will decrease and imaging quality will improve. Should a family physician decide to introduce ultrasound in the office, structured training, practical experience, systematically retrievable log books, uniform data forms, and periodic quality assurance reviews will contribute to a uniformly high standard.[20]

Family physician competency has been established for obstetrical ultrasounds. After a 3-day course, two family physicians had an accuracy rate of 92% to 96%.[20] After a 6-day course and 12 to 25 examinations in obstetrical ultrasound, family physicians in another study demonstrated accuracy of 84%, which increased to 94% after 50 examinations.[1] In an outcome study of 498 pregnancies in which family physicians performed ultrasound examinations, results compared favorably for expected date of confinement, placenta previa, ectopic pregnancy, multiple gestation, fetal death, and fetal sex.[21] Even in the hands of specially trained sonographers, agreement on obstetrical ultrasounds is only 88%.[22] This compares favorably with other diagnostic studies for which concordance of 85% to 89% is typical.[23–25] The study physician obtained an internal reliability of 96% and an external reliability of 82% on the 22 patients who had findings and were subsequently referred for a second opinion.

With decreasing cost and increasing accuracy, ultrasound may be considered a routine examination in the future. If the generalist physician can acquire skills comparable to those of an ultrasonographer, the question of what role ultrasonography will play in the routine physical examination of the asymptomatic individual will require further study. In select populations, the yield and cost may be acceptable. This series, which is an initial evaluation of the use of abdominal ultrasound by generalist physicians to routinely screen patients, presents issues that require a more extensive prospective study. In the hands of the study physician, ultrasound is accurate, demonstrates asymptomatic disease at a cost similar to that of hospital-based sonography, and may be indicated in patients at risk for abdominal aortic aneurysms. This study alone, however, cannot serve as the basis for a recommendation of ultrasound screening examination in asymptomatic adults.

Acknowledgments

This study was supported by a grant from the New York State Academy of Family Physicians' Research and Education Foundation and the New York State Commission on Rural Resources.

References

1. Hahn RG, Roi LD, Ornstein SM, et al. Obstetric ultrasound training for family physicians: results from a multi-site study. J Fam Pract 1988; 26:553–8.
2. Rodney WM, Prislin MD, Orientale E, McConnell M, Hahn RG. Family practice obstetric ultrasound in urban community health center: birth outcomes and examination accuracy of the initial 227 cases. J Fam Pract 1990; 30:163–8.
3. Oboler SK, LaForce FM. The periodic physical examination in asymptomatic adults. Ann Intern Med 1989; 110:214–26.
4. Fisher M, ed. Guide to clinical preventive services. An assessment on the effectiveness of 169 interventions. Report of the US Preventive Services Task Force. Baltimore: Williams & Wilkins, 1989.
5. Frame PS, Carlson SJ. A critical review of periodic health screening using specific screening criteria. J Fam Pract 1975; Part 1, 2:29–36; Part 2, 2:123–9; Part 3, 2:189–94; Part 4, 2:283–9.
6. Hansbrough J, Eiseman B, eds. Gallstones, prognosis of surgical disease. Philadelphia: WB Saunders, 1980:248–51.
7. Janzon L, Aspelin P, Eriksson S, et al. Ultrasonal graphic screening for gallstone disease in middle aged women: detection rate symptoms and biochemical features. Scand J Gastroenterol 1985; 20: 706–10.
8. Williamson RNC. Progress report: acalculous disease of the gallbladder. Gut 1988; 28:860–72.
9. Braunwald E, Isselbacher KJ, Petersdorf RG, Wilson JD, Martin JB, Fauci AS. Harrison's textbook of medicine. 11th ed. New York: McGraw-Hill, 1987:1360–1.
10. Cooperberg PL, Gibney RG. Imaging of the gallbladder. Radiology 1987; 163:605–13.
11. Thompson IM, Rounder JB, Teague JL, Peek M, Stence CR. Impact of routine screening for adenocarcinoma of the prostate on stage distribution. J Urol 1987; 137:424–6.
12. Resnick MI. Background for screening: epidemiology and cost effectiveness. Prog Clin Biol Res 1988; 269:111–22.
13. Lee F, Littrup PJ, Torp-Pedersen ST, Mettlin C, McHugh TA, Gray JM, et al. Prostate CA: comparison of transrectal ultrasound and digital rectal examination for screening. Radiology 1988; 168:389–94.
14. Lee F, Torp-Pedersen ST, Siders DB. Use of transrectal ultrasound in diagnosis, guided biopsy, staging, and screening of prostate cancer. Urology 1989; 33(suppl):7–11.
15. Campbell S, Bhan V, Royston P, Whitehead MI, Collins WP. Transabdominal ultrasound screening for early ovarian cancer. BMJ 1989; 299:1363–7.
16. Allen PIM, Gourevitch D, McKinley J, Tudway D, Goldman M. Population screening for aortic aneurysms. Lancet 1987; 2:736–7.
17. Quill DS, Colgan MP, Sumner DS. Ultrasound screening for the detection of abdominal aortic aneurysms. Surg Clin North Am 1989; 69:713–20.
18. Ernst CB. Abdominal aortic aneurysm. N Engl J Med 1993; 328:1167–72.
19. Standing Medical Advisory Committee. Special report: screening for the detection of congenital dislocation of the hip. Arch Dis Child 1986; 61:921–6.
20. Rodney WM, Deutchman ME, Hartman KJ, Hahn RG. Obstetric ultrasound by family physicians. J Fam Pract 1992; 34:186–200.
21. Ornstein SM, Smith MA, Peggs J, Garr D, Gonzales J. Obstetric ultrasound by family physicians. Adequacy as assessed by pregnancy outcome. J Fam Pract 1990; 30:403–8.
22. Zador IE, Sokol RJ, Chik L. Interobservance variability: a source of error in obstetrical ultrasound. J Ultrasound Med 1988; 7:255.
23. Dooley CP, Larson AW, Stace NH, et al. Double contrast barium meal and upper gastrointestinal endoscopy: a comparative study. Ann Itern Med 1984; 101:538–45.
24. Rhea JT, Potsasid MS, DeLuca SA. Errors of interpretation as elicited by a quality audit of an emergency radiology facility. Radiology 1974; 132:277–80.
25. Barnes RW, Russell HE, Bone GE, et al. Doppler cerebrovascular examination: improved results with refinement and technique. Stroke 1977; 8:468–74.