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Original Contribution

Screening for abdominal aortic aneurysm in asymptomatic at-risk patients using emergency ultrasound☆

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Abstract

Objective: Abdominal aortic aneurysm (AAA) is a deadly but often clinically silent disease. Patients at increased risk are elderly men with risk factors for vascular disease who may not have adequate screening through primary care. We sought to examine the prevalence and feasibility of screening for AAA in at-risk patients presenting for unrelated complaints using emergency physician–performed bedside ultrasound.

Methods: At-risk patients presenting with unrelated complaints were screened for AAA by emergency physician–performed ultrasound. Scan was rated as complete, limited, or inadequate, and time to complete scan noted. Patients with identified AAA were provided with appropriate follow-up and were followed to look at confirmatory imaging and clinical course.

Results: A total of 179 patients were screened, with 12 AAAs discovered (6.7%; 95% confidence interval, 3.9%-11.4%). Average time to perform the screening ultrasound was 141 ± 135 seconds. Average discrepancy between emergency ultrasound and formal imaging was 3.9 mm. Of 12 (92%) patients, 11 were followed up, with repair recommended in 3 patients.

Conclusion: The emergency department represents a potential opportunity for screening at-risk patients for AAA. Emergency ultrasound is a fast and accurate method for identifying patients with AAA who may benefit from follow-up or intervention.

1. Introduction

Ruptured abdominal aortic aneurysm (AAA) is among the top 20 leading causes of death in the United States, responsible for approximately 15 000 deaths per year [1]. The incidence of AAA is between 3% and 6% in elderly men but increases with risk factors such as hypertension, smoking, and atherosclerotic vascular disease [2,3]. Abdominal aortic aneurysms are likely to be seen more frequently as the population ages. However, AAA is a silent disease that is often not detected on physical examination and typically remains asymptomatic until rupture [4,5]. With early detection, AAA is a treatable disease, but once rupture occurs mortality can exceed 80% [6].

Ultrasound represents an excellent noninvasive screening modality for AAA, with sensitivities as high as 100% [5,7,8].

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The Multicentre Aneurysm Screening Study conducted in Great Britain included 67 800 men older than 65 years who were randomized to screening with ultrasound vs no screening and showed a cost-effective decrease in mortality, leading to endorsement of screening in Great Britain as well as by various groups within the United States [9,10]. The United States Preventative Services Task Force recently recommend screening for AAAs in a defined population; however, these recommendations were tempered by the cost of screening, estimated to be $259 per examination when performed by a radiology department [11,12]. In a small pilot study, Lee et al [12] demonstrated that a "quick screen" evaluation was accurate and completed much more quickly than a conventional study, with improved cost-effectiveness in at-risk populations.

Emergency ultrasound, performed at the bedside by emergency physicians (EPs), is increasingly available in both academic and community emergency departments (EDs) in the United States [13-15]. Bedside EP ultrasound for AAA has been shown to be fast and accurate when performed by physicians with adequate training [15-17]. With over 100 million annual visits to EDs in the United States each year, an ED stay offers a potential window when the patient, adequate equipment, and trained personnel are all in close proximity to allow detection of this potentially fatal disease. In 2000, the Society for Academic Emergency Medicine published recommendations of the Public Health and Education Task Force, concluding that "because many of the most vulnerable patients receive their only medical care through EDs, the ED may be a particularly effective place to offer key preventive services" [18]. Geriatric patients represent one of these vulnerable populations and may have particular barriers to primary care and screening [19].

We sought to examine the feasibility of an ultrasound screening examination for AAA performed by EPs on at-risk elderly patients who presented to the ED with unrelated complaints.

2. Materials and methods

This prospective study was approved by the Institutional Review Board (Human Investigation Committee) at XXXX. All patients provided written, informed consent. This study was conducted in the ED of XXXX, a level I trauma center with an ED residency and an annual census of over 70 000 adult patients. Ultrasound equipment was available for use by trained EPs at all times during the study.

Patients were eligible for enrollment if they were male, older that 60 years, and had at least one other risk factor for AAA (past or present history of smoking, hypertension, prior stroke, peripheral vascular disease, diabetes mellitus, or family history of AAA). Patients were excluded if they presented with a complaint requiring formal imaging for AAA, had previously had a diagnosed or repaired AAA, if they were incapable of informed consent, or if performance of a screening ultrasound would interfere with essential medical therapy. Patients were enrolled on a convenience basis when a trained EP who met study criteria for training was available to perform a screening ultrasound. Examinations were performed by EPs who had completed a 1 month rotation in emergency ultrasound including at least 5 proctored examinations or who had met American College of Emergency Physicians requirements for credentialing in examination of the abdominal aorta [20].

Following informed consent, demographic and historical data were collected, as well as whether AAA was suspected on the basis of physical examination. Ultrasounds were then performed at the bedside using a curvilinear 5 to 7 MHz transducer on a Philips EnVisor Ultrasound Scanner (Philips Medical, Andover, MA) or a B-K Medical Hawk XDI Ultrasound Scanner (B-K Medical, Herlev, Denmark).

The study protocol called for an evaluation of the aorta from the celiac axis to the iliac bifurcation in 2 planes with a measurement of the largest diameter of the visualized aorta. If the aorta was visualized from celiac axis to bifurcation in 2 planes, the examination was labeled complete. If only portions of the aorta could be examined, the scan was labeled as limited. If no portion of the aorta could be visualized, the scan was labeled as inadequate. Doppler was used at the discretion of the EP to assist in identification of the aorta. All studies were recorded for later review as dynamic images in their entirety using high-quality S-VHS videotape or digital video disk and reviewed by the primary investigator for adequacy of examination and appropriateness of the measurement. Time required to complete the study was noted.

Patients with a largest aortic measurement greater than 30 mm were considered to have an aneurysm. Patients with an AAA who on further review were found to have any symptoms related to the AAA or with AAA greater than 50 mm received formal imaging from radiology (typically computed tomography [CT] scan) and vascular surgery consultation in the ED. Patients with asymptomatic AAA were referred to vascular surgery for follow-up imaging and consultation. The follow-up appointment was scheduled with the vascular surgeon, and the patient was provided detailed instruction regarding follow-up. Patients were contacted by telephone between 3 and 6 months to determine compliance with and outcome of follow-up. If contact could not be made after 3 attempts, the patient was declared lost to follow-up. A search of hospital records as well as the national death database was performed on any patients lost to follow-up.

Patients who received a screening examination in which an AAA was not identified were provided with a dated handout stating that screening had occurred and if the examination was complete, limited, or inadequate. In the case of limited or inadequate studies, it was suggested that the patient consider further investigation at the discretion of their primary care physician. These patients were not followed any further for study purposes. Patients and

physicians were not reimbursed for their participation in this study; patients were not billed for the ED ultrasounds.

Data were entered and analyzed using Microsoft Access and Excel (Redmond, WA). Descriptive statistics were used. Data are expressed as means ± SD.

3. Results

One hundred seventy-nine patients were enrolled from August 2005 to September 2006. Demographic data, risk factors, presence of AAA on physical examination, time for completion, and adequacy of the examination are noted in Table 1 for all patients and those with AAA. Mean age of all patients was 73.6 years and was not significantly different between those with and without AAA. The mean number of risk factors was higher in the overall group than in those with AAA (2.1 vs 1.3), although a history of smoking was present in nearly all (91.7%) of patients with aneurysm. Abdominal aortic aneurysm was not suspected based on physical examination before ultrasound in any patients with AAA, and AAA was not found in the 4 patients who had an aneurysm suspected by physical examination. The mean time to complete the examination was less than 3 minutes and did not vary significantly between those with and without aneurysm. A complete examination was possible in most (62.6%) of the patients, although the aorta could not be visualized at all in 4.5% of patients.

Table 1 Demographics, risk factors, physical examination, and aortic ultrasound in all patients and those with identified AAA

	All patients (N = 179)	AAA present (n = 12)
Age (y)	73.6 ± 9.2	76.8 ± 8.2
Ethnicity, n (%)		
White, non-Hispanic	138 (77.1)	10 (83.3)
African American	35 (19.6)	1 (8.3)
Hispanic	4 (2.2)	1 (8.3)
Other	2 (1.2)	0 (0)
Risk factors, average total	2.1	1.3
Smoking, ever	134 (74.9%)	11 (91.7%)
Pack* Years	33	53
Hypertension	125 (69.8%)	5 (41.7%)
Stroke	26 (14.5%)	2 (16.7%)
Peripheral vascular disease	32 (17.9%)	4 (33.3%)
Diabetes	46 (25.7%)	4 (33.3%)
Family history of AAA	6 (3.4%)	0 (0%)
AAA suspected on physical examination	4 (2.2%)	0 (0%)
Aortic measurement, mean ± SD, cm	2.4 ± 0.6	4.0 ± 0.8
Time to Complete Exam, mean ± SD, s	141 ± 135	157 ± 47
Complete examination	112 (62.6%)	11 (91.7%)
Limited examination	59 (33%)	1 (8.3%)
Inadequate examination	8 (4.5%)	N/A

Table 2 Patients with AAA on ED ultrasound examination, with confirmatory imaging and clinical follow-up

Age	Aorta size on ED ultrasound (cm)	Follow-up imaging	Follow-up notes
75	3.0	CT, 3.0 cm AAA	Being followed by PMD
65	3.3	US, 2.7 cm aorta	Being followed by PMD
84	3.4	CT, 3.7 cm AAA	Being followed by vascular clinic
69	3.4	CT, 3.1 cm AAA	Being followed by PMD
72	3.5	Aortography, moderate atherosclerotic disease and calcifications	Being followed by vascular clinic
74	3.6	No follow-up imaging	Patient did not keep vascular appointment, no response to contact after attempts
69	3.7	CT, 3.5 cm AAA	Being followed by PMD
74	3.8	CT, 3.1 cm AAA	Patient followed, subsequently died from vascular and renal insufficiency approximately 3 months after enrollment, no intervention for AAA
88	4.2	CT, 4.8 cm AAA	Being followed by PMD
69	4.7	CT, 5.1 cm AAA US, 4.4 cm AAA	Endovascular stent mapping and recommended but not yet pursued. Vascular surgery following
85	5.1	US, 5.8 cm AAA	Serial Follow up, surgery discussed but patient does not wish treatment at this time
91	5.7	AAA by report though size not mentioned	Follow up with vascular, endoluminal stent recommended but not yet performed

PMD indicates primary medical doctor.

AAA was found in 12 patients (6.7%; 95% confidence interval, 3.9%-11.4%). Aortic size, follow-up imaging, and clinical follow-up are shown in Table 2. Of 12 patients, 11

received follow-up imaging, with aortic size reported in 10. Of these 10, 9 had confirmed AAA. Mean size discrepancy between the ED ultrasound and follow-up imaging was 3.9 mm with 4 higher, 4 lower, and 1 equal to the follow-up (median, 0 mm; range, −7 to +7mm). One patient was entirely lost to follow-up. Although most patients with smaller aneurysms are being followed by their primary doctors or the vascular surgery clinic, repair was recommended in 3 patients, however at time of this writing no interventions had been performed.

4. Discussion

This study indicates that screening of at-risk patients for AAA is feasible using bedside EP-performed ultrasound in at-risk patients and that there is a fairly high prevalence of silent AAA in these patients. Specifically, the results show that the examination can be performed rapidly and that measured aneurysm diameter agrees with formal imaging results. The prevalence of AAA in at-risk patients of 6.7% is similar to the 6% found in a prior study that looked at ED screening for AAA [21]. However, this study includes more patients, describes aneurysm size, reports the time to perform the study, and shows better accuracy in measured aortic size.

The applicability of these findings to more widespread ED screening depends on many factors: availability of EP physicians with ability to perform aortic ultrasounds, finding time to perform the exam in an overcrowded ED, and motivation to perform the examination, including reimbursement. On January 1, 2007, a law went into effect providing reimbursement for a one-time screening for AAA in at-risk Medicare patients as part of a "welcome to Medicare" examination. Screening is only applicable to new Medicare patients within 6 months of enrollment who are either men who have smoked more than 100 cigarettes per year or men or women who have a family history of AAA. These restrictions make it unlikely that more widespread screening will be reimbursed at this time, but it does represent the first radiologic screening examination that is reimbursable through Medicare and may be more widely applied in the future. Specifically, if a "quick screen" could be performed rapidly and accurately, it could be reimbursed at a lower rate and may allow more widespread screening at lower cost.

Although not a primary aim, this study reinforces how poor the physical examination is for detecting AAA, with aneurysm documented as suspected by examination in only 4 patients, none of whom actually had an AAA. Prior studies have shown sensitivities as low as 29% for small AAAs and as high as 76% for large ones [4,5].

4.1. Limitations of the study

This study was limited by being a convenience sample in that screening for AAA was only performed when a trained EP was available to enroll patients. Although the average time to perform the study was less than 3 minutes, this included only scanning time and not machine set up, documentation, and so forth. Although many of these functions could theoretically be performed by ancillary personnel, time constraints may limit the ability of EPs to perform screening examinations.

A decision was made to only include males based on the fact that males are much more likely to have AAA. However, some data suggest that women are more likely to present with a ruptured AAA, perhaps due to decreased detection and tendency to rupture at a smaller diameter [22]. Further studies may include women as well, especially when they have significant other risk factors, particularly a family history of AAA.

Not all patients received formal imaging. Although all but one patient with AAA diagnosed by EP ultrasound had follow-up imaging, imaging was not required if the ED screening ultrasound was negative or indeterminate. It is therefore possible that some AAAs may have been missed.

This study showed a predominance of small AAAs, which are unlikely to rupture in the short term and for whom the benefit of detection is more tentative. Although the Multicentre Aneurysm Screening Study did show an overall benefit to screening, it would take much larger numbers to show the stratification by size that would allow extrapolation and calculation of cost-effectiveness that could result from more widespread screening in the ED population. However, this pilot study does show that the prevalence of AAA in at-risk elderly ED patients is high enough to justify further investigation into the cost-effectiveness of this strategy.

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