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Research article

Abdominal aortic aneurysm screening for high-risk cardiac patients in the emergency department

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ABSTRACT

Background: The prevalence of abdominal aortic aneurysm (AAA) is 1-2 percent in the general population, and is as high as 6 percent in groups with risk factors.

Objectives: The aim of this study was to determine the prevalence of AAA amongst high-risk cardiac patients in the emergency department (ED).

Methods: A prospective study was conducted to evaluate the prevalence of AAA in a high-risk population presenting to the ED. Inclusion criteria included male gender, Caucasian race, age over 50 years, history of smoking, and presentation to the ED with chest pain requiring admission. Patients enrolled in the study were screened for AAA by ultrasound (US) scan. Study subjects were excluded if there was inadequate imaging.

Results: One hundred and nine patients were recruited into the study. Nineteen patients were excluded by the ED US Director secondary to inadequate imaging. Of the remaining 90 patients, eight patients were found to have AAA (n = 8; 8.9%; CI 3.9 - 16.8%). Of the eight patients with an AAA, four had diagnosed cardiovascular disease during their hospital admission. There was no statistically significant difference in secondary risk factors such as hypertension, diabetes, dyslipidemia or previous history of coronary artery disease between those with AAA and those without AAA.

Conclusions: This study found that in a single ED, the prevalence of AAA in high-risk cardiac patients admitted to rule out acute coronary syndrome who could be adequately visualized with ultrasound was over 8 percent. With such a high prevalence, this population could be a potential screening group.

Keywords: abdominal aortic aneurysm, emergency ultrasound, high-risk cardiac patients

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INTRODUCTION

An abdominal aortic aneurysm (AAA) is a dilation of the abdominal aorta defined by a diameter of at least 3 cm.[1] The presence of an AAA greater than 3 cm in the general adult population is approximately 1-1.5 percent.[2] However, AAAs are more common in Caucasian men over the age of 65 and cause 1-2 percent of deaths in this population.[1,3] Abdominal aortic aneurysms are such an important preventable cause of death in the older population that the United States Preventive Services Task Force recommends a one-time ultrasound (US) scan screening for AAA in asymptomatic men aged 65-75 who have ever smoked.[4]

The Multicentre Aneurysm Screening Study showed that screening is a cost-effective tool that can significantly decrease mortality rates associated with AAAs.[5] Currently, the most important risk factors for AAA include increased age, male gender, and lifetime smoking history.[6,7,8] Additional reported risk factors include hypercholesterolemia and hypertension.[3,9]

An association between coronary artery disease (CAD) and AAA has additionally been identified. Madaric et al.,[10] found that the prevalence of AAA was significantly higher in patients with CAD and Nakayama et al., suggested that the existence of CAD makes it necessary for physicians to evaluate for an AAA, due to the strong co-existence of CAD and AAA.[11]

An important diagnostic modality to identify AAA is ultrasonography. Image acquisition is not time intensive, and it has been shown that emergency medicine physicians are able to identify clinically significant aortic abnormalities with high sensitivity.[12] Additionally, those patients with the highest risk for AAA also tend to be the most noncompliant with screening, so identification of this vulnerable group in the emergency department (ED) may optimize screening potential.[13]

Based on the published literature and the utility of bedside ultrasonography in the ED, the authors of this study set out to examine the potential of ultrasound screening of a high-risk, older population in the ED.

METHODS

This prospective study was conducted at a level-one trauma tertiary care facility with an annual ED census of 118,000. The study was approved prior to its commencement by the Human Investigation Committee, the local institutional review board of the hospital. Patients were guided through the written informed consent in which the risks, benefits and alternatives to participation in the study were discussed.

Patients were eligible for the study if they were Caucasian, male, over 50 years of age, with a history of smoking, and admitted to the Telemetry unit for chest pain (CP), shortness of breath, syncope or other qualifying presenting complaints justifying evaluation for acute coronary syndrome. Patients were excluded if they were deemed to not have the capacity to consent or had a known history of AAA. Patients were enrolled in the study on a convenience basis and study investigators screened for eligible patients using the hospital patient tracking system. Demographic data, pertinent past medical history and history of present illness were collected from the patient.

Examinations were performed by ultrasound-qualified emergency physicians who had previously completed more than 25 aorta scans each. All physicians received a one-hour refresher instructional tutorial prior to participating in the study and enrolling patients. Ultrasounds were performed at the bedside using a SonoSite M-Turbo, curvilinear low frequency (2.5 - 5 MHz) transducer (SonoSite, Bothelll, WA). Patients remained in the recumbent position during the examination. The abdominal aorta was evaluated in the transverse axis and measured in three locations: the proximal, mid and distal aorta. The proximal aorta (PAO) was identified by the celiac trunk, the middle aorta (MAO) by the superior mesenteric artery, and the distal aorta (DAO) by the aortic bifurcation. A complete scan required the identification of the superior mesenteric artery and bifurcation of the aorta as well as a clip of the entire aorta. The largest diameter of each segment was measured and recorded as a still image. The images were recorded on the individual US machines at the time of recruitment and reviewed within one week by the ED US director (AB). The ED US director determined if the images were adequate and met criteria for a complete examination, which involved complete visualization of proximal, mid and distal aorta. Cases with suboptimal imaging, inaccurate measurements, and incomplete imaging were excluded from the study.

Patients with an aortic diameter measuring less than 2.5 cm were considered normal, 2.5-3.0 cm were ectatic, and larger than 3 cm were considered to have an abdominal aortic aneurysm. Past literature has used a cutoff for an AAA varying between 2.5 and 4 cm with the majority falling around 3.0 cm.[7]

Three centimeters was chosen as the aneurysm cutoff value due to its consistency in the literature. If an AAA was found in any patient, the scanner informed the primary treatment team of the patient's finding to arrange for appropriate treatment or follow-up. Physicians and patients were not paid for their participation in this study and there was no billing for the ultrasound scans.

Data was entered and analyzed by SAS® software for Windows, version 9.2 (Cary, NC). Patients with AAA were compared to patients with no AAA. Categorical variables were examined using Fisher's exact tests. Continuous variables were examined using non-parametric Wilcoxon rank-sum tests as with only eight cases in the AAA arm, normality was uncertain. Descriptive statistics were used and the values were displayed as means ± standard deviation followed by the medians. Cronbach's alpha of 0.05 was used for significance.

RESULTS

One hundred and nine patients met the inclusion criteria and were enrolled into this study over a period of 10 months. The study concluded once a small population of around 100 patients were enrolled, although once all the scans were reviewed, the final study population was slightly under 100. Nineteen patients were excluded by the ED US director secondary to inadequate imaging because not all three locations (proximal, mid and distal aorta) were seen and measured. Twenty-five physicians performed the screenings including residents and attending faculty. Residents who recruited for this study represented all three postgradute years (PGY).

Demographic data, several risk factors and aortic measurement for all patients and those with and without AAAs are presented in Table 1. The mean age of all patients was 67 years. There was no statistically significant difference between those with or without an AAA ($p = 0.07$). The patients were evaluated for various cardiac risk factors present in their medical history. There were no significant differences between the two groups for any of the risk factors, including hypertension, diabetes, dyslipidemia, and CAD (Table 1).

Table 1. Patient data: Demographic data, risk factors and aortic measurements for all patients and those with and without identified AAA.

Characteristic	All patients (N = 90)	AAA absent	AAA present (N = 8)	P values
Age (years)	67 ± 12 (64.5)	66 ± 12 (64)	74 ± 11 (72.5)	0.072
Risk factors n (%)	64 (71.1%)	57 (69.5%)	7 (87.5%)	0.43
Hypertension				
Diabetes	26 (28.9%)	23 (28.1%)	3 (37.5%)	0.69
Dyslipidemia	38 (42.2%)	34 (41.5%)	4 (50.0%)	0.72
CAD	34 (37.8%)	29 (35.4%)	5 (62.5%)	0.15
Aortic measurement				
mean ± SD, (median) cm				
PAO	2.17 ± 0.47 (2.05)	2.07 ± 0.36 (2.00)	3.16 ± 0.32 (3.17)	NA
MAO	2.07 ± 0.60 (1.96)	1.94 ± 0.33 (1.93)	3.35 ± 1.15 (2.91)	NA
DAO	1.91 ± 0.55 (1.86)	1.82 ± 0.36 (1.82)	2.84 ± 1.07 (2.43)	NA

AAA: abdominal aortic aneurysm; CAD: coronary artery disease; PAO: proximal aorta; MAO: medial aorta; DAO: distal aorta.

Eight patients were found to have an AAA ($n = 8$; 8.9%; CI 3.9 - 16.8%). Aortic size at the three measured locations, and cardiovascular follow-up of the eight patients with AAA are shown in Table 2. Six of the eight patients with AAA had follow-up imaging within one-year of the AAA screening exam and confirmation of AAA by either magnetic resonance imaging (MRI), computerized tomography (CT), or radiology US. Of the remaining two patients with an identified AAA, one patient had an AAA >4.0 cm and passed away during the hospital admission while the other had an AAA >3.0 cm confirmed by the ED US Director. The latter patient was called to gather follow-up data but could not be reached. Of the eight patients with an AAA, four had diagnosed cardiovascular disease as determined by positive cardiac enzymes, positive catheterization or stress test, an electrocardiogram (EKG) indicating an acute MI or the presence of aortic dissection. Another patient later returned to the hospital presenting with chest pain and had a non-ST-elevation myocardial infarction (NSTEMI). The patients were treated for their presenting cardiac-related chief compliant, and their primary care team addressed the presence of an AAA at their own discretion.

Table 2. Data for patients with AAA. Descriptive and follow-up data for patients identified to have an AAA on ED ultrasound imaging.

Age	Aortic size (cm)	Diagnosis Follow-up cardiovascular
76	PAO: 3.11 MAO: 2.25 DAO: 2.24	Gastritis Stress Test Negative, Negative Cardiac Enzymes
91	PAO: 3.20 MAO: 3.80 DAO: 4.06	Unstable Angina Negative Stress Test; Returned with CP and NSTEMI
69	PAO: 2.50 MAO: 3.08 DAO: 1.82	Pacemaker placed
83	PAO: 3.14 MAO: 2.39 DAO: 2.10	Congestive Heart Failure Negative Cardiac Enzymes
81	PAO: 3.30 MAO: 4.32 DAO: 2.61	NSTEMI Positive Cardiac Enzymes
64	PAO:3.59 MAO: 5.58 DAO: 4.75	Deceased Positive Cardiac Enzymes, Positive Cardiac Catherization
64	PAO: 3.2 MAO: 2.73 DAO: 1.97	Aortic Dissection Negative Cardiac Enzymes
62	PAO: 3.40 MAO: 2.65 DAO: 3.20	Positive Cardiac Catherization, Negative Cardiac Enzymes

AAA: abdominal aortic aneurysm; ED: emergency department; PAO: proximal; MAO: medial; DAO: distal; NSTEMI: non-ST-elevated myocardial infarction; CP: chest pain.

DISCUSSION

This study demonstrates that the screening of cardiac patients for AAA in the ED is a potentially effective modality to identify asymptomatic AAA in a high-risk older population. Given the relatively high prevalence of asymptomatic AAA in these patients and the performance of bedside ultrasonography without difficulty and in a time effective manner, this technique in the ED setting may be potentially lifesaving as a screening tool.

The prevalence of AAA in this study of high-risk patients was 8.9 percent (n = 8; CI 3.9-16.8%). This prevalence is considerably higher than the reported prevalence of 1 to 1.5 percent in the general population, and higher than the prevalence rates of 5.15 to 6.7 percent reported in high-risk patients in previous studies.[2,14–17] There were no significant differences among the two groups in this population in age or specific risk factors, including hypertension, diabetes, dyslipidemia and CAD. If the cutoff of AAA was increased to 4 cm to allow for less false positives, the prevalence would decrease to 3.3 percent (n = 3; CI 0.7-9.4%). However, surgical intervention usually occurs around 5 cm and a 3 cm cutoff allows more time for follow-up and surveillance. Furthermore, the literature is consistent with a value of 3 cm as a definition of an AAA, demonstrating that the higher prevalence in this study makes this high-risk group a potential screening group.

Four of the eight patients with AAA also had positive cardiac findings. Two had positive cardiac enzymes, and of those two patients, one had an NSTEMI and one had a positive cardiac catheterization. Another patient had a positive cardiac catheterization with negative cardiac enzymes. The fourth patient had an aortic dissection. A fifth patient returned to the ED on a separate visit with chest pain, leading to a final diagnosis of an NSTEMI.

The high prevalence of abnormal abdominal aortas and the significant presence of positive cardiac findings in over half of the patients diagnosed with AAA, suggests a relationship between presentation to the ED with symptoms consistent with acute coronary syndrome and the presence of an AAA. Thus, this patient population of older males presenting with cardiovascular symptoms creates an ideal screening population in the ED as a relatively large prevalence of abnormal abdominal aortas apparently exists.

Public health in the ED has its limitations as it does in all other professional groups, due to education and funding. Currently, most EDs primarily focus their public health efforts on violence, mental health issues, substance abuse and sexually transmitted infections, issues commonly dealt within the ED.[18] However, chest pain is the second most common reason a patient visits the ED, thus allowing for a large screening population, if meeting the other high-risk factors.[19] The ED could be considered a potential location for screening as it is a safety net for patients who lack access to healthcare. Almost 80 percent of adults who visit the ED do so because they are uninsured and lack access to other options compared to those individuals with insurance.[20] These patients are therefore otherwise unable to get the necessary preventative care including screening studies without access to primary care physicians and cardiologists. The ED should therefore try to fill in the gaps for those who need screening. Abdominal aortic aneurysm screening is a feasible method of screening as ultrasound is readily available in many EDs, emergency physicians are well trained to use ultrasound and the screening study could take less than five minutes.[21,2,17] Furthermore, AAA screening differs from other screening studies in that it gives realtime results that the provider is then able to tell the patient to help with appropriate follow-up. This screening method could be incorporated as part of the work-up for a patient presenting with chest pain, as it is not time consuming and additionally does not detract from the presenting complaint.

Although the ED could represent an attractive area for screening due to these factors, it could be limited by the availability of emergency physicians to perform screening and the reimbursement surrounding screening. Currently, Medicare, the federal health insurance program in the United States, provides reimbursement for one-time screening for men who smoke more than 100 cigarettes per year or with a family history of AAA within the first six months of enrolling in Medicare. This precedent for reimbursement reinforces the importance of screening and perhaps ED physicians could perform quick screens for a fraction of the cost of current screening guidelines. This could allow for more widespread screening at a reduced cost. Furthermore, the ED could be used as an adjunct for those who missed the six month cutoff to receive their screening.

This study is limited by its small sample size. However, the results of this pilot study warrant further review and analysis of AAA in this patient population to better identify the role of AAA screening in the emergency department.

The results of this study must be considered with regards to the following limitations. This study population was limited to a convenience sample, in that patients were screened once found in the hospital's tracking system and only if a trained physician was available to scan. Additionally, a characteristic of ultrasonography is that it is more operator dependent than other imaging modalities and therefore is more prone to bias and interpretation errors. Although all physicians received a training session, some were more experienced than others and the variable levels of training and experience were not accounted for. This study additionally took place in a single academic hospital with an annual census of 118,000; therefore, it is possible that it cannot be generalized to other hospital settings. Although no follow-up imaging studies were required after the initial emergency department ultrasound diagnosis of AAA, it was confirmed by chart review of follow-up imaging or definitively by the ultrasound director in seven of the eight cases. Those with a normal ultrasound excluding AAA did not receive follow-up imaging so it is possible that AAA may have been missed on some of these high-risk individuals. Future research can focus on the detailed cost-effectiveness of this screening modality.

CONCLUSIONS

There appears to be higher prevalence of abdominal aortic aneurysms in older patient populations symptomatic for cardiovascular disease such as myocardial infarction than in the general population. Furthermore, there is a high prevalence of positive cardiac findings in patients with AAA than patients with normal aortas. Our data suggests that this older patient population would be an ideal screening group to evaluate for AAA in the ED.

AUTHORS' CONTRIBUTIONS

AB designed the study, recruited patients, preformed ultrasounds, reviewed the ultrasound studies, analyzed and interpreted the data, revised the manuscript and gave the final approval for submission. PS helped design the study, recruited patients and performed ultrasound studies. LD completed the literature search, analyzed and interpreted the data, wrote, edited and submitted the manuscript. All authors read and approved the final manuscript.

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