# Effectiveness of Screening for Abdominal Aortic Aneurysm During Echocardiography

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**Screening patients with abdominal aortic aneurysm (AAA) is associated with reduced AAA-related mortality, but population screening is poorly implemented. Opportunistic screening during imaging for other indications might be efficient. Single-center series reported AAA rates of 0.8% to 6.5% in patients undergoing transthoracic echocardiography (TTE), with disparities due to selection bias. In this first multicenter study, we aimed to assess the feasibility and criteria for screening AAA during TTE in real-life practice. During a week of May 2011, 79 centers participated in a nationwide survey. All patients aged ≥65 years requiring TTE for any indication were eligible, except for those with operated abdominal aorta. We defined AAA by an anteroposterior diameter of the infrarenal aorta ≥30 mm. Of 1,382 consecutive patients, abdominal aorta imaging was feasible in 96.7%, with a median delay of 1.7 minutes (>3 minutes in 3.6% of cases). We found AAA in 50 patients (3.7%). Unknown AAA (2.7%) was more frequent in men than women (3.7% vs 1.3%, respectively, p = 0.007) and increased by age at 2.2%, 2.5%, and 5.8% in age bands of 65 to 74, 75 to 84, and 85+ years, respectively. None of the female participants aged <75 years had AAA. Smoking status and family history of AAA were significantly more frequent among patients with AAA. The ascending aorta was larger in those with AAA (36.2 ± 4.7 vs 34.0 ± 5.2 mm, p = 0.006), and bicuspid aortic valve and/or major aortic regurgitation were also more frequent (8% vs 2.6%, p = 0.017). In conclusion, rapid AAA screening during TTE is feasible and should be limited to men ≥65 years and women ≥75 years.**  **(Am J Cardiol 2014;114:1100−1104)**

Because many patients undergoing transthoracic echocardiography (TTE) present risk factors for abdominal aortic aneurysm (AAA) and the ultrasound probe used for TTE is suitable for abdominal aorta imaging, AAA screening during TTE has been reported in several single-center series, with discrepant results related to different enrollment criteria and lesion definition, as well as patients' and examiners' characteristics.[1] To date, no multicenter study assessed the feasibility and interest of a systematic AAA screening during TTE. The aim of this study was to assess the actual rate of AAA among patients undergoing TTE and the feasibility of its screening in a large multicenter study. We hypothesized that screening AAA during TTE is highly feasible.

## Methods

The *Echocardiographie Trans-Thoracique et Anévrysme de l'Aorte Abdominale* (E2T3A) is a prospective, nationwide, multicenter, cross-sectional study in France, promoted by the Working Group of Vascular/Thrombosis and the Council of Echocardiography of the French Society of Cardiology. The study has been approved by the Consultative Committee on Data Management for Biomedical Research (CCTIRS, Ministry of Research, France) and the National Committee of Information and Freedom (CNIL, Paris, France).

During the first trimester of 2011, cardiologists in France performing cardiac ultrasonography have been invited through congresses and e-mails to take part in this study. Those who accepted to participate filled a questionnaire regarding their experience in vascular ultrasonography, as well as the type of medical facility where they work (public hospital, private clinic, or office). Those who had no experience of abdominal aorta imaging received a video clip showing how to use their cardiac ultrasound probe to scan

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See page 1104 for disclosure information.

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[1] A full list of the investigators is given in Supplementary Data.

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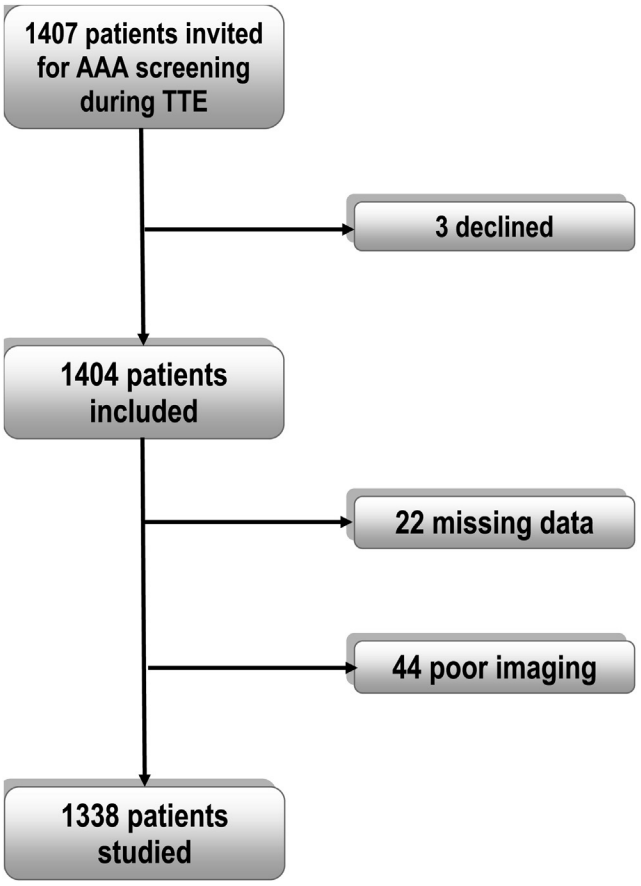


Figure 1. The E2T3A study: patients' flowchart.

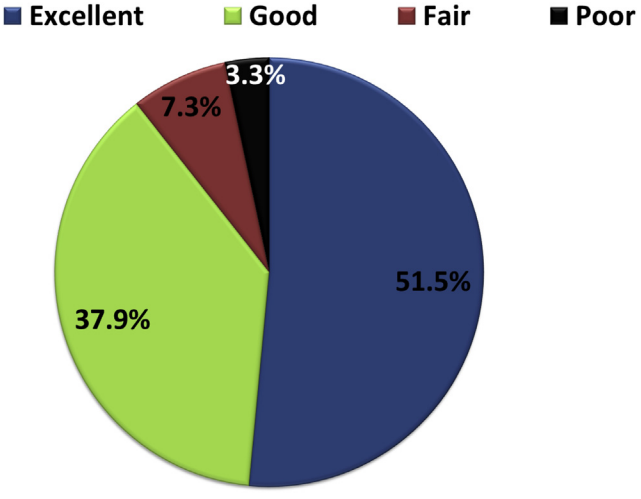


Figure 2. Imaging quality as rated by the examiners.

the abdominal aorta and measure the maximal anteroposterior diameter of the infrarenal aorta. They trained themselves before the study period and were assisted by more experienced colleagues during the training period. The study period was set at May 16 to 20, 2011. The investigators were asked to offer AAA screening at the end of TTE to all patients aged ≥65 years during at least half a day. A history of abdominal aortic intervention (either surgery or

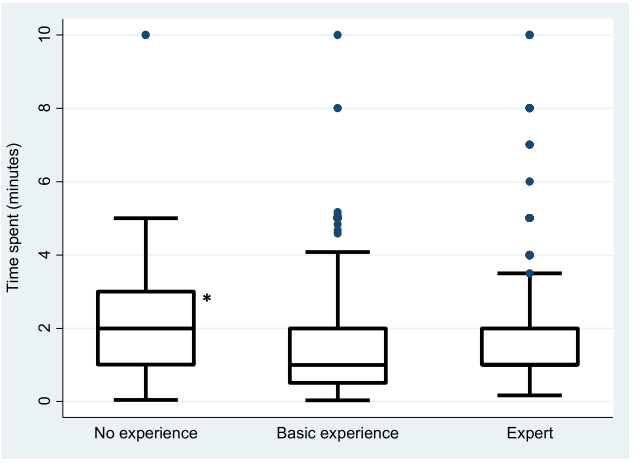


Figure 3. Time spent for the imaging of the abdominal aorta after TTE, according to the examiners' experience of vascular imaging. *p <0.0001 versus the other 2 groups.

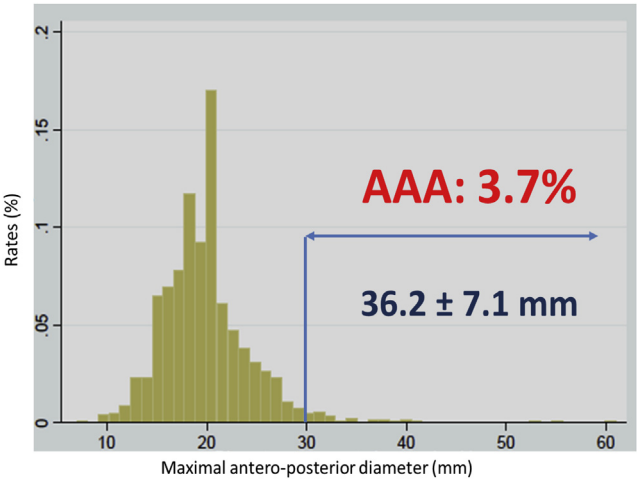


Figure 4. Distribution of abdominal aortic diameters—the E2T3A study. The *arrow* indicates the range of aortic diameters in case of AAA.

endovascular) was the only exclusion criterion. Data were collected electronically using an electronic case report form, including demographic data, indications for TTE, cardiovascular risk factors and drugs, family history of AAA, and cardiac and aortic ultrasound measurements. The aorta imaging quality and the time spent specifically to scan and measure the abdominal aorta were recorded. An AAA was defined by an anteroposterior diameter ≥30 mm.

Quantitative data are presented as numbers (%) and qualitative data as mean (SD). Differences between groups were tested using chi-square tests for categorical data and Student *t* tests for quantitative data. Nonparametric tests (Mann-Whitney and Kruskal-Wallis tests) were used when the distributions were skewed. All statistical analyses were performed using Stata/SE, version 10.1 (Stata Statistical Software; StataCorp LP., College Station, Texas).

## Results

One-hundred eight cardiologists from 76 centers across the country took part in the study. Overall, 1,407 patients

Table 1
Comparison of screened patients according to the presence or absence of AAA

| Variable | Abdominal Aortic Aneurysm | | |
|---|---|---|---|
| | No | Yes | p |
| Age (years) | 75.2 ± 6.8 | 76.1 ± 7.8 | 0.45 |
| Male gender | 737 (57.2%) | 42 (84.0%) | 0.0001 |
| Smoker | 422 (34.1%) | 24 (50.0%) | 0.023 |
| Hypertension* | 876 (68.9%) | 33 (66.0%) | 0.662 |
| Hypercholesterolemia* | 677 (54.7%) | 30 (60%) | 0.22 |
| Diabetes mellitus* | 298 (24.0%) | 11 (22.0%) | 0.804 |
| Body mass index (kg/m$^2$) | 26.6 ± 4.8 | 27.0 ± 4.3 | 0.27 |
| Family history of AAA | 12 (1.0%) | 2 (4.0%) | 0.037 |
| Coronary artery disease* | 347 (27.6%) | 17 (34%) | 0.319 |
| Heart failure* | 234 (18.4%) | 8 (16.0%) | 0.662 |
| Peripheral artery disease* | 118 (9.4%) | 2 (4%) | 0.208 |
| Cerebrovascular disease* | 183 (14.4%) | 6 (12%) | 0.58 |
| Chronic obstructive pulmonary disease* | 122 (9.6%) | 5 (10%) | 0.891 |
| Chronic kidney disease* | 121 (9.8%) | 7 (14%) | 0.28 |
| Cancer (5 yrs)* | 92 (7.4%) | 2 (4.0%) | 0.411 |
| Antiplatelet drugs | 581 (47.1%) | 25 (50%) | 0.413 |
| Statins | 652 (53.1%) | 24 (48%) | 0.902 |
| RAS blockers | 730 (59.8%) | 34 (68%) | 0.086 |
| Beta-blockers | 543 (44.4%) | 18 (36%) | 0.408 |

* According to clinical history.

Table 2
Echocardiographic data in the study population

| Variable | Abdominal Aortic Aneurysm | | |
|---|---|---|---|
| | No | Yes | p |
| Indications for TTE | | | |
| Heart failure | 151 (11.7%) | 1 (2.0%) | 0.033 |
| Hypertension | 310 (24.1%) | 14 (28.0%) | 0.52 |
| Dyspnea | 249 (19.4%) | 6 (12.0%) | 0.194 |
| Arrhythmia | 127 (9.9%) | 6 (12.0%) | 0.62 |
| Coronary artery disease | 246 (19.1%) | 10 (20.0%) | 0.878 |
| Pre-operative work up | 61 (4.7%) | 0 (0%) | 0.115 |
| Chemotherapy | 40 (3.1%) | 0 (0%) | 0.205 |
| Pericarditis/myocarditis | 10 (0.8%) | 0 (0%) | 0.531 |
| Pulmonary embolism | 11 (0.9%) | 2 (4.0%) | 0.026 |
| Stroke/peripheral embolism | 42 (3.3%) | 1 (2.0%) | 0.619 |
| Endocarditis | 16 (1.24%) | 3 (6.0%) | 0.005 |
| Prosthetic valve | 97 (7.5%) | 3 (6.0%) | 0.684 |
| Hypertrophic cardiomyopathy | 24 (1.9%) | 1 (2.0%) | 0.945 |
| Findings | | | |
| LV end-diastolic diameter (mm) | 50.1 (7.7) | 52.6 (6.6) | 0.0096 |
| LV end-systolic diameter (mm) | 32.2 (8.4) | 35.6 (8.2) | 0.0039 |
| Septal thickness (mm) | 10.9 (3.6) | 11.0 (2.1) | 0.376 |
| Posterior wall thickness (mm) | 10.3 (4.0) | 11.5 (10.5) | 0.99 |
| LV ejection fraction | 0.61 (0.12) | 0.61 (0.13) | 0.728 |
| Abdominal aorta antpost diam (mm) | 19.5 (3.6) | 36.2 (7.1) | 0.0001 |
| Ascending aorta diameter (mm) | 34.0 (5.2) | 36.1 (4.4) | 0.0015 |
| Aortic regurgitation 2+ | 192 (15.4%) | 12 (24%) | 0.061 |
| Bicuspid aortic valve | 10 (0.8%) | 1 (2.0%) | 0.383 |

were invited for AAA screening, of whom finally 1,338 were analyzed (58% men, mean age 75.2 ± 6.8 years). Figure 1 displays the patients' flowchart. The refusal rate was very low (0.2%). The imaging quality as judged by the investigators is displayed in Figure 2. Overall, the abdominal aorta diameter was measurable in 96.7% of cases. The average time needed to scan and measure the abdominal aorta was 1 minute and 44 seconds (±1 minute 30 seconds). In 96.4% of cases, the imaging lasted <3 minutes. This delay was longer for those without previous experience of vascular imaging (Figure 3, p <0.0001).

The abdominal aorta diameter distribution is shown in Figure 4. The prevalence of AAA was 3.7%, with a mean diameter at 36.2 ± 7.1 mm in subjects with AAA. Among them, the proportion of AAAs within 30 to 34, 35 to 39, 40 to 44, 45 to 49, and ≥50 mm was 54%, 22%, 14%, 2%, and 8%, respectively. The largest aneurysm (61 mm) was found in an 85-year-old man who underwent TTE for dyspnea. Among women, the largest AAA measured 53 mm in a 76-year-old woman who underwent TTE during examination after syncope. Overall, the prevalence of AAA was significantly greater in men compared with women (5.4% vs 1.4%, p <0.0001). Of the 50 patients with AAA, 35 (70%) were unaware of their condition, so that the prevalence of unknown AAA was 2.6%. The prevalence of AAA did not differ according to the type of health care center.

Table 1 lists demographic and clinical parameters of those with and without AAA. Regarding risk factors, only smoking status and family history of AAA were significantly more frequent among patients with AAA. No significant difference was found between the 2 groups regarding co-morbidities and cardiovascular treatments. Table 2 lists the comparison of the 2 groups regarding TTE indications and measurements. Compared with those without AAA, the indications for TTE were less frequently related to heart failure but more frequently related to endocarditis or pulmonary embolism in patients with AAA. These patients had larger left ventricular end-diastolic and end-systolic diameters, with similar ejection fraction and wall thicknesses. Interestingly, among those with AAA, the ascending aorta was larger, with significantly higher rates of aortic valve disease (bicuspid aortic valve and/or 3+ aortic regurgitation: 8.0% vs 2.6% among patients without AAA, p = 0.017). Excluding patients with type-C (« fair ») imaging quality or those screened by inexperienced cardiologists for vascular imaging did not alter significantly the prevalence of AAA (data not shown).

## Discussion

This first multicenter study confirms the usefulness of AAA screening during TTE in patients aged ≥65 years, especially in men. One of 18 men aged >65 years referred for TTE do have an AAA, mostly undiagnosed. The screening for these lesions, of prognostic implication, is highly feasible during TTE, at the extra cost of on average 3 minutes during TTE. Even among cardiologists with low experience of vascular imaging, the feasibility rate is very high. These findings, along with a low refusal rate, highlight an opportunity to screen AAA easily in those undergoing TTE everyday worldwide.

Nowadays, a substantial number of AAAs referred for intervention is still incidentally found during an abdominal imaging. The prevalence of incidental AAA during any abdominal imaging tests is estimated at 1%.[2]

Table 3
Previous publications on screening for abdominal aortic aneurysm during echocardiography

| Author (Year) | N | Selection | Age | AAA Definition mm | Aorta Segment Studied | Aorta Imaging Success Rate | Prevalence (Men/Women) |
|---|---|---|---|---|---|---|---|
| Eisenberg 1995[12] | 323 | Unselected | 57 | >25 | Distal aorta not always visualized | 82% | 2.0% (8.5/2.5) |
| Schwartz, 1996[13] | 250 | Unselected | — | >30 | Not stated | 86% | 6.0% (NA) |
| Spittell, 1997[14] | 209 | >50 y with HTN | 71.3 | >30 | Whole abdominal aorta | 96% | 6.5% (8.4/4.3) |
| Jaussi, 1999[15] | 297 | Unselected | 58.6 | >30 | Infra-renal | >95% | 5.7% (8.2/1.7) |
| Seelig 2000[16] | 14 876 | Unselected, >50 y | 68.5 | >30 | Not stated | Not stated | 0.8% (1.3/0.2) |
| Bernard, 2002[17] | 1106 | Unselected | 61 | >35 | Infra-renal | 87% | 1.0% (NA) |
| Gianconni, 2003[18] | 181 | Unselected (Not stated) men | 61 | ≥30 | Not stated | 91% | 3.8% (3.8/—) |
| Bekkers, 2005[19] | 742 | Unselected | 60.5 | >30 | Infra-renal | 93% | 5.7% (NA) |
| Ruggiero, 2006[20] | 1107 | Selected & unselected | — | — | Not stated | 95% | 5.6% (NA) |
| Roshanali, 2007[21] | 1285 | Unselected | 40.7 | >40 | Supra-renal only | 91% | 3.8% (4.5/3.6) |
| Gentille-Lorente, 2011[22] | 512 | Unselected | 65.1 | ≥30 | Infra-renal | 96.5% | 5.1% (7.4/1.5) |
| Navas, 2012[23] | 90 | Unselected, >55 y | 72 | ≥30 | Whole abdominal aorta | 93% | 5.5% (NA) |

A systematic screening program of AAA among men >65 years has been shown to be effective, by revealing AAA in almost 5% of cases and, beyond, by reducing the AAA-related death by 45%, with a trend for a 2% total mortality reduction.[3] The US Prevention Task Force recommended in 2005 the AAA screening in men aged ≥65 years who had ever smoked and positioned against screening in women.[4] Despite these guidelines, AAA screening programs are poorly implemented. The Screening Abdominal Aneurysms Very Efficiently (SAAAVE) act in 2007 proposes AAA screening for every new male Medicare beneficiaries at age of 65 years, if they smoked >100 cigarettes lifelong.[5] A recent report highlighted that only <10% of potential beneficiaries had an abdominal ultrasound, and <3% of the abdominal ultrasounds had the SAAAVE-specific reimbursement code, with no effect on 1-year AAA-specific hospitalization or death.[6] Several countries in Europe have implemented similar programs.[7] The effectiveness of population screening program may also be challenged by new data reporting a decrease of AAA prevalence in recent population studies, mostly due to a substantial decrease in smoking rates, especially among men.[8,9]

In the absence of any efficient screening program, there are still many missed opportunities to detect AAA. In a series of ruptured AAAs managed in Glasgow, 77% of them were unaware of their condition before symptoms, whereas 76% attended a hospital for any health reason during the previous 5 years.[10] These data highlight the potentials of an opportunistic screening for AAA and ability to detect many of these cases timely.

The opportunistic screening for AAA has already been assessed in 2 settings in which the ultrasound machine and the patients' profile are in favor of this approach. Among patients visiting a vascular laboratory for any indication, AAA screened systematically was detected in 3% of cases.[11] The prevalence of AAA among patients undergoing TTE has been assessed in several series with disparate results (Table 3).[12–23] This prevalence varied dramatically from 0.8% to 6.5% because of differences in inclusion criteria, aortic site measured, and diameter threshold. In contrast to most other series, the largest series in the Mayo Clinic using the cutoff diameter of 30 mm reported a rate as low as 0.8%.[16] One plausible explanation would be a selection bias because those patients were mostly already managed by specialists before referral.

All these aspects justify our pragmatic multicenter study undertaken in different settings. Despite different levels of cardiologists' expertise in vascular echography, the imaging success rate and average time spent are similar to previous series, plausibly performed by experienced examiners. The prevalence of AAA in our study is somehow less than that in other similar series, although our population was older. This is in line with the most recent population studies reporting a decreasing rate of AAA overall. Similar to other series during TTE, we found smoking status and family history of AAA as the sole risk factors associated with AAA.[13–15] In population studies, these 2 parameters are the strongest risk factors associated with this lesion.[24,25]

The larger left ventricular size found in this study has also been reported in 2 earlier series.[19,21] The increased ascending aorta diameters in patients with AAA are original, as well as the higher rates of aortic valve regurgitation. These conditions may be related to common phenotypes of major or minor elastopathies. However, at least in our population >65 years, the cardiac abnormalities found are not specific enough to target more restrictively AAA screening in those undergoing TTE. Beyond the detection of AAA, measuring the abdominal aorta diameter might also be useful to detect patients at an increased risk of cardiovascular events.[26,27] Although statins and renin-angiotensin system inhibitors might be beneficial to reduce the AAA's growth, they are even more interesting for cardiovascular prevention as a whole. In our study, 1/2 and 1/3 of patients with AAA were not under statins and renin-angiotensin system inhibitors, respectively.[28]

Our study has several limitations. We have not excluded patients aware of having a small AAA, to assess the unbiased prevalence of AAA in patients undergoing TTE. Both rates, with or without the inclusion of these patients, are provided. Importantly, in several cases of "known" AAA, the cardiologist was actually unaware of the presence of this condition, and the patient informed the cardiologist after the discussion about the study or the AAA imaging. This highlights the importance of a holistic management of the cardiovascular patient. Many cases with "known" AAA were not under any surveillance. One may question about

the validity of the measurements, when performed by those with poor experience on vascular imaging. It is shown that the level of experience does not affect dramatically the accuracy of abdominal aorta measurement.[29] Besides, only a very few patients with large AAA detected would have required immediate further confirmation. Those with smaller AAA can be scheduled for aortic imaging during the follow-up. Although echocardiography is performed only by cardiologists in France, this differs from many countries where sonographers perform most examinations, but our findings can be transposed to these countries as well. Last, the outcome of the patients in our study is unknown. Some of these patients might have several co-morbidities, so that the detection of a small AAA might not alter their prognosis. From this standpoint, we cannot advocate a systematic screening of men after the age of 85 years. The estimation of life expectancy, quality of life, and costs generated after a positive screening should lead to reasonable clinical judgment. Even if we limit the screening in men from 65 to 84 years and women from 75 to 84 years, the number of patients needed to screen to find 1 AAA remains interesting, respectively at 21 and 35.

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## Disclosures

The authors have no conflicts of interest to disclose.

## Supplementary Data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.amjcard.2014.07.024.

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