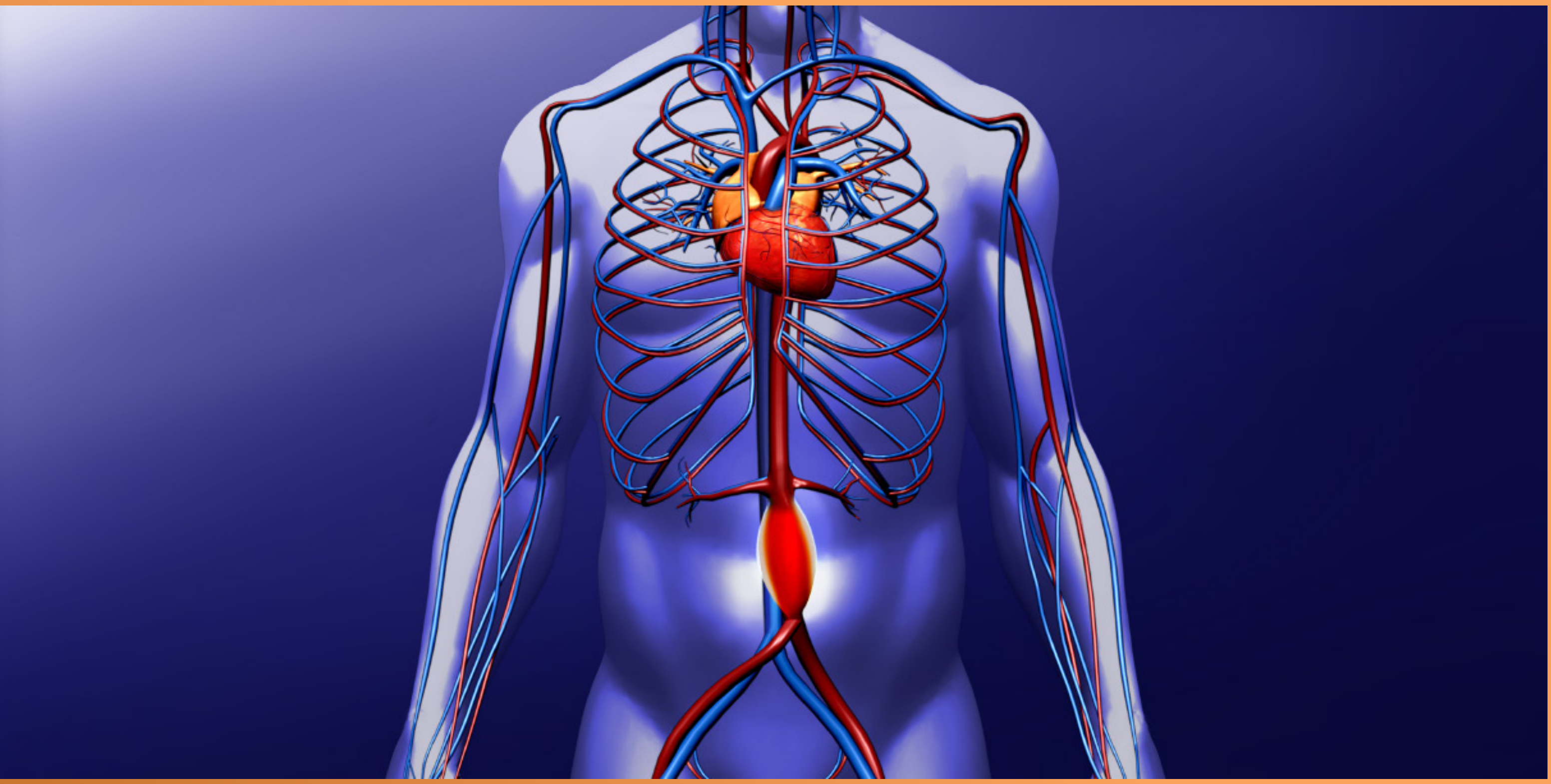
ABDOMINAL AORTIC ANEURYSM: UPDATED SCREENING GUIDELINES



Getting tested early = Staying healthy longer

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Getting tested early = Staying healthy longer

ANCC Accredited NCPD Hours: 2.5hrs

Target Audience: RN/APRN

Goal

The goal of this article is to discussthe evidence behind the updated screening guidelines for Abdominal Aortic Aneurysm (AAA)

Objectives

- Discuss the importance of updated AAA screening guidelines in current times
- Describe how AAA is identified as an important health problem
- Identify a suitable screening test for AAA according to updated guidelines
- Discuss the grading of recommendations for updated AAA screening guidelines
- Analyse the screening modality of choice for AAA according to updated guidelines

Need Assessment

The updated screening guidelines for Abdominal Aortic Aneurysm provide an opportunity to review the criteria for AAA screening in asymptomatic adults. The updated evidence review includes several interesting observations that may reflect gaps between recommendations and existing clinical practice. Reduction in AAA-related mortality was observed from screening trials are included, but it is interesting to note that pooled analysis did not reflect an effect on all-cause mortality. Other benefits associated with screening included reduction in emergency surgery.

Introduction

Abdominal aortic aneurysm (AAA) (Figure 1) is defined as a permanent dilatation of the abdominal aorta that exceeds 3 cm. Most AAAs arises in the portion of abdominal aorta distal to the renal arteries and is defined as infrarenal. Most AAAs is totally asymptomatic until catastrophic rupture. The strongest predictor of AAA rupture is the diameter. Surgery is indicated to prevent rupture when the risk of rupture exceeds the risk of surgery

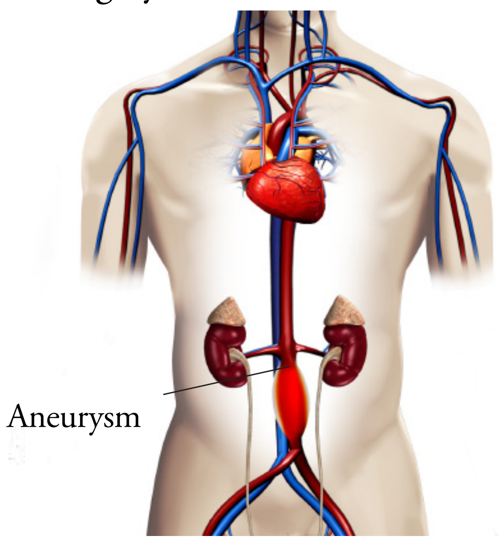

Figure 1 : Abdominal aortic aneurysm

Most AAAs arises in the portion of abdominal aorta distal to the renal arteries and are defined as infrarenal

Other risks, such as connective tissue disorders are much less common, and associated with AAA in younger patients.

For the abdominal aorta, the threshold is a diameter of more than 3 cm. Most AAAs develops in the portion of aorta 1 to 2 cm distal to the renal artery and is termed infrarenal AAA. These occur mainly in men older than 65 years. A key risk factor is cigarette smoking. From a molecular perspective,(-Figure 2) three processes are involved in the development of AAA: proteolysis, inflammation, and smooth muscle cell (SMC) apoptosis. Although some symptoms can be linked to AAA, most aneurysms are totally asymptomatic until rupture, which leads to death in 65% of patients. [1, Rank 1]

Abdominal aortic aneurysm(AAA) is defined as a permanent dilatation of the abdominal aorta that exceeds 3cm.

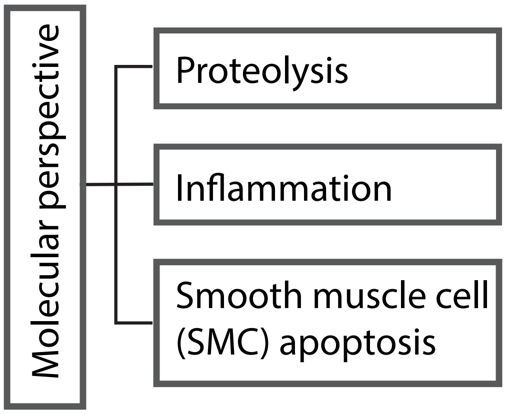

Figure 2 : Molecular perspective

Importance of AAA Screening in Current Times

The US screening programme has now been expanded long way. Long-term follow-up continues to demonstrate significant benefits for abdominal aortic aneurysm (AAA)-related all-cause mortality. Results from the first 5 years of the formal screening programme have demonstrated similar success. Ultrasound scanning is an effective and safe screening tool for the detection of AAA [2, Rank 3]

AAA as an Important Health Problem

AAA is defined as a full thickness dilatation of the abdominal aortic diameter of ≥1.5, measured in the anteroposterior plane. In men, this is taken to mean 3 cm or greater. Around 85% of aortic aneurysms occur within the infra-renal segment of the abdominal aorta. The most common risk factors (Figure 3) for AAA include smoking, hypertension, and hypercholesterolemia, increasing age and family history and other

Risk of AAA begins to risearound the age of 50 in men in whom it is significantly more common (ratio of approximately 4:1), and later in women. AAA is usually asymptomatic until it ruptures, although pain in the abdomen or lower back can represent a rapidly enlarging or mycotic aneurysm, which should be considered for emergency repair. Aneurysm-related and all-cause mortality following ruptured AAA remains high (up to 80%). This includes a combination of pre-hospital death and failure to survive to discharge. Recent published analysis calculated a pooled risk of rupture of 3.5% for AAA 5.5–6 cm, 4.1% for 6.1–7 cm and 6.3% for AAA ≥7 cm, with risk accumulating over time. This has decreased over time; previously AAA ≥6 cm carried a rupture risk of 14.1% in men and 22.3% in women, suggesting changes in patient behaviour could contribute to a reduction in AAA-related mortality. The average risk of rupture in women with AAA of between 5–5.9 cm is up to four times as high as in men. Hence, ongoing debate and suggestions that repair should be considered once diameter reaches 5 cm in women. [5, Rank 4]

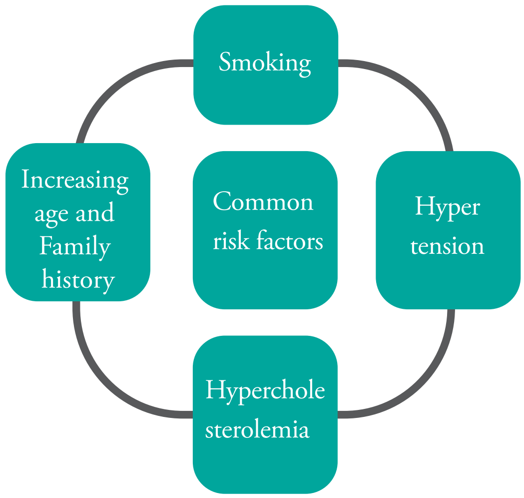

Figure 3 : Risk factors

Although the screening programme in the US is active, many men are still referred with an incidental finding of AAA following investigations for pathology such as prostate cancer.

Most AAAs are totally asymptomatic untill catastrophic rupture. The strongest predictor of AAA rupture is the diameter

The National Vascular Registry (the vascular services quality improvement programme that collates and publishes outcomes for all major vascular procedures) suggests over half of patients are referred to a vascular surgeon over the age of 65 via channels other than the screening programme. [7, Rank 5]

Suitable Screening Test

Ultrasound imaging can reliably visualise the aorta in 99% of individual. This method has been validated against reconstructed three-dimensional CT imaging of the aorta. ***Ultrasound imaging has the benefits of being non-invasive, non-ionising and not requiring nephrotoxic contrast*** use. Ultrasound was utilised in all of the major AAA screening trials, and supported the significant body of literature concluding that AAA screening using ultrasound was ***time-efficient, inexpensive and accurate.***

The threshold for diagnosis of AAA is currently set at an infra-renal aortic diameter of 30 mm (3 cm). The threshold for referral to a vascular surgeon for consideration of treatment is based on the outcomes of the small aneurysms trial. This trial clearly demonstrated benefit of surgical intervention at 55 mm. Data failed to demonstrate longer-term mean survival benefits of early surgery for patients with AAA smaller than 5.5 cm.

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Surveillance intervals are

set at arbitrary timeframes based on less robust evidence, with the assumption that larger AAA should be surveyed more frequently. The NAAASP surveillance programme has recently reviewed its protocols and is set to change, based on data from the RESCAN study. This particular study is showing a mean rate of growth of 1.28–2.44 mm year–1 for AAA between 30–44 mm, and 3.61 mm year–1 for AAA of 50 mm. [3, Rank 3]

Grading of Recommendations

Recommendations are graded according to the Grading of Recommendations Assessment, Development and Evaluation system (**GRADE**). GRADE offers two strengths of recommendation: strong and weak. The strength of recommendations is based on the balance between desirable and undesirable outcomes; the confidence in the magnitude of the estimates of effect of the intervention on outcomes; the confidence in values and preferences and their variability; and whether the intervention represents a wise use of resources.

Strong recommendations are those for which the task force is confident that the desirable effects of an intervention outweigh its undesirable effects (strong recommendation for an intervention) or that the undesirable effects of an intervention outweigh its desirable effects (strong recommendation against an intervention). A strong recommendation implies that most individuals will be best served by the recommended course of action and that the recommendation can be adopted in practice or as policy in most situations. [8, Rank 2]

Strong recommendations are normally based on high-quality evidence (i.e., high confidence in the estimate of the effect of an intervention). Strong recommendations may recommend in favour of an intervention (when there is high confidence of benefit) or against an intervention (when there is high confidence of harm). However, there are ***five circumstances*** in which the task force may consider a strong recommendation based on low- or very low-quality evidence:

- When low-quality evidence suggests benefit in a life-threatening situation (evidence regarding harms can be low or high)
- When low-quality evidence suggests benefit and high-quality evidence suggests harm or a very high cost
- When low-quality evidence suggests equivalence of two alternatives, but high-quality evidence of less harm for one of the competing alternatives
- When high-quality evidence suggests

equivalence of two alternatives and low-quality evidence suggests harm in one alternative

- When high-quality evidence suggests modest benefits and low-or very low-quality evidence suggests possibility of catastrophic harm

Weak recommendations are those for which the desirable effects probably outweigh the undesirable effects (weak recommendation for an intervention) or undesirable effects probably outweigh the desirable effects (weak recommendation against an intervention), but appreciable uncertainty exists. Weak recommendations result when the balance between desirable and undesirable effects is small, the quality of evidence is lower, or there is more variability in the values and preferences of patients. Cases where the balance of cost and benefits is ambiguous, key stakeholders differ about the acceptability or feasibility of the implementation, and the effects on health equity are unclear are likely to result in a weak recommendation. A weak recommendation implies that most people would want the recommended course of action but that many would not. For clinicians, this means they must recognize that different choices will be appropriate for each individual, and they must help each person arrive at a management decision consistent with his or her values and preferences. Policy-making will require substantial debate and involvement of various stakeholders. [9, Rank 4]

Evidence is graded as high, moderate, low or very low quality, based on how likely further research is to change the task force's confidence in the estimate of effect.

Considerations for Implementation of Updated Guidelines

Male sex, family history and increasing age have all been associated with an increased risk of AAA. A review of observational studies on the risk of AAA among smokers indicated that smokers have a higher risk of AAA than never smokers. Current smokers have a higher risk of developing AAA than former smokers. Those who smoke more than 20 cigarettes a day have a higher risk of AAA than those who smoke less. In relation to growth and rupture of an AAA, a meta-analysis conducted by the RESCAN collaboration found that current smoking has a modest impact on growth of an AAA and doubles the risk of rupture. Clinicians could

Ultrasonography was used to screen for AAA in the RCTs because of its relative ease of use and known sensitivity and specificity

ask about smoking history during a discussion on screening for AAA, as patients who have ever smoked may be more interested in being screened. [10, Rank 4]

There is some evidence that ***cardiac failure, renal impairment, chronic obstructive pulmonary disease, peripheral vascular disease, cerebrovascular disease, ischemic heart disease and diabetes are associated with greater risk of death following elective repair of an AAA.*** It is important that men aged 65 to 80 years with chronic health conditions should be aware of their particular risks from elective repair of an AAA before they decide to be screened. In contrast, men older than 80 years who do not have these conditions may choose to be screened. Increasing age and female sex are also associated with increased risk of death following AAA repair.

Ultrasonography was used to screen for AAA in the RCTs because of its relative ease of use and known sensitivity and specificity. A Canadian observational study indicated that, with training, providing AAA screening in a family physician setting was accurate and feasible. [12, Rank 2]

Endovascular repair is less invasive than conventional surgery and has lower perioperative mortality, although long-term outcomes are similar for the two methods. No randomized trials have evaluated the benefits of screen-directed endovascular repair compared with no screening. However, in the judgment of the task force, it is reasonable to assume that benefits associated with screen-directed repair are comparable with endovascular and conventional techniques. Although the less invasive nature of endovascular repair might seem to encourage screening strategies that intervene at an earlier stage (e.g., smaller AAA size) as compared with conventional surgery, this practice is not supported by trial data. Given the less invasive nature of endovascular procedures and lower rates of perioperative death, patients may be more inclined to choose screening where this type of repair is available. [15, Rank 4]

Recommendations are graded according to the Grading of Recommendations Assessment, Development and Evaluation system (GRADE). GRADE offers two strengths of recommendation

Screening Modality of Choice for AAA

Abdominal aortic aneurysms (AAAs) are defined by ***dilation of the abdominal aorta to a maximum diameter of at least 3 cm or 1.5 times that of the normal intervening segment (usually 2 cm in an adult). They are highly prevalent, particularly among elderly males; arising in up to 8% of men over 65 years of age.*** Due to the risk of rupture, AAAs are also potentially lethal and comprise the 14th leading cause of mortality in the United States (U.S.), accounting for 4,500 deaths each year. Yet, AAAs pose a vexing problem: by the time symptoms arise, the aneurysms have usually already ruptured. At this point, treatment is frequently futile and fatality inevitable.

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This clinical scenario provides an ideal backdrop for the introduction of a screening test that would allow early diagnosis of asymptomatic AAAs and timely intervention to prevent rupture and death. In this regard, ultrasound, which is both highly sensitive and specific in detecting AAAs but poses essentially no risk, comes to the forefront as the screening modality of choice. However, as with any screening program, the potential benefits of early detection must be weighed not only against immediate costs (e.g., technical sonography fees) but also long-term downsides such as periprocedural risk. For example, of the 45,000 AAA repairs performed annually in the U.S. to prevent rupture, 1,400 result in death.

Weighing the balance of evidence, the U.S. Preventive Services Task Force (USPSTF) in February 2005 for the first time recommended one-time sonographic screening for AAA in men ages 65–75 who had ever smoked and selected screening in other demographic groups. Herein, the past and present USPSTF AAA ultrasound screening guidelines and their supporting data are reviewed . Alternative guidelines are also discussed. Finally, evolving concepts and controversies in AAA screening are highlighted, including inconsistent data on screening benefits and appropriate follow-up, screening underutilization, and the possibility of clinically significant incidental findings, alternative screening methods, and redundant imaging. [14, Rank 3]

USPSTF AAA Screening Recommendations: Past and Present

The USPSTF guidelines for AAA screening recommended ***one-time sonography in males between the ages of 65 and 75 who had ever smoked. Smoking in these patients are defined as the use of ≥100 cigarettes in their lifetimes.*** This was the most definitive affirmative recommendation and attributed a level "B" grade, indicating that there was at least fair evidence that screening improved health outcomes and outweighed harms, with a moderate net benefit. For male never-smokers aged 65–75, the agency made no general recommendation for or against screening (grade "C"). Finally, for all women, the USPSTF advised against screening, a level "D" recommendation, indicating at least fair evidence that screening was ineffective or harm outweighed the risk.

The updated USPSTF AAA screening guidelines were similar but more nuanced. The agency again recommended one-time sonography in elderly male ever-smokers, with grade "B" evidence. Yet, it is noteworthy that the letter grade definitions changed after July 2012; grade "B" now indicated high certainty of moderate net benefit or moderate certainty of moderate to substantial benefit, with ultimate recommendation to provide the service. Similarly, for elderly male never-smokers, the agency again issued a letter "C" evidence grade. However, under the new definitions, this statement now meant that screening should be "selectively" offered depending on professional judgment and patient preferences, weighing factors that would increase AAA risk (such as cerebrovascular and coronary artery disease) or decrease risk (such as diabetes and African American race). Overall, the agency indicated a moderate certainty of small net benefit. For ever-smoker women ages 65–75, the USPSTF, now issued a class "I" recommendation, indicating that there was insufficient evidence to make a recommendation for or against screening. Finally, for never-smoker women of any age, the agency still recommended discouraging screening, a class "D" statement now indicating moderate or high certainty of no net benefit or on balance harms that outweigh benefits. [18, Rank 2]

The impact on screening practices associated with the availability of the revised guidelines is not immediately apparent. However, in one recent retrospective study of AAA screening utilization at a large tertiary academic medical centre showed that revised guidelines compared to the period before was associated with an increase in the proportion of exams performed in the elderly male ever-smoker population (most appropriate screening group). On the other hand, screening rates in other demographic groups did not significantly change.

Recently, the USPSTF has begun drafting a research plan to re-evaluate the evidence for AAA screening. No new evidence synthesis is currently available. Nevertheless, this ongoing analysis reflects the timeliness of the topic and the need for referring providers and clinical imagers to be cognizant of future potential guideline revisions and associated practice implications. [19, Rank 3

AAA Screening: Sonographic Technique and Reporting Guidelines

Acknowledging inter-operator technique variability, it is recommended that screening AAA ultrasounds be performed by a registered diagnostic medical sonographer with vascular expertise

Acknowledging inter-operator technique variability, it is recommended that screening AAA ultrasounds be performed by a registered diagnostic medical sonographer with vascular expertise (or other similarly qualified personnel). ***Ultrasound equipment and transducers may vary but should allow for adequate penetration and resolution based on patient body habitus and other technical factors.*** The American Institute of Ultr asound in Medicine (AIUM) offers detailed guidelines on the proper performance and reporting of AAA screening ultrasound exams, summarized herein.

According to the AIUM, the abdominal aorta should be scanned in longitudinal and transverse planes along and perpendicular to the long axis of the vessel, respectively. The artery is imaged in its proximal, mid, and distal segments defined by locations below the diaphragm and near the celiac artery, near the level of the renal arteries, and above the iliac bifurcation, respectively. For each of these segments, the anteroposterior (AP) of the abdominal aorta is measured in the longitudinal plane, while the width is measured in the transverse plane. All measurements are performed outer edge to outer edge at the largest visible diameter of the abdominal aorta in each segment. If an aneurysm is detected, its location relative to the renal arteries and aortic bifurcation is documented as well as its maximal dimensions. In addition, longitudinal and transverse images of the bilateral common iliac arteries are captured just below the aortic bifurcation, documenting maximal AP and transverse dimensions from outer edge to outer edge. Finally, color and spectral Doppler with waveform analysis of the aorta and iliac arteries are performed to confirm patency of the vessels and assess for intraluminal thrombus. [22, Rank 4]

For reporting AAA screening ultrasounds, the ***AIUM recommends that exams be classified as "positive" (infrarenal AAA present), "negative" (infrarenal AAA absent), or indeterminate (partial or inadequate abdominal aortic visualization)***. If an aneurysm is detected, the maximum dimension should be indicated. Otherwise, the largest diameter of the abdominal aorta should be noted. Of note, the AIUM makes a clear demarcation between the suprarenal (above the celiac axis) and infrarenal abdominal aorta. For the suprarenal abdominal aorta, the AIUM considers an aneurysm >3.9 cm in a male or >3.1 cm in a female. In contrast, for the infrarenal abdominal aorta, the more common definition (≥3 cm or 1.5× the normal diameter) is used. [25, Rank 5]

USPSTF Recommendations: A Review of The Evidence

The original USPSTF AAA screening guidelines were based on a meta-analysis of studies, prepared by the Agency for Healthcare Research and Quality (AHRQ). The analysis primarily derived from four large randomized controlled trials, which included a combined cohort of male subjects. One study was judged to be of "good" quality evidence according to USPSTF definitions (well-designed, well-conducted study) and the other three of "fair" quality (sufficient but limited evidence), due to lack of information on subject baseline characteristics and whether outcome raters were blinded.

All of the trials included only patients over age 65 and found a reduction in AAA-related deaths associated with the invitation to attend to screening, though only statistically significant in two of the studies. However, of note, there was no significant difference in all-cause mortality. Based on statistical modelling, it was estimated that screening only ever-smokers in the 65–74 year-old male population would detect approximately 89% of all AAAs among men in this age group, thus lending credence to the ultimate USPSTF recommendations. [28, Rank 4]
The report also derived several additional important conclusions. Because no new aneurysms over 4 cm in diameter were diagnosed at 10-year follow-up after an initial screen, rescreening patients after an initial negative result did not appear beneficial. Moreover, there was no significant differ-

ence in AAA-related death or all-cause mortality in patients with aneurysms 4–5.4 cm who were managed with immediate repair rather than serial imaging. Subjects in the surveillance arm were more prone to myocardial infarction, while those in the repair group had more AAA-related hospitalizations. Data on untreated aneurysms measuring ≥5.5 cm was limited, as they are usually not observed. Still, while recognizing significant perioperative morbidity and mortality risks of AAA repair, the agency ultimately concluded that AAAs ≥5.5 cm, known to have rupture rates of more than 9%, should be repaired.

Ultimately, 24 "fair" to "good" quality studies were examined, including 13 randomized controlled trials, 8 cohort studies, and 3 case-control studies. The overall conclusion that one-time AAA screening reduced AAA-related but not all-cause mortality was again verified; this was primarily based on the 4 trials included in the original 2005 report, with longer-follow-up available. The report also raised the possibility of risk prediction analysis to better identify the optimal screening population, noting that such factors as male sex, older age, and smoking history are associated with increased AAA prevalence, while greater years since quitting smoking, nonwhite race/ethnicity, diet, exercise, and diabetes are associated with decreased AAA prevalence. While firm conclusions could not be drawn, these concepts support the USPSTF's ultimate recommendation to offer "selective" screening in elderly male never-smokers. [19, Rank 2]

Interestingly, data on women were still limited primarily to the small cohort described in the report; yet, the USPSTF did ultimately provide different screening recommendations for elderly female ever-smokers compared to other women. The AHRQ report did acknowledge the limitations of the small female cohort and also cited a more recent study that found the prevalence of AAA in female ever-smokers was 2.1%, compared to 0.8% in female never-smokers. In addition, the report noted across studies consistently higher rates of AAA rupture in women compared to men; however, the overall lower prevalence of AAA in females compared to males lowered the net screening benefit.

As before, the balance of evidence did not favor early medical or invasive (open repair or EVAR) therapy for small aneurysms. The report did acknowledge controversy surrounding rescreening after an initial negative exam but again noted that newly detected AAAs were usually small and unlikely to affect clinical outcomes. It is also noteworthy that the 2014 AHRQ report acknowledged the not uncommon scenario of an AAA detected incidentally on computed tomography (CT) performed for other purposes. However, the agency ultimately concluded that such CTs could not be presumed to substitute for sonographic screening due to limited data and potentially incomplete anatomic evaluation or reporting vigilance compared to a structured program. [23, Rank 3]

The USPSTF recently drafted a research proposal to again systematically review the evidence for AAA screening in anticipation of possible further guideline revisions. The proposed questions for further study are largely the same as those appearing in previous evidence syntheses but would incorporate more recent data and longitudinal follow-up. The major issues to be studied include (Figure 4): the effects of one-time screening on health outcomes; variations in outcomes according to risk factors and demographic characteristics; the effects of rescreening after a negative scan; the harms of screening once or more times; the effects of medical or surgery therapy on outcomes for small AAAs <5.5 cm; and the harms associated with treating small AAAs. While the USPSTF has not substantially changed its evidence conclusions or recommendations on AAA screening, continued vigilance is needed to be cognizant of the most current data and their validity.

The major issues to be studied

- The effects of one-time screening on health outcomes
- Variations in outcomes according to risk factors and demographic characteristics
- The effects of rescreening after a negative scan
- The harms of screening once or more times

Figure 4 : Major issues to be studied

AAA Screening: Review of other Guidelines

While the USPSTF recommendations are in general the most widely recognized among practitioners in the U.S., a variety of other guidelines are available. These are not substantially from the USPSTF guidelines but somewhat more inclusive. In the U.S., the American College of Cardiology (ACC) also recommends screening male ever-smokers ages 65–75 but also men ≥60 years old who are siblings or children of individuals diagnosed with an AAA. The Society for Vascular Surgery (SVS), in its most recent publication, recommended screening for all men ages 65 years or above, men ages 55 years or above with a family history of AAA, and women ages 65 years or above with a family history of AAA or past or present smoking use. Finally, the Canadian Society for Vascular Surgery recommends screening all men ages 65–75 if they are eligible for surgery and amenable to it and consideration to screening in women above age 65 or men above age 75 with multiple risk factors; it recommends against screening other women above age 65 and any adult below age 65.

Aside from guidelines, the availability of insurance coverage may ultimately drive provider and patient screening decisions. The U.S. Medicare program has covered the cost of ultrasound screening to ever-smoker men ages 65–75, as per USPSTF recommendations. Interestingly, adults with a family history of AAA are also covered, in a somewhat more inclusive stance compared to that of the USPSTF. AAA screening was initially only covered if referred as part of the "Welcome to Medicare" initial preventive visit. However, effective January 27, 2014, Medicare now only requires a referral from any healthcare professional with requisite ordering privileges. [24, Rank 4]

AAA Screening: Emerging Concepts and Controversies

AAA screening has now been deemed beneficial for over 10 years. However, as new studies amass additional data with longer follow-up, and AAA diagnosis and treatment methods continue to evolve, controversies continue to arise. Indeed, the USPSTF's recent proposal to revisit yet again the evidence for AAA screening highlights the timeliness of this topic. Some of the major emerging concepts are summarized herein.

Validity and Applicability of AAA Screening Guidelines

The prevalence of AAA has declined in the past several decades, in part related to a decline in smoking use, reducing the effectiveness of screening.

In recent years, ***some have questioned the validity and applicability of current AAA screening practices, supported by several arguments. First, the randomized trials on***

which screening guidelines were primarily based did not account for overdiagnosis of aneurysms that would never have ruptured or required surgery at follow-up. Second, the prevalence of AAA has declined in the past several decades, in part related to a decline in smoking use, reducing the effectiveness of screening. Third, the psychological stress associated with a new diagnosis of AAA can never be truly exactly quantified but may tip the balance toward relative harm from screening. Fourth, the detection of small aneurysms may inadvertently lead to overtreatment; indeed, >50% of EVARs in one series were performed on AAAs under 5.5 cm. Fifth, estimates of the cost-effectiveness of screening vary. Finally, the prevalence of AAA is known to be lower in those who undergo screening compared to those who do not undergo screening; thus, offering screening may also accentuate health care inequities without reaching the target population. [36, Rank 2]

While screening criteria are now based primarily on demographic characteristics and high-level risk factors, further insights into the genomics of AAA formation will undoubtedly help to better inform who should be screened. Although several candidate genes have been identified, the science is still in very early stages. Furthermore, size criteria are predictive but crude indicators of AAA rupture. More precise noninvasive modeling of aortic hemodynamic parameters such as wall shear stress, flow displacement, and helicity is now possible with new imaging methods such as four-dimensional (4D) ultrasound and 4D flow magnetic resonance imaging (MRI). While computationally intensive, such techniques could be the standard of care in future years. Assuming AAA screening should be performed as indicated in USPSTF guidelines, current research suggests a pervasive underutilization of the recommended sonography. In fact, utilization is estimated only in the range of <1% to 20% based on Medicare beneficiary data and primary care physician surveys. The elderly poor are disproportionately underscreened and prone to late AAA detection and rupture. In a study, on average just under one AAA screening exam was performed per day, likely out of proportion to the size of large healthcare network that included many screening-eligible Medicare patients. It has been estimated that on average 1.31 years of life are gained per 10 patients screened for AAA, which is similar to estimates for breast cancer screening; thus, greater screening utilization could have a large positive impact on population health. While there is no "silver bullet" for ensuring recommended screening is performed, a multifaceted effort, ranging from provider and patient education to electronic health record reminders and point-of-care tools, may be optimal. [30, Rank 3]

Necessity of Regular Imaging Follow-Up

AAA screening facilitates detection of mostly small aneurysms for which early repair would cause more harm than benefit. While most agree that such aneurysms should have regular imaging follow-up to monitor their size and morphology, recommendations on appropriate follow-up are heterogeneous with limited supporting evidence. Usually, the larger the aneurysm size, the closer the screening interval is suggested; however, the optimal time to wait between exams is not known. For example, follow-up intervals ranging from 1–3 years have been suggested for aneurysms <4 cm, when considering guidelines across multiple countries. A recent meta-analysis by the RESCAN collaborators found that surveillance intervals could be lengthened to 3 years for AAAs 3.0–3.9 cm, 2 years for AAAs 4.0–4.4 cm, and annually for those 4.5–5.4 cm, while maintaining a rupture rate of <1%. At the same, the number of surveillance scans could on average by reduced by more than 50%.

It is also not uncommon for aneurysms to evade follow-up. For example, in one retrospective series, nearly 35% of patients did not obtain follow-up according to the minimum RESCAN standards. Most commonly, the lack of follow-up was due to provider failure to order a repeat scan. Such behavior could be due to a lack of education or robust electronic systems, although the confusion surrounding what merits appropriate follow-up could also contribute to heterogeneity in practice. [36, Rank 5]

Alternative screening modalities and redundant imaging

The evidence review concluded that a CT in which an AAA was incidentally detected could not be presumed to substitute for AAA screening sonography. This may be true on a purist review of the limited available data. However, clinical imagers would likely agree that the aorta is often well-imaged by other modalities such as CT or MRI with fewer technical limitations and less inter-operator variability compared to ultrasound. If the interpreting imager could consistently and accurately assess the quality of the scan (i.e., adequate visualization of entire abdominal aorta) and maintain vigilance in reporting aortic sizes and aneurysms, this could produce several unique opportunities. First, those with a detected aneurysm could reasonably forego screening sonography but be referred for periodic sonographic surveillance. Second, a CT or MRI performed for other purposes might suffice in place of recommended sonographic follow-up after a diagnosis of AAA. Third, some patients without traditional risk factors such as elderly age and smoking use might be serendipitously discovered to have an AAA. Finally, if the AHRQ's conclusion that patients in the traditional screening demographic group do not benefit from rescreening after negative sonography, a normal-caliber aorta on CT or MRI might analogously obviate the need for any additional dedicated screening.

Of course, the caveat remains that measurement technique is likely different and less accurate on sonography compared to other modalities (when a knowledgeable imager is performing the measurements). Thus, it is unclear whether traditional size cutoffs applied to other modalities can predict the same outcomes. Indeed, up to 5-mm intra- and interobserver measurement variability is considered a minimum standard for an acceptable AAA ultrasound screening program, and many centers exceed this threshold. While screening improves outcomes on a population level according to randomized controlled trials when this variation is effectively averaged, the effects of variation on an individual level are not known. [29, Rank 2] Nevertheless, there are likely opportunities to customize screening based on the availability of CT or MRI performed for other purposes. Several studies indicate not infrequent detection of AAAs on abdomen CT or lumbar spine MRI when the abdominal aorta is thoroughly examined. In one single-center retrospective study of over 500 male patients who underwent screening sonography, 20.7% of subjects were found to have had at least one prior radiologic test that adequately imaged the abdominal aorta when the patient was at least 65 years of age. Most commonly, an abdominopelvic CT was available, followed by lumbar spine MRI. While data are not robust, one study found that incomplete AAA imaging surveillance after incidental detection was associated with a decreased likelihood of elective AAA repair and an increased mortality risk. [31, Rank 1]

Incidental findings

Just as other modalities may incidentally reveal an aneurysm, so too may AAA screening sonography incidentally detect unexpected findings that are likely or potentially clinically significant. These ***"incidentalomas"***

may merit clinical evaluation, additional imaging, or periodic surveillance, in turn incurring additional cost and anxiety to the patient. Of course, because patients should not be screened unless asymptomatic, the clinical significance of many incidental findings is not immediately obvious. Still, some findings such as an early renal neoplasm could easily evade clinical presentation for years. Further compounding the issue, a variety of non-radiology personnel may perform and interpret screening AAA sonography. For the sole intention of screening, such practices are not necessarily discouraged and may provide greater availability of services in areas where specialized radiologists are not available. Indeed, studies have shown that only limited sonographic training is required to perform accurate abdominal aortic measurements. Moreover, non-radiologists appear to perform similarly to radiologists in the detection and measurement of AAA. Nevertheless, this heterogeneous group of imagers may not be uniformly attuned to detecting and interpreting the significance of incidental findings outside the aorta. A dual radiologist/non-radiologist interpretive approach as often implemented for cardiac MRI is a possible solution, but it is not clear whether the net benefit would justify the incremental time and cost. [32, Rank 2]

Health Economic Analyses of Optimistic Screening for AAA

In all published decision analytic models of AAA screening hypothetical patients with an AAA ≥ 5.5 cm were assumed to face a constant probability of rupture (average for males aged 65–79 years) no matter how many years they have had a large AAA. In cohort simulations such a constant probability of rupture gives a wrong distribution of death over time and a mean age of males having emergency surgery for ruptured AAA that is much too low. The mean age of death from ruptured AAA is 76 years (range 65–92) for males aged ≥ 65. One way to "build memory" into a model is to implement time dependency, but none of the modelling studies seems to have done so. Accordingly, when underestimating the age of males dying of ruptured AAA in the non-screening group the calculated number of "gained life-years" due to screening and avoiding ruptures is too high. [33, Rank 3]

Most of the health economic studies of AAA screening only included short term hospital costs. Major implications for society due to comorbidity and severe surgical complications (e.g. stroke or chronic renal failure) were not included because most studies did not consider cost after hospital discharge.

Patient pathways after such events can be very costly. Furthermore, screening might induce extra long term cost of treatment of those unfit for surgery.

Economic evaluations did not incorporate evidence that the lives of tobacco smokers are generally shorter than those of the general population, and that they have a higher demand for health services (i.e. higher social and health care costs) and a lower QOL in the remaining life-years.

There has been considerable interest in smoking cessation programmes during the last decade. Successes in reducing the number of smokers have been linked to potential savings in future health care costs. Economic evaluations of AAA screening seem to have ignored the relationship between tobacco smoking and AAA incidence. The incidence may even fall to levels that render population screening ineffective in terms of lives saved, let alone cost. [37, Rank 4]

There is a lower prevalence of large AAAs in males who have never smoked, so the potential benefit from screening non-smokers is small. The USA Preventive Services Task Force recommends AAA screening in male smokers only for this reason. The possibility of screening only male smokers could probably increase cost-effectiveness, although some authors argue the benefit from targeted screening is marginal compared with population screening.

All cost-utility studies assumed that patients with AAA could return to a QOL comparable with the average population: there is only poor evidence for this assumption. None of the randomised trials of AAA screening have collected evidence about QOL before and after screening and elective surgery in the screening group compared to the average population (i.e. the non-screening group). Only studies of QOL with poorer designs have been published. [25, Rank 5]

Furthermore, the clinical literature of QOL after elective repair that are being referred to seems to be in conflict with public health evidence that smokers experience a lower QOL in their remaining years of life compared to the average population. At least more sensitivity analyses should have been done to evaluate the possibility of lower QOL due to comorbidity and severe surgical complications such as chronic renal failure, major amputation or stroke.

Various other factors likely to reduce cost-effectiveness were ignored in the economic evaluations. In most cases, cost calculations were based on open repair and not on endovascular aneurysm repair. Despite lack of evidence of cost-effectiveness, this method of treating AAAs is being used increasingly in many countries. It may reduce early mortality more effectively, but it may substantially reduce the cost-effectiveness of screening. [30, Rank 2]

In all published decision analytic models of AAA screening hypothetical patients with an AAA ≥ 5.5 cm were assumed to face a constant probability of rupture

The possibility is that ad hoc detection of AAA cases will gradually increase as imaging (mostly ultrasonography) becomes more widely utilized for other reasons. This may reduce the prevalent pool of undiagnosed AAAs and hence screening effectiveness.

Researchers found that "eight of the nine population screening models have incorporated at least two assumptions, which would artificially favour a screening programme". This review has not been updated; the search period ended, and they excluded studies conducted alongside trials, which is a major source of evidence for cost-effectiveness. The review includes ten new cost-effectiveness analyses, and only four studies overlap. The review gives the "whole" picture of cost-effectiveness of AAA screening, which have not been presented before.

The individual conclusions of cost effectiveness cannot be rejected on the basis of this systematic review, but we can seriously challenge the assumptions on which the studies of cost-effectiveness are based. This leaves little doubt that the reported cost-effectiveness ratios of AAA screening in most cases have been too low. [39, Rank 3]

Physiological Impact of Updated AAA Screening Guidelines

Abdominal aortic aneurysm (AAA) is defined as an abnormal dilatation of the abdominal aorta of 30 mm or more, and constitutes a significant health problem worldwide. Each year in England and Wales, AAAs cause over 4000 deaths following aortic rupture, with approximately 8000 patients a year undergoing surgery to prevent this. The National Health Service (NHS) AAA screening programme (NAAASP) was fully rolled out across England, based on evidence from several RCTs suggesting that AAA-related mortality was reduced through participation in AAA screening.

This highlights one of the major issues with screening for AAA in that, although it remains cost-effective, the majority of patients identified do not require immediate surgery and are subsequently entered into ongoing surveillance, either 6-monthly or annually. Most men with a screen-detected AAA will spend 3–5 years in surveillance before reaching the threshold for elective AAA repair, rising to over 7 years for men with a 30-mm AAA. [37, Rank 3]

This has led to questions being raised over the psychological impact of AAA screening. Some have even suggested that AAA screening may do more harm than good. A small number of observational studies have investigated quality of life (QoL) in those who are identified at screening to have an AAA, demonstrating varying results and conclusions when comparing screened and unscreened cohorts.

Effects of Updated AAA Screening Guidelines on Long-Term Health-Economic Modelling

Abdominal aortic aneurysm (AAA) traditionally has been considered a disease of men, strongly associated with smoking. However, ***a third of deaths caused by AAA rupture are in women.*** In men, synthesis of four randomised trials has shown a benefit of population-based screening in reducing AAA-related mortality by up to 40% although any reduction in all-cause mortality is small. Several countries have introduced cost-effective population screening programmes for AAA in men aged at least 65 years, and screening for older men is available in the USA.

Abdominal aortic aneurysm (AAA) traditionally has been considered a disease of men, strongly associated with smoking.

The only randomised trial of AAA screening in women, which was done, was underpowered. The US Preventive Services Task Force recommended against screening in women. The reasons for this recommendation include the reportedly lower prevalence of AAA in women, on the basis of the maximum aortic diameter threshold of at least 3 cm, and paucity of evidence about the management of AAA in women. However, with long-term health-economic modelling in men suggesting that population-based screening would be cost-effective with an AAA prevalence as low as 0·35–0·5%, smoking now almost as common in women as in men, and with the association between smoking and AAA almost twice as strong for women compared with men, the case for AAA screening in women needs to be formally assessed. [38, Rank 4]

There would be no quick answers from doing a randomised trial of AAA screening in women, because of the large sample size and long-term follow-up that would be required. The alternative is long-term modelling. This requires contemporary and reliable estimates of parameters that can influence the clinical and cost-effectiveness of screening in women. The aim of this project was to obtain this information and then apply discrete event simulation modelling to explore the hypothesis that a variation of the current AAA screening programmes for men might prove clinically beneficial and cost-effective in reducing deaths from ruptured AAA in women

Historically, abdominal aortic aneurysm (AAA) has been considered to be a disease in older male smokers, with prevalence being 4–5 times higher in men than in women. We searched MEDLINE, Embase, and CENTRAL using the terms "abdominal aortic aneurysm", "aneurysm", "women" OR "gender" OR "sex" OR "women's health" OR "sex difference", "prevalence" OR "incidence" OR "occurrence" OR "frequency", "screening", and "population" OR "population-based".

Abdominal aortic aneurysm (AAA) traditionally has been considered a disease of men, strongly associated with smoking. However, a third of deaths caused by AAA rupture are in women. In men, synthesis of four randomised trials has shown a benefit of population-based screening in reducing AAA-related mortality by up to 40% although any reduction in all-cause mortality is small. Several countries have introduced cost-effective population screening programmes for AAA in men aged at least 65 years,

Four randomised trials of population screening in older men have shown that screening can reduce AAA-related deaths by up to half, meta-analysis of these trials indicate a small decrease in all-cause mortality, and associated studies have shown that screening is cost-effective. Therefore, in many countries or regions, there are programmes for ultrasonographic AAA screening for men. [40, Rank 4]

In women, AAA screening is not recommended as there has been only a single underpowered randomised trial to date. However, the rupture rate of small AAAs is four times higher in women than in men, and a third of the deaths from AAA rupture are in women. Moreover, women with incidentally detected AAA are disadvantaged with respect to availability of elective repair, the types of treatment available, and the higher elective operative mortality and complication rates compared with men. Although the effect of AAA screening on quality of life has been assessed in men, the instruments used might not be sensitive to detect either small changes or changes in specific health domains such as depression and emotional status and, to our knowledge, there have been no studies in women to date. [34, Rank 5]

Surveillance of Updated AAA Screening Strategies

Comprehensive modelling has shown that offering women screening for AAA, using the same screening protocol as for men in the UK, would reduce deaths from AAA in the UK by 7% in women aged from 65 to 75 years and by 3% in women aged from 65 to 95 years, would require 3900 screening invitations to avoid one AAA-death, and would be unlikely to be cost-effective. The best alternative screening strategy was based on screening at age 70 years, giving a reduction of 12% in AAA-related deaths at age 70–80 years and by 8% at age 70–95 years, reducing both the number of screening invitations needed to prevent one AAA-death to 1800 with an overdiagnosis rate of more than 50%. This is in stark contrast to AAA screening in men, for which less than 700 men need to be invited to screening to avoid one AAA-death,5 and for which contemporary modelling, on the basis of current AAA prevalence in the UK, estimates screening to reduce AAA-related deaths by 18% from age 65 to 75 years and by 6% from age 65 to 95 years with a corresponding ICER. [33, Rank 3]

Addressing sex-specific clinical issues might reduce the harms from screening and improve the future clinical benefit and cost-effectiveness estimates for women; these include expanding the use of EVAR in women (to reduce both the non-intervention rate and mortality from elective repair).

The best alternative strategy at age 70 years that used woman-specific definitions of AAA (maximum aortic diameter ≥2·5 cm) is likely to identify many more aneurysms; however, in over half of these women the AAA would have remained asymptomatic without incidental detection. The concern of overdiagnosis must therefore be recognised. The previous definition of AAA for men (a maximum aortic diameter of ≥3 cm) was used in most published studies of AAA prevalence in women, so that prevalence appears to be much lower in women than in men. This is a major driver of the lower cost-effectiveness in women compared with men. In women, the average aortic diameter is smaller than in men, providing reasonable justification for sex-specific diagnosis thresholds, since an aneurysm could be defined by a more than 50% focal increase in arterial diameter. [29, Rank 3]

Impact of Updated AAA Screening Guidelines on Quality of Life

Screening women at age 70 years, as in the best alternative strategy, means that many of these women would not require intervention during their lifetime. Still, after the intervention threshold is reached, elective repair is recommended for most women as was shown by the relatively low proportion of over-treatment in both the reference case (threshold 5·5 cm) and the best alternative strategy (threshold 5·0 cm).

This adds to the debate about whether the threshold for intervention of 5·5 cm, derived from randomised trials in which women were under-represented, could be lowered in women. Women have a four times increased risk of rupture in AAA of less than 5·5 cm diameter for a given AAA diameter compared with men. This risk, together with inspection of the available data for the population distribution of aortic diameters in women, indicates that it would be reasonable to consider lower intervention thresholds in women. A lowered threshold would have the effect of potentially offering elective repair at a younger age, reducing the non-intervention rates and operative mortality. [33, Rank 3]

The possible deleterious effects of a positive AAA diagnosis and subsequent surveillance on quality of life could have a sizeable effect on the cost-effectiveness of screening. Small and temporary changes in utility associated with screening might be important, given that there are concerns that EuroQoL EQ-5D is not sufficiently sensitive to identify such effects. Furthermore, psychosocial consequences of AAA screening, for which the available quantitative studies have been deemed insufficient, could affect health-care costs, and complications following elective repair, which could be more common in women than in men, could further reduce quality of life. Although the magnitude of any decrements needs clarification, their effect is only likely to reduce cost-effectiveness of AAA screening. [25, Rank 5]

Researchers also did not consider the probably higher cardiovascular risk in women with AAA nor the potential benefits of cardiovascular risk management, given that women often are undertreated. A higher risk of other cardiovascular deaths in women with AAA would lower the cost-effectiveness of AAA screening, whereas a screening programme that incorporated risk management could reduce operative mortality and cardiovascular risk, and thus improve cost-effectiveness. Opinion in convened patient and public focus group initially favoured universal screening and did not favour the screening of only high-risk subgroups. Given the strength of the association between smoking and AAA in women, there might be merit and public support in formally assessing the effectiveness of a screening programme for women who have ever smoked. Alternatively, for women it might be more appropriate to consider a combined cardiovascular disease screening programme.

This project has been underpinned by the development and implementation of a bespoke discrete event simulation model to assess AAA screening. This model, which builds on a previously developed Markov model, gives more flexibility to assess different screening options, allows heterogeneity in AAA growth rates between individuals, and permits parameters to depend on patient characteristics, such as elective operative mortality increasing with age and AAA diameter. Other strengths of this research stem from the systematic reviews of the recent literature to obtain best estimates for women-specific parameters, with individual patient clinical trial and registry data providing accurate information on post-operative outcomes for both elective and emergency repair. [32, Rank 2]

A limitation of this research is that there were key quantities for which information was limited or lacking, especially the prevalence of AAA in women (based on woman-specific definition of AAA) and the effect of both screening and elective repair on quality of life. A population prevalence at age 65 years of 0·8% (the upper limit of our sensitivity analysis) would result in a more favourable cost-effectiveness ratio. Conversely, it is possible that prevalence has decreased since the studies were done, reflecting trends in both AAA prevalence seen in men and smoking in women, which could lower the cost-effectiveness of screening. [17, Rank 5]

Prevalence of Competing Comorbidities for Updated AAA Screening Guidelines

Despite excluding the AAA diagnosis and some of the diagnoses made in hospital events proximal to death as part of the M3 index score, people who died from AAA had a much higher level of complexity of comorbidities than the age matched general population in New Zealand as demonstrated by the comparison of the M3 index scores. Since tobacco smoking is strongly associated with AAA, it was not surprising to find that people who died from AAA also had many competing comorbidities which would limit the quality and quantity of life. Indeed, the subgroup with known AAA who had not received abdominal aortic interventions more often had more comorbidities that limit life span such as metastatic cancer and heart failure.

This association is likely to be a challenge for predictive models to stratify the population for those best suited for screening, as people with higher risk of AAA may also be of higher risk of multimorbidity limiting their benefit from screening. The high prevalence of competing morbidities demonstrated in this study may also explain why it is challenging for newer surgical techniques such as EVAR to improve long term survival of people with AAA beyond 1 year, even though EVAR has significantly improved 30-day mortality compared with open repair. Indeed, subgroup analyses from a recent individual level meta-analysis of randomised controlled trials comparing EVAR and open repair did not find early benefit from EVAR for people with moderate renal dysfunction or coronary heart disease. Nevertheless, it would be important for policy makers to consider any new evidence that becomes available in regard to the longer term outcomes of new technological advances. [27, Rank 3]

While many of the morbidities examined by this study are not absolute contraindications to abdominal aortic intervention, they often increase perioperative complexity and overall intervention costs as well as being associated with increased risk of postoperative complications and adverse events. In the context of inevitably treating people with AAA of whom the AAA would have otherwise never caused harm in their life time, it is important to consider the decision to undertake AAA intervention does not always translate to meaningful benefit to patients overall in terms of quality and/or quantity of life.

The trial demonstrated that for people with AAA (≥5.5 cm) who were not eligible for open repair because of comorbidities, EVAR reduced aneurysm related mortality without increasing overall survival. Up to 64% of people who died from AAA might have been potential candidates namely people who had renal dysfunction, cardiac arrythmia, COPD, respiratory failure, heart failure and underlying cardiovascular disease. Preventing a person from AAA rupture alone without significantly prolonging quantity and quality of life because of other morbidities may not be considered as desirable from a people centric point of view. This study highlights the type of common comorbidities that may be worth reviewing and optimising clinically before aortic intervention, as well as allowing a more informed consent about the likely benefits and potential harms related to the aortic intervention. For example, having an accurate assessment of a cancer prognosis or the functional status of people with dementia as appropriate; or optimising cardiovascular disease and heart failure management prior to proposed interventions. [37, Rank 4]

Three situations where hand-held ultrasound administered by non-experts has saved time and had clinical benefits: ectopic pregnancy, AAA, and pericardial effusion.

Updated AAA Screening Guidelines and Diagnostic Accuracy

Hand-held ultrasound is getting increasing interest in various medical fields and strata. Researchers found that abdominal aortic measurements performed by trained medical students were similar to those obtained by experts. They describe three situations where hand-held ultrasound administered by non-experts has saved time and had clinical benefits: ectopic pregnancy, AAA, and pericardial effusion. They found that sensitivity, specificity and predictive values were 100%, in agreement with our previous validation study. They also found that hand-held-ultrasound for AAA screening had a diagnostic accuracy and abdominal aorta measurement comparable to conventional ultrasound. The false positive rate of 21.4% found in the current study could be considered high. However, it should be noted that one of these patients had aortic ectasia and another had a luminal thrombus.

Thus, it could be argued that these are not truly false positives and that the sensitivity is, therefore, higher. Moreover, there is no consensus on the best methods of measuring the diameter of the abdominal aorta. The inner-to-inner and the leading edge-to-leading edge methods give smaller measures of the aortic diameter than the external-to-external wall method, with the estimated prevalence varying from -22% (inner-to-inner) to +36% (external-to-external wall) depending on the method. We chose the external-to-external wall method because confirmatory hospital imaging by standard ultrasound or computer tomography was carried out only to verify the diagnosis. In other words, we accepted an increase in the rate of false positives in order to minimize the risk of false negatives, which could not be observed. This study was performed under real-life clinical setting. Confirmatory hospital imaging by standard ultrasound or computer tomography was used only to verify the diagnosis. Therefore, the study design did not allow some measurements, such as the specificity, negative predictive value or false negative rate. However, this was not the aim of the study and several reports have already demonstrated that this has a good diagnostic accuracy for AAA screening It would have been desirable to explore more combinations of screening intervals and associated AAA size cut-offs. However, the structural changes that are a necessity in an MM would have made this a time-consuming process, thus limiting the number of analyses that could be considered. Conversely, the DES can easily assess any combination of surveillance intervals. To change the interval for patients with a 3.0 to 3.9 cm AAA from one to two years is trivial, because the DES is programmed to allow the input of any chosen partition of the aortic size range with an associated screening interval for each part. This is only possible because an individual's AAA size is measured on a continuous scale. The problems of state transition are further demonstrated when trying to assess the cost-effectiveness of including sub-aneurysmal AAAs in a screening program. In the MM, a new AAA state would need to be incorporated, with extensive reprogramming. In the DES, all that is necessary is to insert "2.5" in the list of surveillance thresholds and "5" in the list of intervals. In addition, the DES parameters can also be easily made to depend on individual-level covariates (e.g., age-dependent mortality rates after surgery). [36, Rank 4]

Rationale for AAA Screening Guidelines

Ruptured aneurysms often occur without warning as AAAs are largely asymptomatic. Ruptured aneurysms are always life threatening and require emergency surgical repair of the abdominal aorta. The risk of death from a ruptured AAA is 80% to 90%. Over one-half of all deaths from ruptured aneurysms take place before the patient reaches a hospital. In comparison, mortality for people undergoing elective surgery is 5% to 7%. However, symptoms for AAA rarely occur prior to rupture. Possible detection of aneurysms at a size when rupture is unlikely to occur is viable through screening. Ultrasound as a screening test for AAA can visualize the aorta in 99% of patients and has a sensitivity and specificity approaching 100% in screening settings for AAAs. In addition, ultrasound is non-invasive, fast, relatively inexpensive, and does not expose patients to radiation. The feasibility of population-based ultrasound screening for AAA has been established through large randomized screening trials

Ultrasound screening can reliably visualize the aorta in 99% of people, has high levels of sensitivity and specificity, and provides the opportunity to detect an AAA at a stage when rupture is unlikely to occur. Early intervention at the presymptomatic stage may reduce the frequency of rupture and subsequently decrease mortality and the requirement for emergency hospital treatment. Elective surgery for an AAA is associated with a 5% to 7% mortality rate compared to a fatality rate of 80% to 90% for emergency repair of a ruptured AAA. [24, Rank 4]

There are opposing views on the risks and benefits of establishing ultrasound screening programs for AAA because of the operative mortality rates associated with surgical repair, particularly for an AAA that would never have ruptured if it had not been detected through screening or left untreated. However, ultrasound screening is reasonably cheap and non-invasive, and AAAs may cause a substantial number of mortalities.

Ultrasound is an extremely sensitive and specific screening test for AAA of all sizes, at least in cases where the diagnosis and size of the aneurysm can be confirmed at surgery. Reported sensitivities range from 82% to 99%, with sensitivity approaching 100% in some studies and in series of screening patients with a pulsatile mass. In one evaluation screening program, ultrasound measurement had a sensitivity of 100% for AAAs of

4.5 cm or more and a specificity of 100% for AAAs up to 3.0 cm. The positive predictive value of ultrasound for AAA screening was 100%. However, in a small proportion of patients, visualization of the aorta will be inadequate due to obesity, bowel gas, or periaortic disease. [34, Rank 3]

The USPSTF made no recommendations for or against screening for AAA in men aged 65 to 75 who have never smoked. The prevalence of large AAAs in men who have never smoked is much lower compared with the AAA prevalence in men who have ever smoked. Because screening and early treatment may lead to harm, including an increased number of surgeries with associated morbidity and mortality, and psychological harm, the USPSTF concluded that the balance between the benefits and harm of screening for AAA is too close to make a general recommendation in this population.

Conclusion

Screening AAA sonography particularly for the elderly male ever-smoker population has now been recommended for more than 10 years. Time will tell whether new USPSTF efforts to revisit the evidence for AAA screening will result in substantial guideline revisions. However, with continued affirmation of a reduction in AAA-related mortality attributed to one-time sonography, current core screening practices are likely to endure as the standard of care in the near future. Still, regardless of future UPSTF actions, there remain many areas for further study and practice improvement, including optimizing screening based on risk factors, increasing screening utilization, clarifying and ensuring appropriate follow-up intervals, managing incidental findings, and exploring the utility of alternative screening modalities. At the same time, the steady accumulation of knowledge about the genetic, physiologic, and biomechanical underpinnings of aneurysm formation, growth, and rupture, coupled with continued advanced in minimally invasive diagnostics and sophisticated imaging technologies, has the potential to transform the field and facilitate much more precise and patient-specific screening practices in coming years. [40, Rank 4]

***Important information for post-test are highlighted in red letters, boxes and diagrams.**

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