Vascular Ultrasound Screening for Asymptomatic Abdominal Aortic Aneurysm

Dépistage par échographie vasculaire de l'anévrisme de l'aorte abdominale asymptomatique

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Abstract

This health technology assessment examines vascular ultrasound screening for abdominal aortic aneurysm (AAA) in asymptomatic populations. Screening reduces the incidence of AAA ruptures, rates of emergency surgical repair and AAA-attributable mortality in males ages 65 to 74. The benefit of screening women has not been established. Ontario data suggest that AAA is underdiagnosed in women, and that women are systematically undertreated. Targeting smokers for screening was found to maximize cost-effectiveness. Economic analysis found that screening may generate savings from the avoidance of emergency surgeries. Based on these findings, the Ontario Health Technology Advisory Committee has recommended screening for AAA in both male and female ever-smokers ages 65 to 74.

Résumé

L'évaluation de cette technologie de la santé se penche sur le dépistage, par échographie vasculaire de l'anévrisme de l'aorte abdominale (AAA) auprès des populations asymptomatiques. Le dépistage permet de réduire l'incidence de ruptures d'AAA ainsi que le taux d'interventions chirurgicales urgentes et le taux de mortalité attribuables aux AAA chez les hommes de 65 à 74 ans. Les avantages du dépistage auprès des femmes n'ont pas encore été démontrés. En Ontario, les données suggèrent que les taux de prévalence et de détection chez les femmes sont sous-estimés et que celles-ci reçoivent un traitement systématiquement insuffisant. On observe que le dépistage ciblé auprès des fumeurs permet de maximiser le rapport coût-efficacité. L'analyse économique révèle que le dépistage peut mener à des économies, notamment en permettant de réduire le recours aux chirurgies urgentes. Le Comité consultatif ontarien des technologies de la santé recommande le dépistage de l'AAA chez les hommes et les femmes, entre 65 et 74 ans, fumeurs ou ex-fumeurs.

Context

Abdominal aortic aneurysm (AAA) is an abnormal dilatation of the aorta that can rupture, often without warning. Ruptured AAAs are always life-threatening and require emergency surgical repair. Risk of death from ruptured AAA is 80% to 90%, with over half of deaths occurring before the patient reaches hospital. In comparison, mortality for individuals undergoing elective surgery is only 5% to 7%. Since AAA symptoms rarely occur prior to rupture, detection of aneurysms at a size when rupture is unlikely is viable through screening. Ultrasound screening can visualize the aorta in 99% of patients, and with sensitivity and specificity approaching 100%, it is non-invasive, fast, relatively inexpensive and does not expose patients to radiation.

The review of AAA screening summarized here was initiated by the Ontario Health Technology Advisory Committee (OHTAC) – an arms-length expert advisory committee composed of clinicians, researchers and administrators – which provides evidence-based recommendations on health technologies to the Ontario Ministry of Health and Long-Term Care. OHTAC met in January 2006 to review the utility of vascular ultrasound screening for AAA in Ontario patients over the age of 65. The committee's complete analysis and recommendations are publicly available (OHTAC 2006a,b).

Policy Questions

- Is population-based ultrasound screening for asymptomatic AAA effective in improving health outcomes?
- How often should screening occur?
- What are treatment options post-screening?
- Are there differences between universal and targeted screening strategies?
- Are there harms of screening?
- What is the cost of universal and targeted screening strategies?

Evidence

Methodology

English-language articles were retrieved from ACP Journal Club, DARE, INAHTA, EMBASE, MEDLINE and references of extracted articles to determine the effectiveness of ultrasound screening for AAA. Case reports, letters, editorials, non-systematic reviews, non-human studies and comments were excluded. Studies that met the inclusion/exclusion criteria were included and appraised for quality. The complete analysis is described in the full report (OHTAC 2006b).

The systematic review yielded four large, moderate- to high-quality, population-based randomized controlled trials (RCT) evaluating screening program effectiveness (Lindholt et al. 2005; Norman et al. 2005; Ashton et al. 2002; Scott et al. 1995) and two high-quality RCTs evaluating management of small aneurysms after screening (Lederle et al. 2000; UK Small Aneurysm Trial Participants 1998). Three low- to moderate-quality RCTs (Lederle et al. 2000; Norman et al. 2005; Jamrozik et al. 2000), one meta-analysis of 14 population-based screening studies (Cornuz et al. 2004) and administrative database information (Ontario Ministry of Finance 2005; Statistics Canada 2001) were included to evaluate targeted screening strategies based on risk factors associated with AAA prevalence in screening studies. Analysis of the psychological effects of AAA screening was based on moderate-quality RCTs and observational studies (Ashton et al. 2002; Lederle et al. 1997; Lucarotti et al. 1997;

Lederle et al. 2003; UK Small Aneurysm Trial Participants 1998; Spencer et al. 2004; Wanhainen et al. 2004). Screening trial results were stratified by sex. Meta-analyses were conducted for men aged 65 years and older, and, for both sexes in the small-aneurysm trials, for which reporting was not stratified by sex.

Effectiveness

Meta-analysis among men aged 65 to 74 indicated that invitation to a population-based AAA ultrasound screening reduced AAA rupture incidence (odds ratio [OR] 0.50; 95% confidence interval [CI] 0.31, 0.80: absolute difference [AD] –0.16%), rates of emergency AAA surgical repair (OR 0.46; 95% CI 0.24, 0.88: AD –0.09%) and AAA-attributable mortality (OR 0.57; 95% CI 0.45, 0.74: AD –0.12%); but had no significant impact on all-cause mortality (OR 0.97; 95% CI 0.93, 1.01: AD –0.19%); and increased elective surgical repair rates for AAA >5 cm (OR 3.18; 95% CI 2.11, 4.79: AD 0.56%) (Lindholt et al. 2005; Norman et al. 2005; Ashton et al. 2002; Scott et al. 1995). Meta-analysis of small-aneurysm (4.0–5.4 cm) trials indicated no significant differences in survival between early elective surgical repair and surveillance for AAA-attributable mortality (OR 0.77; 95% CI 0.54, 1.12: AD –1.27%) or all-cause mortality (OR 0.99; 95% CI 0.66, 1.48: AD –0.36%). These findings support surveillance as the appropriate small-aneurysm treatment option after screening and offering surgical repair for AAA ≥5.5 cm (Lederle 2000; UK Small Aneurysm Trial Participants 1998).

Smoking is the greatest risk factor for developing AAA. The impact of screening based on smoking status was modelled using assumptions based on meta-analysis of the screening trials combined with Ontario population data (2005) and smoking prevalence estimates from the National Population Health Survey (Ontario Ministry of Finance 2005; Statistics Canada 2001). Targeted screening based on smoking history may detect 89% of prevalent AAAs and increase screening program efficiency. The number needed to screen (NNS) to prevent one AAA death was 288 for ever-smokers and 1,024 for never-smokers.

The only screening trial including women found no evidence of effectiveness for AAA screening; however, the sample size was small (Scott et al. 1995). According to Ontario administrative data, women have a higher than expected ruptured AAA case-fatality rate and later age of onset for AAA, potentially introducing harms of screening, since treatment would occur at older ages.

One-time screening is sufficient for a population-based screening program (Lederle et al. 2000; Emerton et al. 1994). The average detection rate of AAA ≥3 cm was 5% from the screening trials (Lindholt et al. 2005; Norman et al. 2005; Ashton et al. 2002; Scott et al. 1995). Among 1,011 men aged 65 to 80 with negative scans, the incidence of new aneurysms at 10 years was 4%, with no new aneurysm larger than 4.0 cm (Scott et al. 2001).

Elective surgical repair was associated with a 6% operative mortality rate in screening trials (Lindholt et al. 2005; Norman et al. 2005; Ashton et al. 2002; Scott et al. 1995), and approximately 3% of small aneurysms 3.0–4.5 cm ruptured during surveillance (Lederle et al. 2000; UK Small Aneurysm Trial Participants 1998). Less than 1% of aneurysms are not visualized on initial screen. Although increased anxiety is associated with screening, there is no evidence of permanent psychological harm (Ashton et al. 2002; Lindholt et al. 2000; Lucarotti et al. 1997; Lederle et al. 2003; UK Small Aneurysm Trial Participants 1998; Spencer et al. 2004; Wanhainen et al. 2004).

Economic evaluation

Three options were analyzed for up-front budget impact where the entire specified cohort was screened over a three-year period with repeat screenings for two subsequent years for prevalent AAA cases using focused (abdominal aorta) ultrasound: (a) male ever-smokers ages 65 to 74, (b) male and female ever-smokers ages 65 to 74 and (c) all males and females ages 65 to 74. Quick-screen ultrasound was chosen owing to shorter time needed to screen patients, lower cost in comparison to full abdominal scans and high-level diagnostic accuracy for screening (Lee 2002).

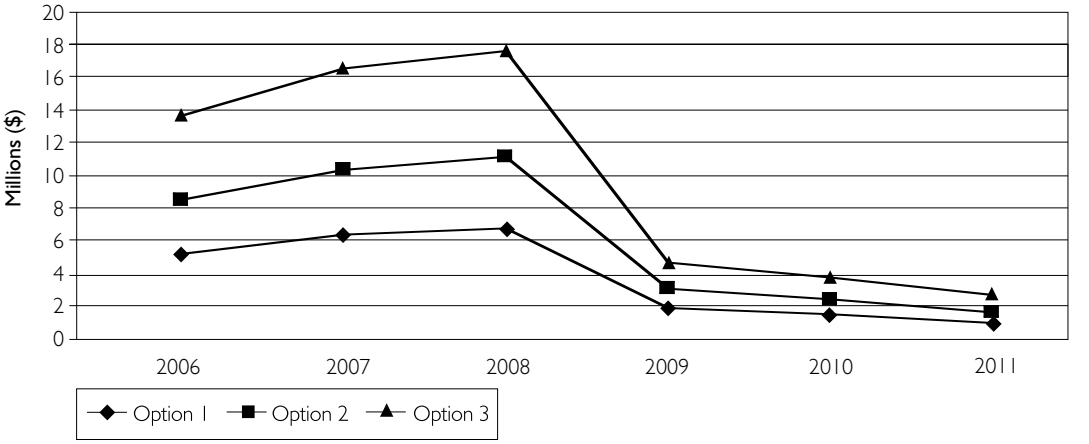
In Ontario, the technical and professional cost of an ultrasound of the aorta is $53.80. Figure 1 shows the direct total budget impact of each screening option as implemented over three years. The up-front budget impact takes into account only the cost of screening. Costs decrease in subsequent years once the entire cohort (as defined by the option) undergoes screening. Table 1 displays the general assumptions used in the budget impact model.

Screening can also generate downstream savings to the hospital system. With screening, the number of urgent cases can be reduced, as these can now move to elective surgeries. At present, ruptured AAAs account for 15% of urgent repair, and unruptured cases account for another 15% of urgent cases. The hospital cost for a ruptured urgent case is $30,157 versus $17,996 for an unruptured elective case (Ontario Case Costing data, OCCI 2008). Analysis based on current practice patterns indicates savings of $6,826 for each emergency ruptured repair avoided, and $5,883 for each emergency unruptured repair avoided by elective surgical repair.

Policy Considerations and Recommendations

AAA screening programs exist in other jurisdictions. In Ontario, there are approximately 331,214 men and 211,825 women aged 65 to 74 who have a history of smoking; corresponding estimates for never-smokers are 82,286 for males and 246,175 for females.

FIGURE 1. Budget impact of screening options (2006–2011)*



* Option 1: All males aged 65 to 74 years that have ever smoked (80.1% smoking rate); Option 2: Males and females aged 65 to 74 years that have ever smoked (80.1% and 46.25% smoking rates, respectively); Option 3: Universal screening of males and females aged 65 to 74 years.

TABLE 1. Assumptions used in budget impact model

Population description	Estimate
a) Percentage of ever-smoked males > 65 years	80.10%
b) Percentage of ever-smoked females > 65 years	46.25%
c) Percentage of repeat screens	6.40%
d) Acceptance rate for screening	72.00%
e) Percentage of males > 65 years	8.00% (2006)
f) Percentage of females > 65 years	9.70% (2006)

Sources: (a–b): Statistics Canada 2001; (c) average across 4 screening trials (Lindholt et al. 2005; Norman et al. 2005; Ashton et al. 2002; Scott et al. 1995); (d) Crow et al. 2001 and Cornuz et al. 2004; (e–f) Ontario Ministry of Finance 2005.

Substantial system pressures related to AAA screening include ultrasound screening, patient waiting rooms, ultrasound technologists, radiologists, operating room time, acute care hospital beds and numbers of vascular surgeons in the province. There are also pressures associated with follow-up and aftercare of patients, including repeated scans of small aneurysms. Use of an aorta-only ultrasound takes <10 minutes to perform reducing cost, time and potential incidental findings of conditions unrelated to screening (e.g., benign lesions) associated with a traditional full abdominal scan screening test. Increases in primary care, radiology and vascular surgeon workloads and associated costs are expected with screening program implementation. Despite the increase in services for both surveillance of small aneurysms and elective repair, urgent and emergency repairs would be avoided, with reductions in operative complications and mortality rates.

Smaller aneurysms in women may be of more clinical significance since women normally have a smaller aortic diameter than men. A 5 cm aneurysm in a woman

stretches the aortic wall to a greater extent, and aneurysms in women rupture more frequently and at smaller diameters (Small Aneurysm Trial Participants 1998). Canadian studies indicate that there is a gender bias regarding diagnosis and patient selection for surgical treatment of AAA. (Johnston 1994; Parsons et al. 1997) Although there is insufficient evidence to support screening women for AAA, ultrasound screening is relatively inexpensive and could be considered for this population taking into account the smaller aortic diameter in women and later ages of rupture.

Screening has been found to be cost-effective and increase life years saved (Wanhainen et al. 2005; Boll et al. 2003; Lee 2002; UK Small Aneurysm Trial Participants 1998; Multicentre Aneurysm Screening Study Group 2002; Connelly et al. 2002). Despite the initial cost of establishing screening in Ontario, screening results in cost avoidance of emergency repairs, decreased morbidity from operative complications and reduced number of unnecessary deaths due to ruptured aneurysms. Savings from AAA screening result from the cost difference between urgent emergency repair and the lower cost (and associated lower complication and mortality rates) of elective surgical repair of AAA. Cost-effectiveness of AAA screening compares favourably with cited estimates of $26,000 to $44,000 USD per quality-adjusted life-year for cervical cancer, hypertension and breast cancer screening programs that are currently practised in Ontario (Wanhainen et al. 2005).

Based on the above findings, OHTAC recommended to the Ontario Ministry of Health and Long-Term Care:

- AAA screening for men and women ages 65 to 74 years with a history of smoking;
- Pragmatic evaluation of AAA screening outcomes, especially given the paucity of evidence for women; and
- An implementation strategy to be developed to introduce AAA screening, including stakeholder involvement to promote AAA screening.

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