Periodic health examination, 1991 update: 5. Screening for abdominal aortic aneurysm

Canadian Task Force on the Periodic Health Examination

In this update the Canadian Task Force on the Periodic Health Examination used its standardized method for evaluating and weighing the scientific evidence[1] to evaluate screening for abdominal aortic aneurysms (AAAs) among asymptomatic people. It found that the potential benefits of screening were unclear because of a lack of evidence. In the MEDLINE search for articles published from 1990 to the present "aortic aneurysm" was used as a major heading and "aorta, abdominal" as a major or minor heading; case reports were excluded. Searches of MEDLINE for articles published from 1981 to 1989 were done with the use of the heading "abdominal aortic aneurysm." Pertinent references of identified articles were reviewed and a content expert was consulted.

Screening for Abdominal Aortic Aneurysms

An aneurysm is a localized abnormal dilation of an artery caused by structural weakness. An AAA (defined as dilation of the aorta of more than 3 cm detected by means of ultrasonography) most frequently arises below the renal arteries and may extend beyond the bifurcation. Although such aneurysms occasionally result from infection (e.g., syphilis) or congenital connective tissue disease (e.g., Ehlers–Danlos syndrome) most are due to atherosclerotic changes affecting the arterial wall. As an aneurysm enlarges it may remain asymptomatic for many years. Most AAAs are asymptomatic until they rupture. Symptoms occur from the effects of pressure on adjacent structures (e.g., back pain), from embolization of a thrombus (which forms within the lumen of the aneurysm) or in association with other symptoms such as intermittent claudication caused by atherosclerosis.

Despite the low prevalence of AAAs there is considerable interest in detecting the condition through screening, since noninvasive diagnostic techniques are available and a natural history of slow expansion provides the opportunity for early detection. Rupture is almost invariably fatal without surgery; even with surgery the death rate remains high. Elective resection of an identified aneurysm

__Chairman:__ Dr. Richard Goldbloom, professor, Department of Pediatrics, Dalhousie University, Halifax, NS. __Vice-chairman:__ Dr. Renaldo N. Battista, director, Division of Clinical Epidemiology, Montreal General Hospital, Montreal, Que. __Members:__ Drs. Geoffrey Anderson, assistant professor, Department of Health Services Research and Development, University of British Columbia, Vancouver, BC; Marie-Dominique Beaulieu, professor and director of research, Department of Family Medicine, University of Montreal, Montreal, Que.; R. Wayne Elford, associate professor and chairman of research, Department of Family Medicine, University of Calgary, Calgary, Alta.; John W. Feightner, associate professor and research director, Department of Family Medicine, McMaster University, Hamilton, Ont.; William Feldman, professor of pediatrics, University of Toronto, and head, Division of General Pediatrics, Hospital for Sick Children, Toronto, Ont.; Alexander G. Logan, associate professor, Faculty of Medicine, University of Toronto, Toronto, Ont.; Brenda Morrison, associate professor, Department of Health Care and Epidemiology, University of British Columbia, Vancouver, BC; David Offord, professor, Department of Psychiatry, McMaster University, Hamilton, Ont.; Christopher Patterson (__principal author__), associate professor and head, Division of Geriatric Medicine, Faculty of Health Sciences, McMaster University, Hamilton, Ont.; Walter O. Spitzer, professor and chairman, Department of Epidemiology and Biostatistics, McGill University, Montreal, Que.; and Elaine Wang, assistant professor, Department of Pediatrics, Faculty of Medicine, University of Toronto, Toronto, Ont. __Resource people:__ Dr. Phillip Mickelson, medical consultant, health standards, Health Services Directorate, Department of National Health and Welfare, Ottawa, Ont.; Ms. Jennifer Dingle, coordinator, Canadian Task Force on the Periodic Health Examination, Department of Community Health and Epidemiology, Dalhousie University, Halifax, NS; and Ms. Brenda Beagan, research associate, Canadian Task Force on the Periodic Health Examination, Department of Community Health and Epidemiology, Dalhousie University, Halifax, NS.

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is routine and is associated with a low operative death rate and a virtually normal life expectancy.

Burden of illness

The prevalence of AAA has been estimated to be 0.4% to 5.4% among older men in primary care settings[2-4] and 5.3% to 21% among men and 6% to 12% among women attending hospital hypertension, cardiology or outpatient clinics.[5-11] Large autopsy studies[12,13] have reported prevalence rates of 6.6% overall and 3% among people over 40 years of age.

Prevalence varies with geographic location and increases with age,[13,14] male sex[5,7,14] and possibly coexisting vascular disease; the direct association of hypertension and AAA is unclear,[4] but hypertension is associated with reduced survival after aneurysmal repair.[15] There are limited data on the prevalence of aneurysms in different racial groups; Auerbach and Garfinkel,[13] in an autopsy study, noted a prevalence rate of 2.4% among 282 black subjects and 7.5% among 1130 white subjects. Familial clustering of aneurysms occurs,[16,17] possibly through X-linked dominant, autosomal dominant or multifactorial transmission.[18,19] The MZ phenotype for α_1-antitrypsin was found more frequently in patients with AAA (11%) than in the general population (3% to 4%); this suggests a genetic predisposition for AAA.[20] There also appears to be an association between cigarette smoking and the development of aneurysms.[7,10,13] Some of the variation in prevalence rates and the apparent increase in prevalence may be due to improved detection, but this has not been documented in the literature.

Among people over 55 years of age AAA has been reported to have an annual incidence of 22 to 499 per 100 000 men and 20 to 315 per 100 000 women;[21-24] these findings were based on (a) diagnosis through physical examination and radiology, (b) hospital admissions and (c) autopsy data. The incidence of AAA increases with age[15,21-23,25] and at all ages is higher among men.[15,21]

Data on the rate of expansion of AAAs are conflicting but generally indicate that smaller aneurysms increase in size more slowly than larger ones.[26-29] Studies involving patients referred for possible vascular surgery showed the mean expansion rate of aneurysms less than 5 cm in diameter to be 0.37 to 0.48 cm/yr.[26,27,30,31] Community-based studies found a smaller mean expansion rate (0.17 to 0.33 cm/yr); the median expansion rate was 0.13 to 0.22 cm/yr.[28,29,32,33] Limited data on aneurysms larger than 5 cm in diameter have provided estimated mean expansion rates of 0.34 to 0.72 cm/yr.[26,27] Mathematical modelling has suggested that over time the expansion rate is exponential.[34]

When an aneurysm ruptures, the classic symptoms are excruciating back pain, hypovolemic shock and a pulsatile abdominal mass. The mass may be difficult to palpate in the presence of a large retroperitoneal hematoma. Clinical series have demonstrated that although pain almost always signals aneurysmal rupture, the classic triad is present in approximately 70% of cases reaching hospital.[35] In three studies rupture was the initial presenting event in 20% to 35% of patients with AAA.[36-38] Saccular aneurysms are more likely to rupture than fusiform ones. The incidence of rupture increases with age[22-25] and aneurysm size.[29,39,40] Although the absolute size is important it should be considered in relation to the diameter of the aorta, which is usually 2 cm at the diaphragm in men 65 to 74 years.[3] In 24 000 consecutive autopsy examinations at the Massachusetts General Hospital, Boston, 473 cases of AAA were identified; of the aneurysms less than 4 cm in diameter 9.5% had ruptured, and of those greater than 10 cm in diameter 60.5% had ruptured.[39]

In a retrospective series of 67 patients (mean age 72 years) whose initial mean aneurysm diameter was 3.9 cm and who were too unwell for surgery the annual rate of rupture was 6%.[40]

After 8 years of follow-up in a community-based retrospective study none of the aneurysms less than 3.5 cm in diameter had ruptured. Of the aneurysms between 3.5 and 4.9 cm in diameter 5% had ruptured by 9 years, and of those greater than 5 cm in diameter 25% had ruptured by 8 years. Overall, 6% of the aneurysms had ruptured by 5 years and 8% by 10 years.[29] These low rupture rates have been criticized because the authors excluded five patients in whom rupture occurred less than 48 hours after the ultrasound examination, and autopsy data may have either overrepresented or underrepresented the cause of death from AAA rupture. No ruptures were documented at autopsy for more than 25 aneurysms less than 5 cm in diameter that had been surgically repaired.[29] Thus, the natural history of AAA involves slow expansion until the aneurysm reaches 5 to 6 cm in diameter. Thereafter, the aneurysm grows more rapidly and ruptures at a predictable rate.

AAA was the cause of death in 1.2% of men and 0.6% of women in the United States in 1974.[41] In Britain it was the cause of death in 1.5% of those over 50 years of age.[12] Standard rates of death from aortic aneurysms in Canada were 9.0 per 100 000 men and 2.8 per 100 000 women in 1986 (Dr. Gerry Hill, Laboratory Centre for Disease Control, Ottawa: unpublished data). Similar death rates were reported from 1974 to 1978 (10.1 and 2.9 per 100 000 respectively), when the hospital separation rate for AAA was 23 per 100 000 men and 6 per 100 000 women (Table 1).[14] Fig. 1 shows the trends in the rates of death from AAA in Canada from 1951 to 1986.

Detection manoeuvres

AAA may be detected through physical examination, ultrasonography, plain abdominal radiography, aortography, computerized tomography (CT) or magnetic resonance imaging (MRI). The screening characteristics of these procedures have not been fully explored because of the inherent difficulties in obtaining surgical confirmation of the diagnosis (or in performing a superior diagnostic test) in sufficient numbers of asymptomatic subjects.

Physical examination

In surgical patient series 65% to 90% of aneurysms were palpable.[37,42-46] However, in series with a lower prevalence rate and smaller, harder-to-detect aneurysms physical examination was usually less sensitive (22% to 96%).[6,9,10,47-49] Structures other than the aorta may be felt to pulsate, which will lead to a false-positive diagnosis of AAA;[47,48] the specificity of physical examination has been reported to be 69% to 94%[6,9,37,48] and the positive predictive value 9.5% to 91%.[6,9,37,47,48,50,51] The wide variation in sensitivity and specificity may be related to the size of the AAA and to the experience and skill of the examiner. Even when an aneurysm is present its size may be overestimated at physical examination.[6,42,52]

It remains to be established whether most aneurysms 4 cm or greater in diameter can be reliably detected through physical examination in a primary care setting.

Ultrasonography

Abdominal ultrasonography is ideal for detecting and estimating the size of an AAA. It appears to have a sensitivity approaching 100% in detecting AAAs in symptomatic patients with a pulsatile abdominal mass.[37,46] The sensitivity varies from 82% to 99%.[5,38,47,51,53,54] When compared with intraoperative measurement with the use of calipers ultrasonography appears to overestimate the size of the aneurysm;[45,46,52,55] this is apparently due to difficulty in distinguishing the layers of the aortic wall. Graeve and associates[56] argued that the true size of the aneurysm can only be measured intraoperatively by passing a calibrated needle through the anterior wall of the aneurysm until it reaches the vertebrae. When compared with needle measurement ultrasonography is extremely accurate in estimating the anteroposterior diameter of an aneurysm, high concordance being demonstrated in 15 patients undergoing elective AAA repair.

Although earlier studies of ultrasonography used B-mode technology, the newer grey-scale technology is superior in definition and diagnostic accuracy.[57]

Technical problems arise with ultrasonography if the patient is obese or has excessive intestinal gas at the time of examination. In addition, patient compliance with an invitation to be screened for AAA in the primary care setting can be poor (38% to 93%).[2-4,10]

Other imaging techniques

Plain abdominal radiography reveals an aneurysm only when there is calcification within the wall. This precludes an accurate estimation of AAA size or presence in 40% to 67% of cases.[42,52,58] Aortography involves arterial cannulation and injection of radio-opaque dye and is thus unsuitable for screening purposes. Digital subtraction angiography is similarly unsuitable.

CT scanning is highly sensitive and specific for the identification of AAA and may be more accurate than abdominal ultrasonography.[46,57] However, CT scanning is less available than ultrasonography, is significantly more expensive in terms of capital outlay and operating expenses and involves the additional risk of intravenous radio-opaque dye. MRI offers new standards in image definition but is not widely available and is extremely expensive.

Table 1: Rates per 100 000 population of hospital separations and deaths related to aortic aneurysms by age and sex in Canada, 1974 to 1978[14]

	Sex; hospital separation rate		Sex; death rate	
Age, yr	Men	Women	Men	Women
35–44	2	1	1	0
45–64	38	7	11	2
65–74	170	40	64	14
≥ 75	189	81	134	51
All	23	6	10	3

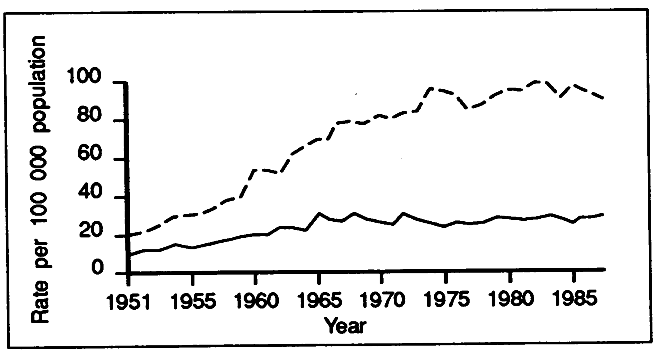

Fig. 1: Rates of death from abdominal aortic aneurysms per 100 000 population in Canada from 1951 to 1986. Squares represent data for men and crosses data for women. (Dr. Gerry Hill, Laboratory Centre for Disease Control, Ottawa: unpublished data.)

Effectiveness of intervention

There are no studies comparing screened and unscreened asymptomatic populations in terms of AAA-related illness and death. Although there are also no controlled trials demonstrating the effectiveness of surgical treatment, the best evidence from case series and before–after studies is compelling. In a series of 102 untreated patients with AAA (reported on before the widespread use of surgery in 1950) the death rate was 51% at 3 years and 81% at 5 years, as compared with the expected death rates of 12% and 21% respectively determined on the basis of life-table analysis.[59] Series that included patients for whom surgery was contraindicated reported similar death rates: 65% to 67% at 3 years and 81% to 85% at 5 years.[60-62] A retrospective study from the Okanagan Valley, BC, reported a 5-year death rate of 67% among those receiving medical treatment of AAA.[63]

There was no effective surgical treatment for AAA until 1951, when the replacement graft technique was introduced.[64] Since then the development of better graft materials and improved surgical and supportive techniques have led to an impressive improvement in surgical outcome.

Most centres now perform elective surgical repairs, with a rate of death in hospital of less than 5%.[36,38,65-78] Death is more likely when the aneurysm is large, there is impaired renal function, the blood loss is greater than 4 units[79] or coronary artery disease is present.[79,80] Immediate postoperative causes of death include myocardial infarction, cardiac arrest, acute renal failure, pulmonary embolism, femoral artery embolism, gastrointestinal hemorrhage, respiratory failure and sepsis. If there is no coexisting disease the survival curve closely approaches that for age-matched control subjects.[73,77,80] However, postoperative death rates are higher among people with AAA who have hypertension or vascular disease and closely parallel the rates among age-matched subjects with vascular disease but no aneurysm.[15]

Waiting for symptoms to occur is unsatisfactory, since many aneurysms rupture before less urgent symptoms develop. Only 38% to 64% of those with ruptured AAAs reach hospital alive.[81] Surgical death rates continue to be extremely high among those with ruptured aneurysms and in many cases exceed 50%.[17,36,38,39,65-76,78,82-84] These figures argue strongly for the identification and elective surgical repair of aneurysms that have not ruptured. Death rates among symptomatic patients with nonruptured aneurysms are intermediate between those for patients undergoing elective surgery and those for patients undergoing emergency repair. As a rule elective surgery is not recommended unless the aneurysm is at least twice the diameter of the proximal aorta. Reconstruction is generally recommended when it is 5 cm or greater in diameter.[85]

Although there is no medication that has been proven to slow the rate of expansion of AAAs treatment of coexisting hypertension has been recommended.[86] In one small retrospective study the expansion rate was lower among patients who were receiving β-adrenergic blocking agents than among those who were not (0.17 v. 0.44 cm/yr).[87]

The detection of an aneurysm in an asymptomatic patient may lead to excessive anxiety concerning potential rupture. However, no literature on this subject is available.

Two estimates of the cost of surgery have been published,[74,75] but in both the details of the economic analysis were sketchy and no indication was given of sensitivity analysis or comprehensive cost allocation.

Pasch and collaborators[74] estimated that the total hospital cost of elective AAA resection was $10 114 (standard deviation [SD] $963) (1984 US dollars). The cost of surgical repair of a ruptured AAA was $18 223 (SD $6193). The average length of hospital stay was similar in the two groups (16 days), greater variation occurring among the 20 with a ruptured aneurysm (16 [SD 5.7] days) than among the 109 undergoing elective surgery (16 [SD 1.4] days). Taking into account the surgical death rate of 70% in the ruptured aneurysm group and 3.6% in the elective surgery group the authors estimated the cost per survivor to be $34 369 for repair of a ruptured AAA and $10 866 for an elective resection.

Cooley and Carmichael,[75] in an editorial response to the figures of Pasch and collaborators, stated that at the Texas Heart Institute, Dallas, the in-hospital cost of elective AAA repair was $6829 and repair of a ruptured aneurysm $10 650.

In Malmö, Sweden, a mathematical model has been created to explore the cost per year of expected prolongation of life that could result from abdominal ultrasound screening among 100 000 men aged 60 years followed up for 20 years.[88] The direct health care costs were estimated to be $10 833 to $22 833 (1986 US dollars) for elective surgery and $22 833 to $45 666 for emergency surgery. The authors concluded that if screening were to be carried out there would be a very high cost in terms of life-years lost from surgery within the first year of screening and then a net gain in lives saved. The cost per life-year gained was $7591 for those without coexisting vascular disease and $6379 for those with intermittent claudication.

Another estimate, from Britain, suggested that the cost per quality-adjusted life-year for abdominal ultrasound screening varied from £440 for a 60-year-old man to £1510 for an 80-year-old woman.[89]

Conclusions

The prevalence of AAA is low in the general population. Risk factors include male sex, high age, coexisting vascular disease, a family history of AAA and smoking. Physical examination is relatively insensitive for detecting small aneurysms (which would be considered for follow-up observation) but appears to be more sensitive for detecting larger aneurysms (which may require resection). Abdominal ultrasonography is highly sensitive and specific, even for small aneurysms. Elective resection is clearly preferable to waiting for symptoms to develop. Estimated costs for widespread screening are high but not excessive. Compliance with screening has generally been poor.

Because the prevalence and incidence of AAA is age and sex dependent it has been argued that physical examination of men over the age of 60 is a prudent manoeuvre.[90] Ultrasonography should be used if any suspicious pulsation is detected, if the aorta is tender or if obesity makes estimation of the aortic diameter difficult. For people who smoke and have hypertension, claudication or other evidence of vascular disease or a family history of AAA a more liberal policy of case-finding through ultrasonography could be considered. Referral to a vascular surgeon is indicated for aneurysms greater than 5 cm in diameter or for saccular aneurysms regardless of size.[86] Expert opinion[86] also supports serial ultrasonography (every 3 to 6 months) and treatment of hypertension and other risk factors after the detection of aneurysms smaller than 5 cm in diameter.

Recommendation (Table 2)

There is poor evidence to include screening through physical examination or ultrasonography for abdominal aortic aneurysms in or exclude it from the periodic health examination of asymptomatic people.

Research priorities

The following are areas of research recommended at an international workshop on AAA held in Ottawa in January 1989.[85]

1. In the primary care setting determining the characteristics of physical examination to detect AAAs of different sizes, ultrasonography being used as the gold standard.

2. Determining the natural history of small AAAs discovered through screening with the use of serial ultrasonography. (Studies are under way.)

3. Defining and quantifying risk factors for the

Table 2: Summary of manoeuvre, effectiveness, level of evidence and recommendation for screening for abdominal aortic aneurysms

Manoeuvre	Effectiveness	Level of evidence*	Recommendation*
Physical examination	Can have poor sensitivity in detecting small aneurysms and has not been evaluated among asymptomatic people in terms of detection rate or impact on death	Cohort studies[6,9,37,47,48,50,51] (II-2)	Poor evidence to include in or exclude from periodic health examination of asymptomatic people (C)
	Death rate is considerably lower for elective resection than for emergency resection of ruptured aneurysm	Case series and before–after studies[17,36,38,39,65–84] (III-3)	
Ultrasonography	Has not been evaluated in primary care in terms of detection rate or impact on death, but its sensitivity and specificity are excellent for people with positive clinical findings	Cohort studies[5,37,38,46,47,51,53,54] (II-2)	Poor evidence to include in or exclude from periodic health examination of asymptomatic people (C)
	Death rate is considerably lower for elective resection than for emergency resection of ruptured aneurysm	Case series and before–after studies[17,36,38,39,65–84] (III-3)	

*For descriptions of the other levels of evidence and classification of recommendations see Appendix I in part 1 of the 1989 update (*Can Med Assoc J* 1989; 141: 206).

development and rapid expansion of AAAs.

4. Determining the value of ultrasound screening for AAAs in high-risk people.

5. Determining the most effective strategy for physician education, since physicians other than vascular surgeons may not be fully aware of the outcome of elective and emergency surgery.

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