Eur J Vasc Endovasc Surg (2010) **39**, 208—216

Screening for Abdominal Aortic Aneurysm among Patients Referred to the Vascular Laboratory is Cost-effective

K. Mani [a,*], M. Ålund [a], M. Björck [a], J. Lundkvist [b], A. Wanhainen [a]

[a] *Department of Surgical Sciences, Section of Vascular Surgery, Uppsala University Hospital, SE-751 85 Uppsala, Sweden*
[b] *Medical Management Centre, Karolinska Institutet, Stockholm, Sweden*

Submitted 31 August 2009; accepted 4 November 2009
Available online 25 November 2009

KEYWORDS
Abdominal aortic aneurysms;
Screening;
Cost-benefit analysis

Abstract Screening for abdominal aortic aneurysm (AAA) in high-risk groups has been recommended based on a high prevalence of disease, while being questioned due to a high frequency of co-morbidities and inferior life-expectancy. We evaluated the long-term outcome and the cost-effectiveness of selective AAA screening among patients referred to the vascular laboratory for arterial examination.
Methods: A total of 5924 patients, referred to the vascular laboratory of a university hospital, were screened for AAA with ultrasound (definition: $\varnothing \geq 30$ mm), 1993—2005. Outcome data were gathered through hospital records and the national population registry. A Markov model was used for health—economic evaluation.
Results: An AAA was detected in 181 patients (mean age 72.8 years), of whom 21.5% underwent elective repair (perioperative mortality 5.1%) after 7.5 years of follow-up. Four of six patients diagnosed with AAA rupture were operated upon. Relative 5-year survival compared with the general Swedish population, controlled for age and sex, was 80.4% (95% confidence interval (CI): 70.8—88.8). The cost-effectiveness was robust in base-case (11 084 Euro/life year gained) and in sensitivity analyses of prevalence, cost and survival.
Conclusions: Patients in whom AAA was detected at selective screening had inferior long-term survival and were operated on less frequently, compared with AAA patients described in previous studies. Yet, selective screening at the vascular laboratory was cost-effective.

* Corresponding author.
E-mail address: kevin.mani@surgsci.uu.se (K. Mani).

1078-5884/$36 © 2009 European Society for Vascular Surgery. Published by Elsevier Ltd. All rights reserved.
doi:10.1016/j.ejvs.2009.11.004

To decrease the number of deaths from ruptured abdominal aortic aneurysm (AAA), early detection by screening persons at high risk for AAA is advocated, and randomised controlled trials have shown that screening men aged 65–80 years reduces AAA-related mortality by about 50% in a cost-effective manner.[1–5] Currently, population-based screening is being implemented in several countries.[6–8]

A more selective approach, with screening of specific high-risk groups has been suggested,[9–12] and is implemented within the Medicare programme in the United States.[13] A history of smoking and known atherosclerotic disease are some of the criteria that have been suggested for selective AAA screening based on a high expected prevalence of disease.[11,14–16] However, high-risk screening has also been questioned due to an expected high frequency of co-morbidities in these patient groups, affecting operability and long-term survival negatively,[17,18] reducing the cost-effectiveness of this screening strategy.

Despite these concerns, selective screening for AAA among patients undergoing arterial examinations due to suspected cardiovascular disease has been reported from several centres.[19–22] The aim of this study was to investigate the long-term outcome and the cost-effectiveness of selective high-risk screening for AAA among patients referred to the vascular laboratory for arterial duplex scan.

Methods

Since 1993, patients referred to the vascular laboratory at the Uppsala University Hospital for peripheral arterial duplex examination are screened for AAA.[22] Among 5924 selectively screened patients between 1993 and 2005, 181 were found to have an AAA, and they form the basis of this study (in addition to the 179 AAAs detected at screening previously reported from this cohort,[22] two AAAs were identified during the completion of the current study).

Patient records were reviewed retrospectively for all patients with AAA detected at screening. Patient co-morbidities at the time of screening were registered. Follow-up examinations related to the detected AAA were recorded, as well as AAA-related interventions and their outcome. Survival data were obtained through cross-checking with the Swedish national population registry. For deceased patients, the cause of death according to the death certificate was retrieved from the Swedish cause of death registry. Relative survival[23] was calculated by comparing the observed survival of patients with AAA detected at selective screening to the expected survival of the entire Swedish population adjusted for gender, age and calendar year. The expected survival and the standardised mortality ratio (SMR) were calculated by using life tables obtained from the Human Mortality Database.[24]

The cost-effectiveness of a selective high-risk screening programme in this setting (compared with non-screening) was assessed using a previously described[17] Markov cohort simulation model (Fig. 1). The cost (Euro, 2006 value) per life year gained (LYG) was the main outcome measure and cost per quality-adjusted life years (QALY) a secondary outcome measure. An incremental cost per effect of $< 50\,000$ Euro was regarded as acceptable.[25] Model probabilities were based on follow-up data from the present cohort when obtainable, or from a literature review on outcome of AAA[17] (Table 1). Cost of selective AAA screening at the vascular laboratory was estimated based on additional time required for aortic examination during a peripheral arterial examination (average 4 min). Follow-up cost for AAA patients not requiring surgery was calculated based on AAA-related follow-up visits and cost per visit.[26] In patients where AAA surgery was performed, cost was estimated based on average cost of AAA repair and follow-up after aortic surgery studied previously at our institution.[26] Model parameters were varied, based on literature review and results of current study, in one-way sensitivity analyses to evaluate the effect of uncertainties on the cost-effectiveness of the screening strategy.

Data from the general Swedish population was used to estimate the QALYs gained through AAA screening within the Markov model (based on EQ-5D,[27] utility index 0.79 for 70–79-year-olds and 0.74 for $>$ 80-year-olds). As a base-case, it was assumed that the screening population has the same utility index as the age-matched general population. To evaluate the effect of reduced utility index on health–economic outcome of screening, two purely hypothetical scenarios were tested: (1) the entire screening population has a 25% reduction in utility (due to general co-morbidities) and (2) patients with a known AAA suffer a 10% reduction in utility until the aneurysm is repaired (due to an assumed negative psychological effect of a known AAA on the patient), and the rest of the population has the same utility as an age-matched general population.

Data evaluation was carried out with software packages (statistical analysis: SPSS PC version 16.0, SPSS, Chicago, IL, USA; health–economic evaluation: TreeAge Pro 2007, TreeAge Software, Inc., Williamstown, MA, USA). Independent samples t-test was used for comparison of normally distributed continuous variables and Fisher's exact test was used to compare proportions of nominal variables. The study was approved by the Committee of Ethics of Uppsala University.

Results

Long-term outcome

After a mean follow-up of 7.5 years (standard deviation (SD) 2.8) 47.5% of the patients were alive. Patients' characteristics are described in Table 2. In general, 106 patients underwent surveillance. In 19 patients surveillance was initiated, but later terminated, due to poor general health (14 patients) or due to no expansion of the AAA (5 patients). In 75 patients no surveillance was initiated. In 11 of these, poor general health was explicitly mentioned as the cause for not following up on the patient further. In the remaining 64 patients, no specific cause was recorded in the patient charts. Fifty-nine of these patients had aneurysms $\leq$ 40 mm in diameter, and 39 were $\geq$ 75 years of age.

Mean resources used per patient during follow-up amounted to an estimated total cost of 1579 Euro. Mean survival was 8.3 years (95% confidence interval (CI): 7.4–9.3) and 5-year survival was 63.3% (95% CI: 56.0–70.6). Relative 5-year survival for the entire patient group, compared with the general Swedish population matched for age, sex and