

Screening for Abdominal Aortic Aneurysm in 65-Year-old Men Remains Cost-effective with Contemporary Epidemiology and Management

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WHAT THIS PAPER ADDS

With recent changes in abdominal aortic aneurysm (AAA) epidemiology, the fundamental conditions for AAA may have changed. Using an up-to-date Markov model this study analyses AAA screening within a setting of contemporary epidemiology and surgical management, and indicates that one-time screening of 65-year-old men for AAA remains highly cost-effective and is a clinically relevant health initiative.

Objectives: The epidemiology and management of abdominal aortic aneurysms (AAA) has changed significantly, with lower prevalence, increased longevity of patients, increased use of endovascular aneurysm repair (EVAR), and improved outcome. The clinical and health economic effectiveness of one-time screening of 65-year-old men was assessed within this context.

Methods: One-time ultrasound screening of 65-year-old men (invited) versus no screening (control) was analysed in a Markov model. Data on the natural course of AAA (risk of repair and rupture) was based on randomised controlled trials. Screening detected AAA prevalence (1.7%), surgical management (50% EVAR), repair outcome, costs, and long-term survival were based on contemporary population-based data. Incremental cost-efficiency ratios (ICER), absolute and relative risk reduction for death from AAA (ARR, RRR), numbers needed to screen (NNS), and life-years gained were calculated. Annual discounting was 3.5%.

Results: In base case at 13-years follow-up the ICER was €14,706 per incremental quality-adjusted life-year (QALY); ARR was 15.1 per 10,000 invited, NNS was 530, and QALYs gained were 56.5 per 10,000 invited. RRR was 42% (from 0.36% in control to 0.21% in invited). In a lifetime analysis the ICER of screening decreased to €7,570/QALY. The parameters with highest impact on the cost-efficiency of screening in the sensitivity analysis were the prevalence of AAA (threshold value <0.5%) and degree of incidental detection in the control cohort.

Conclusions: In the face of recent changes in the management and epidemiology of AAA, screening men for AAA remains cost-effective and delivers significant clinical impact.

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Article history: Received 3 September 2013, Accepted 16 December 2013, Available online 31 January 2014

Keywords: Abdominal aortic aneurysm, Cost-effectiveness, Mass screening

INTRODUCTION

In the late 1990s, randomised controlled trials (RCTs), with the Multicentre Aneurysm Screening Study (MASS) being the most influential, demonstrated a cost-effective reduction in long-term mortality from ruptured abdominal aortic aneurysm (AAA) with ultrasound-based screening of elderly men.^{1–4} Paradoxically, the ensuing implementation of nationwide AAA screening programmes in Europe^{5,6} and the USA⁷ coincided with significant changes in the epidemiology and management of AAA observed in the last decade, all

potentially fundamental conditions for the rationality of AAA screening.

The most notable changes are a significantly reduced prevalence of the disease, likely due to reduced smoking and improved cardiovascular risk factor management;^{8–12} a substantially improved short- and long-term survival after AAA repair;¹³ a generally increased longevity in the population; and a net increase in elective surgery, mainly owing to the introduction of EVAR.^{14,15} Thus, the basis for the currently implemented AAA screening programmes may be questioned.

The aim of this study was to determine the current effect and cost-effectiveness of one-time AAA screening of 65-year-old men in a Markov model using the best evidence data from the largest RCT and contemporary population-based data from original articles.

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<http://dx.doi.org/10.1016/j.jvs.2013.12.023>

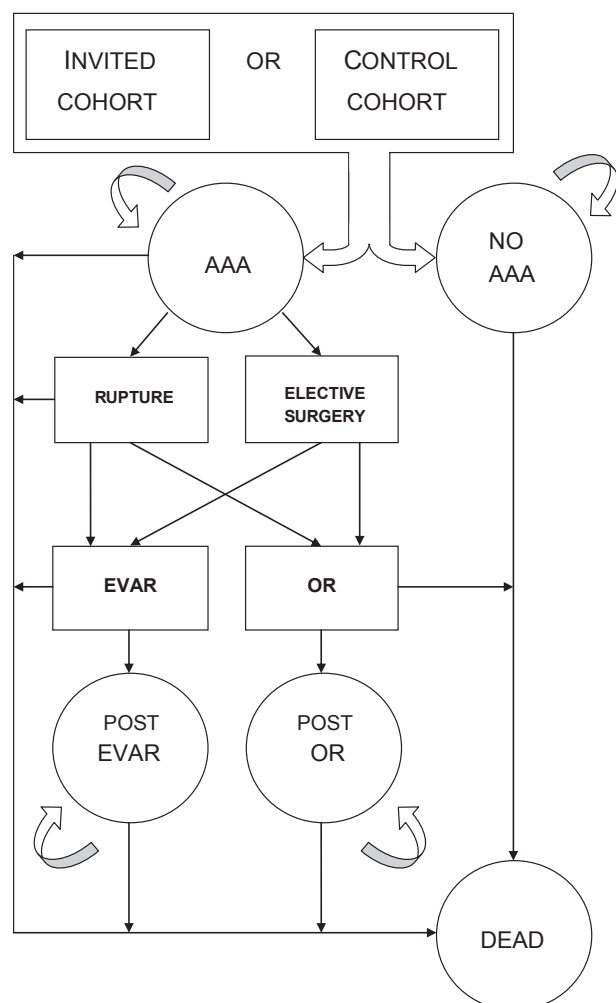


Figure 1. The Markov model. Circles represent health states and boxes represent events. The thin lines with arrows depict possible pathways for individuals in the model. A curved arrow represents the possibility of an individual remaining in a health state for consecutive cycles. *Note.* AAA = abdominal aortic aneurysm; EVAR = endovascular aneurysm repair; OR = open repair.

METHODS

Model strategies

Two hypothetical cohorts of 65-year-old men were assigned to either a strategy of invitation to one-time AAA screening with ultrasound (invited), or a strategy of no screening (control) where AAA management was based on incidental detection. An AAA was defined as a maximum infrarenal aortic diameter of 30 mm or more.

Model structure

A Markov model with five exclusive health states (Fig. 1) was constructed. At the start, individuals from each cohort are assigned to the AAA state or no AAA state based on the prevalence of AAA. The simulation progresses in cycles of 1 year. The effect and cost of each strategy is summarised after a set number of cycles. In addition, in a Monte Carlo analysis, the number of key events, such as

rupture, elective surgery, and death from varying causes, were recorded for the purpose of outcome calculation and subsequent validation of the model. Monte Carlo analysis was set to 1,000,000 individuals in each cohort. The model was developed in the TreeAge Pro 2012 Healthcare software package (TreeAge Software, Williamstown, MA, USA).

Parameters and data sources

The parameters are summarised in Table 1. The screening detected prevalence (1.7%) in the base case (standard scenario or default setting) in the model was based on a recent population-based prevalence study in Middle Sweden.⁸ The time-dependent probability of an AAA progressing to rupture or elective surgery in the respective cohort was based on the MASS study, which reported in detail on these parameters at 4, 7, 10, and 13 years,^{1,16–18} corrected for difference in prevalence between MASS and recent Swedish data.

Based on extensive Swedvasc registry data¹⁹ on the age distribution of AAA repairs and on the survival pattern of individuals with AAA it was assumed that no repairs for intact AAA occurred after the age of 90 years.

Age-specific operative (30-day) mortality after elective and rupture repair by open repair (OR) and endovascular aneurysm repair (EVAR) was retrieved from the Swedvasc¹⁹ registry for the years 2002–2010. General population age-dependent all-cause mortalities were based on contemporary population statistics from Statistics Sweden.²⁰ Data on contemporary gender-specific long-term survival after AAA repair in Sweden²¹ was used for modelling long-term survival for all individuals with AAA, where the 5-year survival rate of an individual with an AAA or surviving elective AAA repair was estimated to be 95% in relation to the general population and to be 90% for an individual surviving surgery for a ruptured AAA.

Health state utilities, the basis for calculation of effect in quality-adjusted life-years (QALYs), were age-dependent, and retrieved from a gender- and age-specific Swedish EQ-5D health-related quality of life population estimate.²²

A number of parameters were included in a sensitivity analysis, and the ranges tested are shown in Table 1. The proportion of incidentally detected and repaired AAAs in the control cohort compared with the screened cohort in MASS at 4 and 13 years was estimated at 25% and 42%, respectively, in accordance with a suggested method.²³ A corresponding contemporary proportion of incidental detection and repair of 39% at 4-year follow-up was estimated from Swedvasc, based on a comparison of 4 years preceding the Swedish screening initiative and 4 years post-screening for 65-year-old men.

More details on parameters are provided in the Supplementary material.

Costs

All costs (Table 2) are taken from the perspective of a health service provider. Using specific gross domestic

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