Author's response to reviews

**Title:** is population screening for abdominal aortic aneurysm cost-effective?

**Authors:**

Lars Ehlers (lars.ehlers@sundhed.au.dk)
Jan Sørensen (jas@cast.sdu.dk)
Lotte Jensen (lotte.groth@stab.rm.dk)
Merete Bech (merete.bech@stab.rm.dk)
Mette Kjølby (mette.kjoelby@stab.rm.dk)

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Title:

Is population screening for abdominal aortic aneurysm cost-effective?

Authors:

Lars Ehlers\textsuperscript{1}, PhD, MSc (econ) ______________________________________________

Jan Sørensen\textsuperscript{2}, MSc (econ) ______________________________________________

Lotte Groth Jensen\textsuperscript{3}, MSc (soc) __________________________________________

Merete Bech\textsuperscript{3}, MSc (adm) ______________________________________________

Mette Kjølby\textsuperscript{3}, PhD, DDS ______________________________________________

Addresses:

\textsuperscript{1}Institute of Public Health, Aarhus University, Denmark

\textsuperscript{2}CAST, Sothern University, Denmark

\textsuperscript{3}Center for Public Health, Denmark

Communicating author:

Lars Ehlers, lars.ehlers@stab.rm.dk, tel. (+45) 87 28 47 52

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none
The annual number of deaths attributable to ruptured abdominal aortic aneurysm (AAA) is approximately 4-500 in Denmark [1-2] corresponding to a death rate of 1-2 % of all men aged 65+. The overall mortality from ruptured AAA is 80–90 %, and about half of the deaths occur before the patients reach hospital [3-5]. Since most patients die from an undiagnosed AAA, it has been advocated to implement screening programmes that establish diagnosis through ultrasonography and offer elective AAA repair to the diagnosed patients.

Four randomised controlled studies (RCTs) have shown a reduction in AAA-related mortality from screening programmes aimed at elderly men [6-9]. However, an expected reduction in mortality is not sufficient basis for advocating the permanent introduction of a screening programme. The programme should be acceptable to the patients and if funded through public funds, the programme should document “good value for money”. In other words, a decision to introduce such screening programmes should be based on evidence for both effectiveness (the programme provides good health outcomes) and cost-effectiveness (the programme provides value for money) [10].

The purpose of this study was to review cost-effectiveness studies of screening programmes for AAA in elderly men and to assess the evidence of the cost-effectiveness of such screening programmes.

Methods.

Search for articles:

Systematic searches were undertaken in the following data bases: NHSEED, EconLit, Medline, Cochrane, Embase, Cinahl and two Scandinavian HTA data bases (DACEHTA and SBU). The literature search covered the period from 01.01.1997-01.01.2007. The search strategies (in Medline,
Cinhahl, Cochrane and Embase) were thesaurus-guided: Aortic-Aneurysm-Abdominal (MeSH) AND Mass-Screening (MeSH), and Aortic-Aneurysm-Abdominal, added Subheading "Prevention and Control". Free text search on screening for AAA was also performed. In addition, the reference lists of identified studies and other recent relevant publications were inspected for additional references.

Criteria for inclusion:

Only studies in English or Scandinavian languages published in peer-reviewed journals were included. To be included the studies should qualify as a full health economic evaluation considering both the cost and effects (i.e. cost-effectiveness analyses, cost-utility analyses, cost-benefit analyses) of screening men for AAA.

Analyses:

All included studies [11-24] were read in full and an assessment was made according to the international guidelines for the critical assessment of economic evaluations in health care [10] and summarised in Table 1. Special attention was given to the included costs and based on the reviewed articles an overview of relevant cost headings were developed (Table 2).

Results

A total of 14 studies were included (see table 1). Of these five were from Scandinavia, four from UK, two from US and one from the Netherlands, Canada and Japan respectively. Seven studies were designed as cost-effectiveness studies using objective health outcomes, and seven was cost-utility studies with health outcomes expressed in quality-adjusted life-years (QALYs). Five studies
were conducted as “piggy-bag” studies alongside clinical trials: two RCTs, two cohort studies and one case-control study. Nine studies employed decision analytic models.

Costs associated with screening for AAA

Based on the reviewed studies the main types of costs associated with population screening, surveillance and surgery for AAA has been compiled as shown in table 2.

(insert table 2)

There are great variations between the studies in the type of costs that have been included. Most studies include only short term costs i.e. it is implicitly assumed that there is no difference in the long term costs between the alternatives. Only three studies [11, 17, 20] include long term costs. The MASS study [11] and Soisalon-Soininen et al. [17] include costs of hospital and community care in a follow up period of 4 and 17 years respectively. This includes costs of hospital re-admissions, general practitioner visits, outpatient attendances and variations in patient pathways due to surgical complications (e.g. dialysis-dependent renal failure, stroke, myocardial infarction, major amputation). Henriksson et al. [20] include an estimate of the average additional annual health care cost after surgery for AAA for the remaining life-time of patients.

All studies include the costs of invitation to screening, ultrasound scanning and surgery. Only three out of the 14 studies include private cost to patients such as transportation and time cost [16, 19-20]. None of the studies have included costs of social services such as home help and nursing homes.
The cost amount varies considerably from study to study (data not shown). An example is the costs of UL-scan in the MASS study [11], which is more than double the cost in Lindholdt et al. [12] (even when adjusting for different cost year). Another example is the cost of transportation (mobile screening team), which varies more than four-fold. The cost of surgery also varies. Part of the differences in cost estimates can be explained by the different organizational arrangements, different geographical circumstances etc. However, it is characteristic for all studies, that they lack a detailed reporting of the cost estimates and therefore offer only limited transparency in the calculations of costs.

*Organisational assumptions behind the economic calculations*

Application of ultrasound technology is considered the golden standard for AAA screening and has been used in all AAA trials and the decision analytic models. All studies assume that UL scans are performed by a mobil team of specialists employed at a hospital. Surveillance of patients with small AAAs is assumed to be handled by the same team. There are some differences with regards to the number and type of screening locations, the average distances to travel for the team and the patients, and the role of the general practitioner. It is characteristic for the considered studies (including the underlying references) that the organisational models are only described superficially, which restricts the opportunities of transferability.

*Economic evaluations alongside clinical trials (short term cost-effectiveness)*

Five economic evaluations are conducted alongside clinical trials using patient-level data in the evaluation of cost-effectiveness of screening for AAA. Two studies [11-12] use patient-level data from a RCT with a time perspective of 4 and 5 years respectively. The MASS study [11] estimates ICER to £28,400 per gained life year or approximately £36,000 per QALY. The authors conclude
that this result is at the margin of acceptability according the NHS thresholds, but they expect cost effectiveness will improve over a longer period. Lindholdt et al. [12] estimates ICER to £6.090 per gained life year without the long term cost and discounting. The three other studies that use patient-level data (from local cohort or case-control-studies) estimate ICER in the same order of magnitude and suggest that screening might be cost-effective [13-15].

**Economic evaluations using decision analytic modelling (long-term cost-effectiveness)**

Nine studies use decision analytic modelling to estimate long term cost-effectiveness of screening for AAA. The general conclusion from these studies is that screening for AAA seems to be cost-effective. However, the ICER vary considerably and a direct comparison of results is not possible due to considerable differences in the analytical basis. The different studies employ different methods (different types of model, different time frame, different perspective) and different assumptions (different sources of evidence for effect and transition probabilities and different assumptions about costs) for their analysis.

**Assumptions about survival, Qol and QALY after elective surgery**

The main advantage of screening is generally assumed to be an increase in the number of patients diagnosed with AAA and offered elective AAA repair. Most of the studies use national mortality rates for the average population as proxy for long term survival after elective surgery. However, some studies make more realistic/conservative assumptions. Wanheinen et al. [14] assumes the mortality among treated AAA patients to be 2.05 times age-matched normal population rates because of high comorbidity rates among AAA patients. Lee et al. [22] adjust the annual mortality rates to take account of expected excess mortality in patients with dialysis-dependent renal failure, stroke, myocardial infarction or major amputation. Henriksson et al. [20] and Soisalon-Soininen et
al. [17] use local mortality data for AAA patients for 5 and 17 years respectively and perform
survival analysis using statistical (Weibull or actuarial) methods in their estimation of life-years
gained.

Seven of the decision analytic studies calculate ICER as the incremental cost per gained QALY. All
these studies have implicitly assumed that quality of life after surgery (and after recovery) is similar
to the quality of life of the age-matched general population. Only in one study (Lee et al. [22]) the
quality of life assumptions are adjusted for the reduced quality of life that patients with major
surgical complications experience.

Similarly, only two studies perform sensitivity analyses of the quality of life assumptions.
Wanheinen et al. [19] assume a short term reduction in quality of life due to anxiety experienced
before an UL scan. They estimate a 5% reduction in the first year QALY which is out-weighted by
the uncertainty in the long term perspective. Henriksson et al. [20] perform a multiway sensitivity
analysis, in which the quality of life is allowed to vary stochastic according to a pre-specified
statistical distribution, but the impact is not possible to distinct.

**Discussion**

The purpose of this review was to perform a critical assessment of earlier cost-effectiveness studies
of screening older men for AAA. Based on our review of the 14 included studies it seems that most
of health economic analysis of screening for AAA might have employed a too restrictive focus and
time horizon to describe the associated resource use and cost and too optimistic assumptions about
mortality and quality of life.
This finding is similar to the study done by Campell et al. [25] who reviewed studies published during 1989 – 2003 that used health economic models to analyse population screening for abdominal aortic aneurysm and assessed their credibility for informing decision-making. Based on their review of twelve models (6 studies were the same as in our review) they found large variations in the underlying basis for the cost-effectiveness analysis and identified a substantial number of factors potentially contributing to such disparities. They also claimed that poor reporting of the methods make it difficult to identify the most plausible and thus most useful model of those developed.

Distinctively we find that many of the assumptions employed in the economic evaluations do not correspond with evidence from public health stating that smokers live shorter than the average population, experience a lower quality of life in older age, and have a higher demand for health services i.e. higher social and health care costs [26-29]. (More than 90% of patients with AAA have a history of smoking, and smoking is the strongest predictor [3-5]). Furthermore, the existing economic studies do not consider the cost and benefits of alternative and/or complementary public health interventions such as smoking cessation programmes, which might influence the cost-effectiveness of screening.

Our findings have implications for future research recommendations in the cardiovascular area. During the last decades a heavy interest in smoking cessation programmes and cost of illness due to tobacco smoking have made decision-makers well aware of the increased morbidity and mortality of the average smoker. Successes in reducing the number of smokers have been linked to potential savings in future health care costs [27-29]. Economic evaluations of screening for AAA on the other hand seems to have ignored the relationship between tobacco smoking and the incidence of AAA.
and the associated consequences on mortality and comorbidity. It thus appears that existing analyses have overrated the advantages of screening for AAA, both in terms of the effect on quality of life after operation, life-expectancy and in terms of subsequent use of health care after operation and consumption in the gained life time.

Since societal resources are limited it is important that decisions to implement new health technologies are based on interdisciplinary assessments [3, 10]. A decision to implement a new screening programme for AAA should therefore include evidence from the cardiovascular research paradigm as well as related public health research.

Conclusion

The review indicates that most of the existing health economic evaluations of screening older men for AAA might have used optimistic assumptions about mortality, quality of life and costs after elective surgery.
Table 1. Main types of costs associated with screening for AAA

<table>
<thead>
<tr>
<th>Main Type of Costs</th>
<th>Description</th>
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<tbody>
<tr>
<td>1. Invitation to screening (and re-invitations for non-attenders)</td>
<td>Includes clerical staff time, postage and stationery, cost of obtaining patient details, office space and equipment, overhead</td>
</tr>
<tr>
<td>2. Ultrasound-scan (and re-scan and surveillance)</td>
<td>Includes clinic staff time, staff travel cost, disposables, annuitization of capital expenditures, maintenance and service contracts, office space/charge of locations</td>
</tr>
<tr>
<td>3. Surgery (pre-assessments for suitability, and elective aneurysm repairs as well as emergency surgery for ruptures, and hospitalization)</td>
<td>Includes theatre time, time spent in intensive care, and general ward, drugs, blood products, non-pathological investigations, graft inserted, overhead</td>
</tr>
<tr>
<td>4. Hospital and community care (short and long term)</td>
<td>Includes readmissions, general practitioner visits, outpatient attendances and patient pathways due to surgical complications (dialysis-dependent renal failure, stroke, myocardial infarction, major amputation)</td>
</tr>
<tr>
<td>5. Patient and family resources</td>
<td>Includes transportation expenditures, medicine and time cost</td>
</tr>
<tr>
<td>6. Resources in other sectors</td>
<td>Includes social services such as home help and nursing homes</td>
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<td>Nr.</td>
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<td>Nr.</td>
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<tr>
<td>7</td>
<td>Soisalon et al. 2001 (SF) [17]</td>
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<tr>
<td>8</td>
<td>Kim et al. 2006 (UK) [18]</td>
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<tr>
<td>Nr.</td>
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<tr>
<td>9</td>
<td>Wanhainen et al. 2005 (S) [19]</td>
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<tr>
<td>10</td>
<td>Henrikson et al. 2005 (S) [20]</td>
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<tr>
<td>11</td>
<td>Boll et al. 2003 (NL) [21]</td>
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<td>13</td>
<td>Conelly et al. 2002 (C)</td>
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<tr>
<td>14</td>
<td>Silverstein et al. 2005 (USA) [24]</td>
</tr>
</tbody>
</table>

* ICER is not comparable between studies because the results are based on different assumptions and definitions
1.1 Referencer

1. The Danish Vascular Registry. The annual report for 2006. [http://www.karbase.dk](http://www.karbase.dk) (last access 02.02.08)


