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The Impact of Decreasing Abdominal Aortic Aneurysm Prevalence on a Local Aneurysm Screening Programme CME

R.J. Darwood*, M.J. Brooks

Department of Vascular Surgery, Bristol Royal Infirmary, United Hospitals Bristol NHS Trust, Upper Maudlin Street, Bristol BS2 8HW, UK

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ABSTRACT

Objectives: The NHS Abdominal Aortic Aneurysm Screening Programme (NAAASP), based on the Multicentre Aneurysm Screening Study (MASS) trial (2002), is being introduced across the UK. Recent studies have demonstrated a decline in prevalence of abdominal aortic aneurysm (AAA). The aim of this study was to examine the effect of this on screening workload.
Methods: A model was developed to predict screening and surgical workload for a screening centre (Bristol – population 1,123,203). Workload was compared using data from MASS with data from the "Early Implementers" (EI) of NAAASP.
Results: Modelling for 2011/2012 using EI data predicted significantly fewer men diagnosed with an AAA compared to MASS data [84 (EI) versus 198 (MASS) $p < 0.0001$] and fewer referrals to a vascular surgeon for AAA repair [10 (EI) versus 30 (MASS) $p = 0.0002$). This difference became more marked with time (2015/16: 90 (EI) versus 212 (MASS) men diagnosed with an AAA ($p < 0.0001$) and 29 (EI) versus 71 (MASS) referred to a vascular surgeon ($p < 0.0001$)). From 2015/16 there was also a significant reduction in the predicted number of ultrasound scans.
Conclusions: Modelling screening activity based on contemporary epidemiological data demonstrates a significant reduction in workload compared to MASS data. This has implications for workforce planning, the introduction of new screening centres and the future of NAAASP.

Introduction

The efficacy of screening for abdominal aortic aneurysm (AAA) in reducing aneurysm-related mortality in men has been established following four randomised controlled trials[1–4] summarised in a Cochrane review in 2007.[5] Each trial differed slightly in protocol and inclusion criteria. The National Health Service (NHS) abdominal aortic aneurysm screening programme (NAAASP) currently being rolled out across the UK was modelled on the Multicentre Aneurysm Screening Study (MASS) and the economic calculations were based on the MASS data.[6] These indicated that AAA screening reached borderline cost-effectiveness at four years (based on NHS thresholds of cost-effectiveness at that time [£30,000 per QALY in 2002[7]]), but became significantly more cost-effective over time.[8] The UK government approved funding for an NHS AAA screening programme (NAAASP) in 2008 and in 2009 the programme began to be rolled out across England. Six areas with pre-existing screening programmes became "early implementers" of the national programme. These included Gloucestershire (screening since 1990) and Chichester (screening since 1988). Similar programmes have been introduced on a county-basis in Sweden and screening is recommended for male smokers between the ages of 65 and 75 years in the United States.

Within the NAAASP men in their 65th year are invited for a single ultrasound scan of their abdominal aorta. Men aged over 65 years are able to self-refer for an ultrasound scan should they wish. Men found to have an aortic diameter of less than 3 cm on their initial screen are reassured and discharged; those with an aortic diameter of 3–5.4 cm enter an ultrasound surveillance programme and those with an aortic diameter of >5.4 cm are referred to a vascular surgeon for consideration of repair of their AAA.[9]

In the MASS study (1997–1999) 4.9% of 65–74 year old men who underwent an ultrasound scan were found to have an abdominal aortic aneurysm (defined as aortic diameter ≥3 cm).[2] More recently several authors have documented a lower prevalence of AAA than this[10–12] leading to concerns that the AAA screening programme may not be cost-effective. The Gloucestershire Aneurysm Screening Programme (GASP) reported a reduction in the prevalence of AAA (≥3 cm) from 4.7% in 1990 to 1.1% in 2009 in men aged 65 years.[10]

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* Corresponding author. Tel.: +44 (0) 7779 300 284.
E-mail address: rosie_darwood@btinternet.com (R.J. Darwood).

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Similarly the Chichester screening programme reported a reduction in prevalence of AAA (≥3 cm) from 3.2% in 2001 to 2.7% in 2008.[11] In 2009/2010 two London units presenting year one results from the NAAASP found a lower prevalence of AAA (≥3 cm) than expected, 0.8%[13] and 1.9%[12] respectively. In addition results from the Swedish screening programme found a prevalence of 1.7% in 65-year old men (between 2006 and 2009).[14]

The area of Bristol, Bath and Weston (UK) is in the process of implementing a local AAA screening programme as part of NAAASP. The aim of this study was to evaluate the predicted impact of a reduction in AAA prevalence in the screened population on the screening and operative workload.

Methods

A model was constructed using Excel™2003 (Microsoft Corps) to estimate the effect the introduction of a local AAA screening programme as part of NAAASP would have on the screen-detected, incidental elective and emergency operative workloads in the three vascular units. The model was based on a simple decision tree to estimate the effect of a change in aortic aneurysm prevalence on screening workload (Fig. 1). This model assumes that NAAASP Standard Operating Procedures[15] are applied and requires screening data and local population data. The screening data for the screening cohorts (men in 65th year) requires the following variables to be taken from existing programmes:

- Screening uptake (percentage of invited men who attend)
- Number of AAA detected (AAA prevalence)
- Number of large (>5.4 cm) AAA at initial scan (AAA size distribution)
- Rate of growth for small (3–4.4 cm) and medium (4.5–5.4 cm) AAA
- Proportion of men with large (>5.4 cm) aneurysms who undergo AAA repair
- Drop out from the programme

Local population data was obtained from the Primary Care Trust Information Management and Technology (PCT I, M & T) Consortium and provided the following;

- Total population (Bristol, North Somerset and South Gloucestershire [BNSSG] commissioning group, NHS Bath and North East Somerset [BaNES])
- Male population over 65 years stratified by 5 year age bands
- New 65-year-olds for each year (i.e. screening cohort)

The baseline data were from general practitioner (family doctor) registrations in 2009, and the changes in population were based on the latest Office for National Statistics (ONS) projections. The Office for National Statistics is a UK government organisation that runs the national census and provides a range of demographic, social and economic statistics. Current ONS UK population projections are for each year until 2015/2016, then for 2020/2021 and 2030/2031.

Current local hospital activity data were provided by the NHS Avon Information Management and Technology Consortium based on codes for abdominal aortic aneurysm repair (L194, L195, L27x and L28x) performed on men from within the screening programme area (post code search) at each of the three vascular units within the area. The number of self-referrals in 65-year-old men was based on MASS data, 2% of the population in 2010, reducing to 1% in 2015 and 0% in 2020.

The output of the model using the MASS screening data were then compared with the output using data from the "early implementers" of the NHS screening programme (NAAASP) in the UK. The rate of growth of known aneurysms was assumed to be the

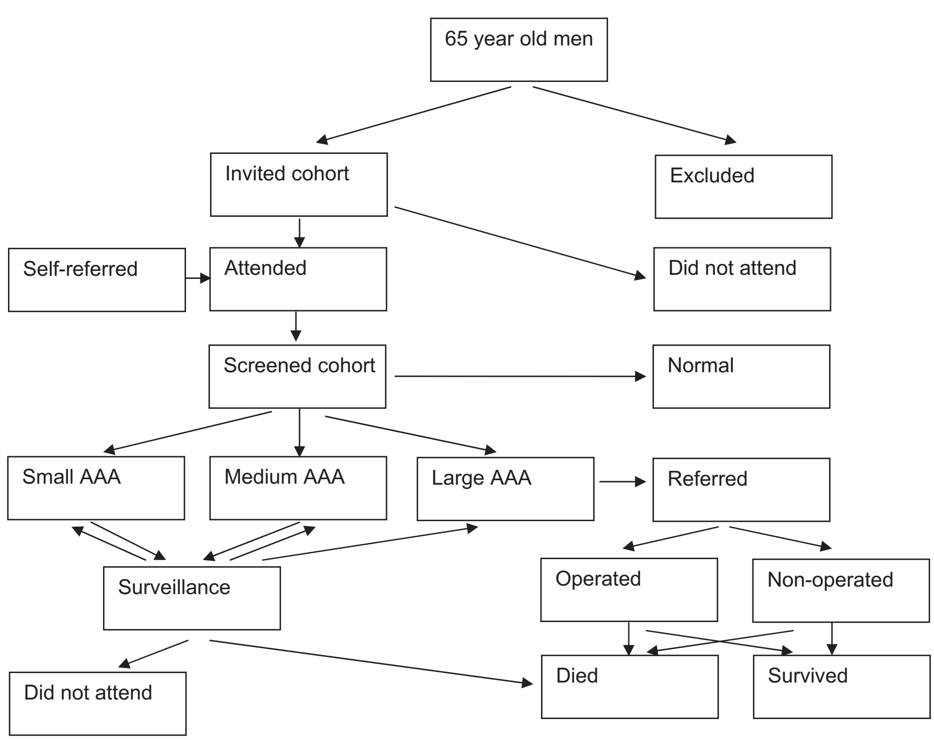

Figure 1. Screening workload model.

Table 1
Screening variables for model.

	MASS data (%) ($n = 27{,}147$)	Early implementers data (%) ($n = 23{,}696$)
Screening Uptake	80	80
Prevalence AAA (>3 cm) [95% confidence intervals]	4 [3.77–4.23]	1.7 [1.54–1.86]
Small AAA (3.0–4.4 cm) as percentage of total AAA	71	82
Medium AAA (4.5–5.4 cm) as percentage of total AAA	17	7
Large AAA (>5.4 cm) as percentage of total AAA	12	11
Percentage AAA operated	90	77

same for both models and was based on MASS data as this is not yet available for NAAASP (Table 1).

Statistic analysis was performed using the Chi-Squared test for significance.

Results

Population

The total population for the screening area of Bristol, Bath and Weston is 1,123,203 in the year 2010–2011, projected to increase to 1,382,242 by 2030/2031. Of these 77,816 are men over 65 years of whom 5924 are new 65-year-olds eligible for screening in 2010/2011. This is projected to increase to 111,811 men over 65 years in 2030/2031 of whom 7818 will be new 65-year-olds eligible for screening (i.e. a 43% increase overall, 32% increase in new 65-year-olds) (Fig. 2).

MASS trial data

The MASS screening data are summarised in Table 1, column 1. Using these data for the Bristol and Bath population the screening programme would detect 198 men with AAA ≥3 cm in 2011/2012, increasing to 212 in 2015/2016 and 250 in 2030/2031. In the first year of screening (2011/2012) 46 surveillance scans would be required (for AAA 3–5.4 cm diameter), increasing rapidly to 840 in 2015/16 and 1688 by 2030/2031 (Fig. 3).

In the first year of screening 30 men would require referral to a vascular surgeon for consideration of AAA repair (AAA > 5.4 cm) increasing to 71 in 2015/2016 and 126 in 2030/2031. Using the MASS data the projected total number of elective aneurysm repairs (screened and non-screened) in men would slowly increase from 120 in 2011/2012 to 153 in 2015/2016 and 165 in 2030/2031 (Fig. 4).

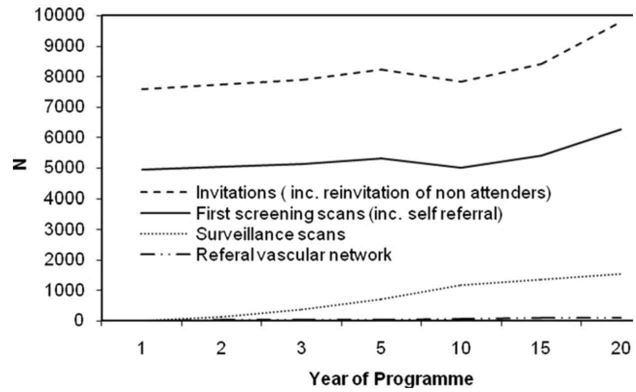

Figure 3. Projected AAA screening related activity based on MASS data.

The projected numbers of emergency AAA repairs for rupture in men after screening is introduced is projected to remain stable (40 per annum) until 2015/2016 due to the projected total population increase, before declining to 24 (40% decrease) by 2030/2031.

Early implementation centre data

The NAAASP "Early implementers" (EI) data are summarised in Table 1, column 2.[17] Using the EI data there would be a highly significant reduction in the number of men with an AAA detected on initial screening in 2011/2012 compared to the MASS data (84 versus 198, $p < 0.0001$). This discrepancy becomes more pronounced with time; in 2015/2016 there would be 90 men diagnosed with an AAA on their initial screen (versus 212 based on MASS data, $p < 0.0001$) and in 2030/2031, 106 men would be diagnosed with an AAA on their initial screen (versus 250 using MASS data, $p < 0.0001$).

There are fewer ultrasound scans (initial and surveillance) projected using EI data (Fig. 5), although this does not reach significance until 2015/2016 (2011/2012: 4948 (EI) versus 4985(MASS) scans, $p = 0.59$, 2015/2016: 5682 (EI) versus 6146 (MASS) $p < 0.0001$, 2030/2031: 7040 (EI) versus 7943 (MASS), $p < 0.0001$).

Using the EI data in the first year of screening (2011/2012) significantly fewer men would require referral to a vascular surgeon with an AAA > 5.4 cm on screening (10 (EI) versus 30 (MASS), $p = 0.0002$), in 2015/2016 twenty-nine men would require referral (compared to 71 using MASS data $p < 0.0001$) and in 2030/2031 fifty-five men would require referral (compared to 126 using MASS data, $p < 0.0001$).

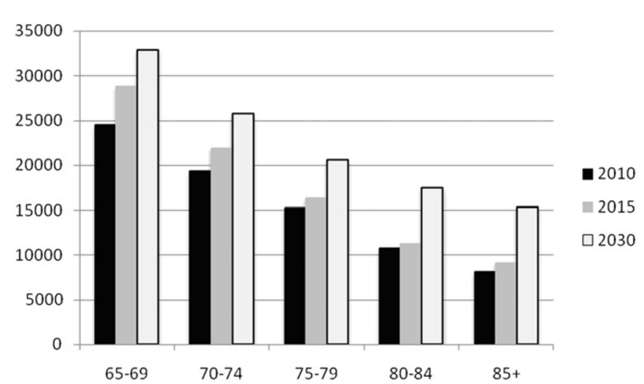

Figure 2. Projected population change in men aged 65 years and older 2010–2030.

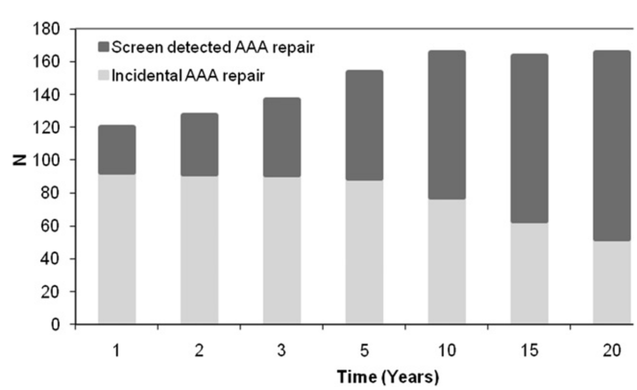

Figure 4. Projected elective AAA activity using MASS data.

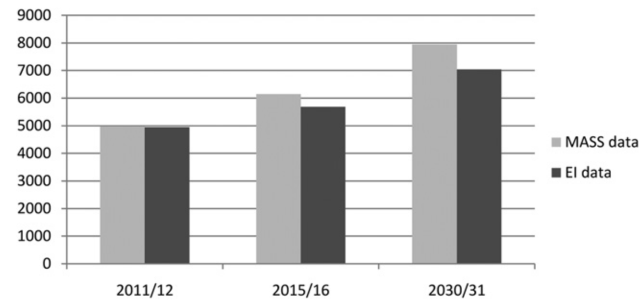

Figure 5. Total number of projected ultrasound scans (screening and surveillance) for Bristol and Bath.

The projected number of total elective AAA repairs in men based on EI data would increase from 100 in 2011/2012 (compared to 120 MASS $p = 0.07$) to 111 in 2015/2016 (compared to 153 MASS $p = 0.0004$) and 94 in 2030/2031 (compared to MASS 165 $p < 0.0001$) (Fig. 6).

The projected number of emergency AAA repairs is the same as using the MASS data.

Sensitivity analysis of screening uptake

In the MASS trial the uptake of AAA screening was 85% in the least deprived quartile and 75% in the most deprived quartile. The impact on predicted screen-detected AAA repair is shown in Fig. 7.

Discussion

Prior to commencing screening local NHS AAA screening programmes are required to calculate screening and surgical activity projections based on MASS data.[16] Recently several studies have reported a reduction in the prevalence of AAA, suggesting MASS data may be historical. This reduction in AAA prevalence may be as great as a reduction from 4.7 to 1.1% in 65-year-old men. We compared scenarios for a local screening programme using historical (1997–1999) MASS data and contemporary (2009–2010) NAAASP data on AAA prevalence to model the impact on screening and surgical workload. Using NAAASP data resulted in a significant reduction in the projected number of men detected with AAA and in the number of men with a large (5.4 cm) AAA being referred for surgery. There was a reduction in the total projected number of elective AAA repairs compared to the MASS data, albeit an increase compared to the workload without screening. There was also

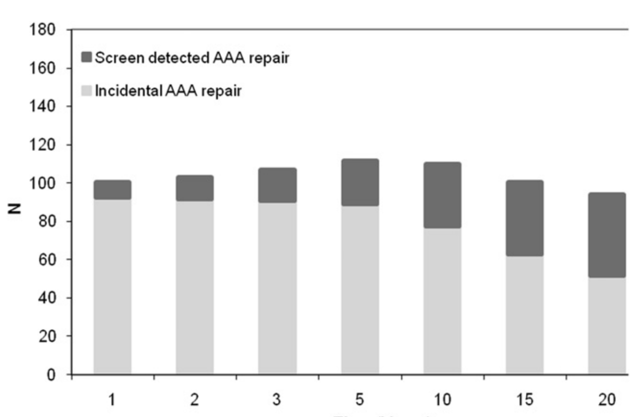

Figure 6. Projected elective AAA activity using early implementation data.

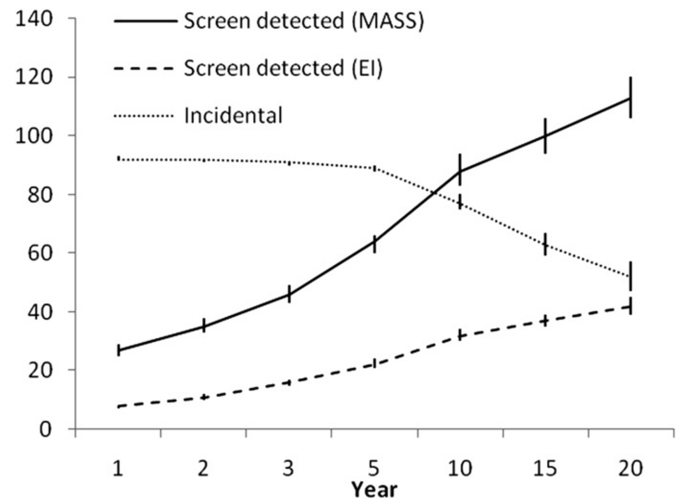

Figure 7. Sensitivity analysis looking at the impact of screening uptake with error bars showing range from 75% to 85% uptake for screening.

a reduction in the total projected number of ultrasound scans required although this was less striking and does not reach statistical significance for the first 5 years of screening.

One possible explanation for the differences in AAA prevalence between NAAASP and MASS is different methodology. MASS recruited 65–74-year-old men whereas in the NAAASP 65-year-old men are invited for screening, although men over 65 years can self-refer, so NAAASP targets a younger population than MASS. Despite this, the Gloucestershire Aneurysm Screening Programme has reported a reduction in prevalence of AAA in 65-year-old men over the last 20 years,[10] suggesting the difference in the observed prevalence between NAAASP and MASS is not solely attributable to the older population screened in MASS. The difference in the age group between MASS and NAAASP may also impact on aneurysm growth and the proportion of men offered aneurysm repair. Interestingly however the proportion of men with an aneurysm >5.4 cm undergoing surgical repair was *lower* in the NAAASP (younger) group.

The second difference is that in the technique of AAA measurement. In MASS scans were performed by ultrasonographers and the maximum aortic diameter was measured from outer-to-outer wall of the aorta. In the NAAASP scans are performed by trained technicians, the maximum aortic diameter is measured from inner-to-inner wall of the aorta. Although there is a discrepancy between inner-to-inner and outer-to-outer wall measurements, a recent study demonstrated this difference to be in the order of 0.27 mm[18] so this is unlikely to explain all of the observed difference in prevalence.

Previous economic analyses on which cost-effectiveness for the NAAASP has been calculated were based on MASS data, which may now be obsolete. The impact of a reduction in AAA prevalence has a significant effect on AAA screening cohorts with a reduction in both the number of men referred for surgery and the number entering surveillance. Cost-effectiveness calculations are complex and there have been conflicting studies regarding the cost-effectiveness of AAA screening. Whilst calculations based on the MASS and Viborg studies have indicated AAA screening to be cost-effective,[8,19] a predictive Danish model using the MASS data concluded AAA screening was not cost-effective.[20] There was a huge variation in the cost per QALY between these studies, which will depend on the costs of screening (different in different countries), the proportion of AAA treated with EVAR and the cost of AAA repair.[21] A recent cost-effectiveness model suggested that in

Norway and the Netherlands AAA screening remains cost-effective even with AAA prevalence rates as low as 1%.[22] Cost-effectiveness and screening workload will also be affected by other screening variables such as screening uptake, rate of aneurysm growth and proportion of men with AAA >5.4 cm who undergo AAA repair.

The reason for a reduction in the prevalence of AAA in 65-year-old men may be multifactorial: smoking and hypertension have been strongly linked with the development and expansion of AAA.[23–25] Epidemiological studies have demonstrated a reduction in smoking-related deaths in men since 1995 in all developed countries and in Europe since the mid-1980s.[26] In the UK smoking has been steadily declining since the 1970s, and the proportion of men over the age of 60 who smoke has reduced from 44% in 1974 to 15% in 2009, based on Office for National Statistics Data.[27] Several studies have shown an inverse relationship with type 2 diabetes and prevalence and growth of AAA.[25,28,29] Obesity, type 2 diabetes and dyslipidaemia are all increasing and this may play a role in the reduction of the prevalence of AAA.[30] In addition statins have been linked with a reduction in AAA and the increasing use of these may also be implicated.[31–33]

It is possible that since the MASS study there has been an increased use of medical imaging, specifically abdominal ultrasound and computerised tomography CT.[34] Awareness of AAA may also have changed and men may present earlier (<65 years) for screening, especially those with a family history. Men with a pre-existing diagnosis of AAA are excluded from NAAASP and so would result in an underestimate of AAA prevalence in the screening cohort.

This model did not demonstrate a reduction in the incidence of ruptured AAA with the NAAASP data compared to the MASS data. It is not known whether the reduction in prevalence in men attending for abdominal aortic aneurysm screening is replicated in those men who do not attend for screening and in women. This is a weakness of the model and it may be that the prevalence of ruptured AAA using the EI data has been overestimated.

It is important to emphasize that the data from NAAASP include 23,696 men from the initial 6 screening centres, which while similar to the number of men screened within the MASS study, only represents a small sample of the overall screening population (men aged 65 years) in the UK. It is not yet known whether the observed reduction in AAA prevalence seen within this cohort is a national phenomenon and therefore at this stage the authors wish to be cautious regarding the generalisability of the study findings. HES (Hospital Episode Statistics) data indicate that despite the apparent observed decrease in the prevalence of AAA the number of aortic repairs is increasing in the UK.

In addition the model was based on local demographics, which will vary across different regions and countries, for example the Bristol population has a higher proportion of over 65-year-old men than the national average. In addition attendance rates for screening may vary in different populations, indeed rates of less than 50% for aneurysm screening have been reported in Northern Ireland.[35]

The model predicted a reduction in the number of men entering surveillance within the AAA screening programme, however a large and increasing number of surveillance scans were still required over time and this did not stabilise within the timescale of the model (20 years). Given the increase in life expectancy men with small AAA may require repair many years in the future. In addition they represent a population who could be targeted for improved cardiovascular risk factor management or potential medical management to reduce AAA expansion.

The observed reduction in prevalence of aortic aneurysms could be regarded as an indication to consider more targeted screening of higher risk groups (such as smokers, those with cardiovascular risk factors). However there is good evidence for a population screening programme (in men) data and no similar data currently for a targeted programme. The NAAASP should provide more demographic data which could indicate whether a targeted programme should be considered in the future if the reduction in prevalence of aortic aneurysm is replicated across the country.

Alternatively it may be that with an increase in life expectancy (Office of National Statistics data indicate life expectancy for a 65-year-old man is increasing and currently over 20 years) a second screen should be considered, or the aortic diameter threshold for inclusion in surveillance should be lowered (e.g. to 2.5 cm). Both of these modifications would clearly increase the cost of the programme significantly and may or may not result in a reduction aneurysm-related mortality. Data from the Gloucestershire Aneurysm Screening Programme which surveilled men with an aorta >2.5 cm found 15% developed an aortic aneurysm >5.4 cm after 10 years follow-up. There is at present no data to indicate whether the growth rate of aneurysms is changing and how this may impact on ideal screening intervals, which will also affect cost-effectiveness.

In summary, early data from NAAASP report a significantly lower AAA prevalence than the MASS study on which both NAAASP workload projections and cost-effectiveness have been calculated. The impact of this on a new local programme in terms of absolute numbers of ultrasound scans and AAA repairs has been modelled in this paper. The reduction in the prevalence of AAA appears real; but it remains to be seen whether these findings are replicated across the country in all screening centres. If this is the case then the NAAASP may require modification, but more data from monitoring pre-existing NAAASP centres should be available to inform these decisions.

Conflict of Interest/Funding

None.

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