National Institute for Health and Care Excellence

Final

Abdominal aortic aneurysm: diagnosis and management

Evidence review A: Risk factors for predicting presence of an abdominal aortic aneurysm

NICE guideline NG156

Methods, evidence and recommendations

March 2020

Final

This evidence review was developed by the NICE Guideline Updates Team

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Risk factors for predicting the presence of an abdominal aortic aneurysm

Review question

Which signs, symptoms and risk factors (or combinations of these) are most accurate in predicting the presence of an abdominal aortic aneurysm? What is the effectiveness of available risk assessment tools?

Introduction

National population-based screening programmes target and invite individuals from particular risk groups in communities for screening whilst opportunistic screening strategies are restricted to patients who consult healthcare practitioners for some other purpose. As a result, a different set of criteria may be necessary to guide clinicians on when it is appropriate to perform diagnostic imaging. This review question aims to determine which signs, symptoms, risk factors or assessment tools are accurate in predicting the presence of an abdominal aortic aneurysm (AAA) and could be used by clinicians in the course of opportunistic screening as a prompt to initiate diagnostic imaging.

PICO table

Table 1: Inclusion criteria

Parameter	Inclusion criteria
Population	• People at risk from AAA • Subgroups of interest: by age, sex, comorbidity
Index test / factors of interest	• Abdominal pain • Back pain • Abdominal palpation • Pulsatile abdominal mass/pulsation • Age • Sex • Other cardiovascular disease (existing or previous) – other aneurysms, atherosclerotic disease, intermittent claudication • Inflammatory disease • Smoking • Blood pressure/hypertension • Dislipidaemia • Hypercholesterolaemia • Family history of abdominal AAA, collagen disorders • Ethnicity • Diabetes • Chronic Obstructive Pulmonary Disease (COPD) • BMI/weight/obesity
Endpoints	• Radiological diagnosis of AAA

Methods and process

This evidence review was developed using the methods and process described in Developing NICE guidelines: the manual. Methods specific to this review question are described in the review protocol in Appendix A.

Declarations of interest were recorded according to NICE's 2014 conflicts of interest policy.

A single broad search was used to identify all studies that examine the diagnosis, surveillance or monitoring of AAA. This was a 'bulk' search that covered multiple review questions. The database was sifted to identify all studies that met the criteria detailed in Table 1. The relevant review protocol can be found in Appendix A.

Initially the review protocol outlined that prospective observational studies that use multivariate logistic regression or Cox regression to explore the association between risk factors and the development of AAA should be considered for inclusion. Following further discussion with the committee, the study design was changed, retrospectively, to include cross-sectional studies because this design was considered more likely to indicate the presence (as opposed of development) of aneurysms in people at risk of AAA. It was agreed that the amendment was needed to ensure that any identified evidence would fall in line with the objectives of this review question. As a result, cross-sectional studies, with sample sizes of more than 500 participants, exploring the association between potential risk factors and the presence of AAA were included.

Studies were excluded if they:

- were cohort studies, case-controls, or case series
- were not in English
- were not full reports of the study (for example, published only as an abstract)
- were not peer-reviewed.

Clinical evidence

Included studies

From a database of 16,274 abstracts, 76 were identified as being potentially relevant to this review question. Following full-text review of these articles, 15 studies (reported in 19 publications) were included.

An update literature search was performed and provided by Cochrane, in December 2017. The search found a total of 2,180 abstracts; of which, 16 full manuscripts were ordered. Upon review of the full manuscripts, 6 studies met inclusion criteria for this review question, and were added.

Excluded studies

The list of papers excluded at full-text review, with reasons, is given in Appendix G.

Summary of clinical studies included in the evidence review

A summary of the included studies is included in the table below.

Table 2: Summary of included studies

Study	Details
Barba A, Vega de Ceniga M, Estallo L, et al. (2013) Prevalence of abdominal aortic aneurysm is still	Study design: cross-sectional study Location(s): Spain Population: 65-year old men (all born in 1943)

Study	Details
high in certain areas of southern Europe. Annals of vascular surgery 27(8), 1068-73	Sample size: 781 Risk factors: smoking status, diabetes, hypertension, family history of AAA, peripheral artery disease, coronary insufficiency, and cerebrovascular disease
Berger J S, Hochman J, Lobach I, et al. (2013) Modifiable risk factor burden and the prevalence of peripheral artery disease in different vascular territories. Journal of vascular surgery 58(3), 673-81.e1	Study design: cross-sectional study Location(s): USA Population: self-referred patients who paid for vascular screening tests Sample size: 3.3 million people; 62.5% (2.06 mil/3.3 mil) female Risk factors: smoking status, hypertension, hyperlipidaemia and diabetes.
Bonamigo TP, and Siqueira I (2003) Screening for abdominal aortic aneurysms. Revista do Hospital das Clinicas 58(2), 63-8	Study design: cross-sectional study Location(s): Brazil Population: men, over 54 years old, who attended cardiology clinics Sample size: 768 Risk factors: age, smoking status, diabetes, hypertension, myocardial disease, peripheral artery disease
Chun KC, Teng KY, Chavez LA, et al. (2014) Risk factors associated with the diagnosis of abdominal aortic aneurysm in patients screened at a regional Veterans Affairs health care system. Annals of vascular surgery 28(1), 87-92	Study design: cross-sectional study Location(s): USA Population: people who underwent AAA screening in a regional (Californian) screening programme Sample size: 6,142; 99.6 % (6,118/6,142) male Risk factors: age, smoking status, myocardial infarction, hypercholesterolemia, hypertension, diabetes, coronary artery disease, COPD, statin use, peripheral vascular disease
Corrado Giovanni, Durante Alessandro, Genchi Vincenzo, et al (2016) Prevalence of previously undiagnosed abdominal aortic aneurysms in the area of Como: the ComoCuore "looking for AAA" ultrasonography screening. The international journal of cardiovascular imaging 32(8), 1213-7	Study design: cross-sectional study Location(s): Italy Population: people between 60 and 85 years from a region in Italy Sample size: 1,555; 51.4 % (801/1,555) female Risk factors: age, sex, and smoking status;
de Carvalho ATY, Santos AJ, Gomes CAP, et al. (2012) Infrarenal abdominal aortic aneurysm: Significance of screening in patients of public hospitals in the metropolitan region of salvador - bahia, Brazil. Jornal Vascular Brasileiro 11(4), 289-300	Study design: cross-sectional study Location(s): Brazil Population: patients, 50 years or older ,who presented at hospitals with one or more of the following clinical conditions or risk factors were eligible for screening: diabetes systemic arterial hypertension, smoking, COPD, peripheral arterial disease, coronary insufficiency, non-ischemic congestive heart failure, dyslipidaemia, carotid stenosis, obesity, chronic kidney disease and a family history of AAA, Marfan syndrome or Ehlers–Danlos syndrome Sample size: 1,350; 66.7% (901/1,350) female Risk factors: age, sex, smoking status, COPD, peripheral artery disease, family history of AAA, Marfan syndrome or Ehlers–Danlos syndrome
Derubertis BG, Trocciola SM, Ryer EJ, et al. (2007) Abdominal aortic aneurysm in women: prevalence, risk	Study design: cross-sectional study Location(s): USA

Study	Details
factors, and implications for screening. Journal of vascular surgery 46(4), 630-635	Population: women, over 65 years old, with at least one of the following factors were eligible for screening: hypertension, history of smoking, cardiovascular disease, or a family history of AAA Sample size: 10,012 Risk factors: age, ethnicity, smoking status, family history of AAA, and cardiovascular disease
Hager J, LT, Carlsson P, and Lundgren F (2013) Lower prevalence than expected when screening 70-year-old men for abdominal aortic aneurysm. European Journal of Vascular and Endovascular Surgery 46(4), 453-459	Study design: cross-sectional study Location(s): Sweden Population: 70 year-old men Sample size: 5,623 Risk factors: smoking status, COPD, cerebrovascular disease, claudication, coronary artery, and hyperlipidaemia
Johnsen SH, Forsdahl SH, Singh K, et al. (2010) Atherosclerosis in abdominal aortic aneurysms: a causal event or a process running in parallel? The Tromso study. Arteriosclerosis, thrombosis, and vascular biology 30(6), 1263-8	Study design: cross-sectional study Location(s): Norway Population: people between 25 and 74 years old Sample size: 6,446; 50.9% (3282/6446) female Risk factors: atherosclerosis (measured by total plaque areas)
Kent KC, Zwolak RM, Egorova NN, Greco G, et al. (2010) Analysis of risk factors for abdominal aortic aneurysm in a cohort of more than 3 million individuals. Journal of vascular surgery 52(3), 539-48 Note: other publications evaluating the same population were produced by the same study group. See evidence tables in Appendix D for further details.	Study design: cross-sectional study Location(s): USA Population: self-referred patients who paid for vascular screening tests Sample size: 3,056,455 people; sex-specific proportions were not reported Risk factors: age, sex, smoking status, BMI, ethnicity, hypertension, coronary artery disease, family history of AAA, hypercholesterolemia, diabetes, peripheral artery disease, carotid disease, and cerebrovascular disease
Le MTQ, Jamrozik K, Davis TME et al. (2007) Negative association between infra-renal aortic diameter and glycaemia: the Health in Men Study. European journal of vascular and endovascular surgery : the official journal of the European Society for Vascular Surgery 33(5), 599-604 Note: other publications evaluating the same population were produced by the same study group. See evidence tables in Appendix D for further details.	Study design: cross-sectional study Location(s): Australia Population: men between 65 and 83 years old Sample size: 12,203 Risk factors: age, BMI, smoking status, history of cardiovascular disease, hypertension, dyslipidaemia diabetes, blood pressure and family history of AAA
Lederle FA, Johnson GR, Wilson SE, et al. (2000) The Aneurysm Detection and Management study screening program: Validation cohort and final results. Archives of Internal Medicine 160(10), 1425-1430 Note: a second older publication of the same study was produced by the same authors. See evidence tables in Appendix D for further details.	Study design: cross-sectional study Location(s): USA Population: people who were 50 to 79 years old and had no history of AAA Sample size: 126,196 – 97.3% (122,788/126,196) male Risk factors: age, sex, ethnicity, family history of AAA, smoking status, hypertension, hypercholesterolemia, coronary artery disease, claudication, cerebral vascular disease, atherosclerosis, diabetes, COPD

Study	Details
Makrygiannis G, Labalue P, Erpicum M et al. (2016) Extending Abdominal Aortic Aneurysm Detection to Older Age Groups: Preliminary Results from the Liege Screening Programme. Annals of vascular surgery 36, 55-63	Study design: cross-sectional study Location(s): Belgium Population: men aged 65-85 years and women aged 74-85 years from a region in Belgium Sample size: 1,101; 65.6% (722/379) male Risk factors: age, smoking status, hypercholesterolemia, peripheral artery disease, and coronary artery disease
Mark-Christensen A, Lindholt J S, Diederichsen A, et al. (2017) Association Between Diverticular Disease and Abdominal Aortic Aneurysms: Pooled Analysis of Two Population Based Screening Cohorts. European Journal of Vascular and Endovascular Surgery 54(6), 772-777	Study design: cross-sectional study combining data from 2 screening programmes Location(s): Denmark Population: people between 65 and 74 years of age from 2 regions in Denmark Sample size: 24,632 Risk factors: age, sex, smoking status, BMI, hypertension, smoking, and family history of AAA
Pleumeekers JCM, Hoes AW, Hofman A, et al. (1999) Selecting subjects for ultrasonographic screening for aneurysms of the abdominal aorta: Four different strategies. International Journal of Epidemiology 28(4), 682-686	Study design: cross-sectional study Location(s): Netherlands Population: people 55 years or older living in a suburb in the Netherlands Sample size: 5,328; 58% (3,090/5,328) male Risk factors: Risk factors: age, sex, smoking status, hypertension (antihypertensive drug use), angina pectoris, intermittent claudication, myocardial infarction, hypercholesterolemia, peripheral arterial disease (indicated by an ankle arm index ≤0.9), and enlarged aorta on palpation
Salvador-Gonzalez B, Martin-Baranera M, Borque-Ortega A, et al. (2016) Prevalence of Abdominal Aortic Aneurysm in Men Aged 65-74 Years in a Metropolitan Area in North-East Spain. European Journal of vascular and endovascular surgery: the official journal of the European Society for Vascular Surgery 52(1), 75-81	Study design: cross-sectional study Location(s): Spain Population: men between 65 and 74 years old registered at healthcare facilities in Barcelona Sample size: 651 Risk factors: smoking status and myocardial infarction
Singh K, Bonaa KH, Jacobsen BK, et al. (2001) Prevalence of and risk factors for abdominal aortic aneurysms in a population-based study: The Tromso Study. American Journal of Epidemiology 154(3), 236-44	Study design: cross-sectional study Location(s): Norway Population: people between 25 and 74 years old Sample size: 6,386; 53.6% (3424/6,386) female Risk factors: age, BMI, smoking status, hypertension (antihypertensive drug use), blood pressure, hyperlipidaemia, and hypercholesterolemia
Vardulaki KA, Walker NM, Day NE, et al. (2000) Quantifying the risks of hypertension, age, sex and smoking in patients with abdominal aortic aneurysm. British Journal of Surgery 87(2), 195-200	Study design: cross-sectional study Location(s): UK Population: people between 65 and 79 years old Sample size: 5,356; (3,035/5,356) female Risk factors: age, sex, smoking status, blood pressure and antihypertensive medication use

See Appendix D for full evidence tables.

Quality assessment of clinical studies included in the evidence review

See Appendix E for full GRADE tables, highlighting the quality of evidence from the included studies.

Economic evidence

Included studies

A literature search was conducted jointly for all review questions by applying standard health economic filters to a clinical search for AAA. This search returned a total of 5,173 citations. Following review of all titles and abstracts, no studies were identified as being potentially relevant to risk factors associated with aneurysm expansion or rupture. No full texts were retrieved, and so no studies were included as economic evidence.

An update search was conducted in December 2017, to identify any relevant health economic analyses published during guideline development. The search found 814 abstracts; all of which were not considered relevant to this review question. As a result no additional studies were included.

Excluded studies

No studies were retrieved for full-text review.

Economic model

This review question does not lend itself to economic evaluation, and was not prioritised by the committee for economic modelling. As such, no economic model was developed for this review question.

Resource impact

Not applicable

Evidence statements

Age

- Low- to moderate-quality evidence from 9 studies, including up to 3,083,743 people enrolled in AAA screening programmes, highlighted that odds of AAA increases with increasing age. Similar trends were found in men (3 studies including up to 12,971 men) and women (2 studies including up to 10,012 women).

Sex

- Low-quality evidence from 7 studies, including 3,217,464 people, indicated that men were more likely to have an AAA than women.

BMI/Weight/Obesity

- Very low- to low-quality evidence from 4 studies, including 3,081,087 people, indicated contradictory associations between increasing BMI and the presence of AAA. In relation to sex-specific associations, low-quality evidence from 1, including 6,386 people, could not identify any association between 4kg/m^2 incremental increases in BMI and the presence of AAA in men or women.

Smoking

- Low-quality evidence from 7 studies, including 3,341,733 people, indicated that current smokers were more likely have an AAA than people who have never smoked (never smokers). Additionally, moderate-quality evidence from 4 studies, including 3,351,536 people, indicated that ex-smokers were more likely to have an AAA than never smokers. Low-quality evidence from 4 studies, including 10,134 men highlighted similar relationships between current smokers, ex-smokers and never smokers. In women, moderate-quality evidence from 1 study, including 3,424 women, highlighted that current smokers were more likely to have an AAA than people who had never smoked whereas the evidence could not differentiate between AAA rates between ex-smokers and never smokers.

Palpable aorta on abdominal examination

- Low-quality evidence from 1 study, including 5,328 people, indicated that people with palpable aorta on abdominal examination were more likely to have an AAA than people who did not.

Cardiovascular disease

- Low-quality evidence from 5 studies, including up to 3,186,486 people, indicated that people with coronary artery disease or coronary insufficiency were more likely to have an AAA than people who did not have any of these conditions. Moderate-quality evidence from 2 studies, including up to 12,203 men, indicated that men with a history of myocardial infarction or cardiovascular disease (not specified) were more likely to have an AAA than men without a history of these conditions. Low-quality evidence from 1 study, including 10,012 women, indicated that women with a history of myocardial infarction or coronary revascularisation were more likely to have an AAA than men without a history of these conditions.

Peripheral arterial disease, atherosclerosis, and claudication

- Low-quality evidence from 6 studies, including up to 3,095,008 people, indicated that people with peripheral arterial disease, atherosclerosis, or claudication were more likely to have an AAA than people who did not have any of these conditions. Low-quality evidence from 2 studies, including 1,549 men, also indicated that men with peripheral arterial disease were more likely to have an AAA than men without peripheral arterial disease. With regards to claudication as a risk factor in men, low-quality evidence from 1 study, including 5,623 men could not differentiate rates of AAA between men with claudication and those without claudication.

Cerebrovascular disease

- Low-quality evidence from 2 studies, including 3,179,243 people, indicated that people with cerebrovascular disease were more likely to have an AAA than those without cerebrovascular disease. A similar relationship was found in low-quality evidence from 2 studies that included 6,404 men. No evidence was identified specific to women.

Diabetes

- Low-quality evidence from 4 studies, including 6,505,378 people, indicated that people with diabetes were less likely to have an AAA than those without diabetes. A similar relationship was found in low-quality evidence from 3 studies that included 13,752 men; however, the results across the studies were inconsistent.

Chronic obstructive pulmonary disease (COPD)

- Low-quality evidence from 3 studies, including 130,280 people, indicated that people with COPD were more likely to have an AAA than those who did not have COPD. A similar

relationship was found in low-quality evidence from 1 study that included 5,623 men. No evidence was identified specific to women.

Hypertension

- Low-quality evidence from 7 studies, including 6,540,694 people, indicated that people with hypertension were more likely to have an AAA than those who did not have hypertension. A similar relationship was found in low-quality evidence from 4 studies, including 16,714 men, and moderate-quality evidence from 1 study including 3,424 women.

Blood pressure thresholds

- Low-quality evidence from 1 study, including 5,363 people, could not differentiate AAA rates between people with systolic blood pressures equal to or above 200 mmHg and those with pressures below 200 mmHg. The same study could not differentiate AAA rates between people with diastolic blood pressures equal to or above 100 mmHg and those with pressures below 100 mmHg.

Dyslipidaemia (including hyperlipidaemia, hypercholesterolemia, and cholesterol thresholds)

- Low- to moderate-quality evidence from 5 studies, including up to 3,319,993 people, indicated that people with hyperlipidaemia or hypercholesterolemia were more likely to have an AAA than those who did not have any dyslipidaemia. Moderate-quality evidence from 1 study, including 12,203 men, indicated that men with dyslipidaemia were more likely to have an AAA than men who did not have dyslipidaemia. No evidence relating to dyslipidaemia was found for women.

Family history of AAA

- Low-quality evidence from 3 studies, including 3,203,875 people, indicated that people with a family history of AAA were more likely to have an AAA than those who did not. Additionally, moderate-quality evidence from 1 study, including 1,350 people, indicated that people with a family history of AAA, Marfan's syndrome or Ehlers–Danlos syndrome were more likely to have an AAA than those who did not. Low-quality evidence from 2 studies, including 12,984 men, indicated that people with a family history of AAA were more likely to have an AAA than those who did not. Conversely, very low-quality evidence from 1 study, including 10,012 women, could not differentiate rates of AAA between women who had a family history of AAA and women who did not.

Ethnicity

Low-quality evidence from 2 studies, including up to 3,056,455 people, highlighted that Hispanic, black and Asian ethnic groups were individually less likely to have an AAA than white people. In relation to women, very-low quality evidence from 1 study, including 10,012 women, could not differentiate AAA rates between native-American people and white people. No evidence was identified specific to men.

The committee's discussion of the evidence

Interpreting the evidence

The outcomes that matter most

The committee agreed that the outcomes that matter most were common risk factors for asymptomatic AAAs which could be used in community settings (outside specialist vascular services) to highlight the need for aortic ultrasound imaging.

The quality of the evidence

Since cross-sectional studies were considered the best study design to answer this review question, each cross-sectional study was initially graded as high in quality and was subsequently downgraded if there were any concerns about bias, indirectness, inconsistency, and imprecision. The committee agreed that the quality of evidence ranged from very low to high. Risk of bias was the main reason why some of the identified evidence was downgraded. In these studies the presence of risk factors was not ascertained by clinical examination, laboratory testing or review of medical records. Instead, patients were asked to complete self-administered questionnaires asking whether they had been diagnosed or were receiving medication for clinical risk factors of interest. Another potential bias was related to the way that the data was analysed. In some studies a stepwise approach was not used to input predictor variables into logistic regression models. Instead, investigators only input variables that were found to be significant in univariate analyses into logistic regression models. Although some of the evidence was considered low in quality, the committee agreed that the evidence reflected their clinical experience. Thus, the committee decided that “offer” recommendations were warranted.

It was noted that all but 1 study reported risk factors associated with the presence of an AAA. Pleumeekers et al. (1999) was the only study that assessed a physical sign indicative of the presence of an AAA. This study highlighted that people with a palpable aorta on abdominal examination were more likely to have an AAA than people without a palpable aorta on examination. The committee agreed that a palpable aorta was an important indicator that an aneurysm is present. However, it needed to be explicitly stated that there has to be some suspicion of an aneurysm to prompt abdominal examination.

The committee agreed that there was strong evidence that the risk of AAA increased with age. However, it was noted that various age cut-offs were used across included studies. Expert testimony from the national AAA screening programme (see Appendix H), highlighted that screening strategies focuses on 65-year-old men but there is a chance that older men with AAA are being missed. As a result, the committee agreed that it was important to specifically mention men aged 66 years and older in the recommendations. In relation to women, the committee noted that moderate-quality evidence showed that women aged 70 years or over had an increased risk of AAA when compared with women aged below 70 years. As a result, this age cut-off was used in the recommendations.

In relation to other risk factors associated with AAA, the committee considered that the majority of studies reported similar effect sizes, making it difficult to establish a hierarchy of association. As a result, the remaining risk factors associated with AAA presence were listed as bullet points in the recommendations. The committee agreed that it was more useful to use general terms such as “coronary, cerebrovascular or peripheral vascular disease” than to specify particular diseases.

Although the evidence on diabetes highlighted that the condition was a protective factor, the committee decided not to make any recommendations. This was because the main aim of the review question was to identify factors that would facilitate opportunistic screening (and increase the chances of people receiving abdominal ultrasound imaging to confirm or dismiss the suspicion of an AAA). The committee also decided not to make any recommendation on BMI as a risk factor because they considered that the studies that assessed BMI reported contradictory results.

Benefits and harms

The committee recognised that the national AAA screening programme has the ability to screen and identify a large number of people with AAA in the UK; however, there will always be some people who are missed by the programme. Furthermore, the committee noted that men who do not take up screening often have the highest risk of an AAA. As a result, the committee agreed that focusing recommendations on risk factors that could be used for

opportunistic screening would improve detection rates. This would increase the chances that AAAs are identified early (before rupture) and reduce overall AAA-related morbidity and mortality.

The committee noted that there is a small risk of harm (such as unnecessary intervention) associated with population-based screening: evidence from the national screening programme highlighted that approximately 1 in 10,000 men die following intervention indicated by screening. The committee recognised that there may be also be small harms associated with targeted case-finding in men and women. However, it was agreed that the benefits of identifying AAAs early outweighed the risks of intervention-related or rupture-related mortality.

Cost effectiveness and resource use

The committee noted that expert testimony from the national AAA screening programme highlighted that population-based screening of 65-year-old men is cost-effective down to the prevalence of 0.35%. The committee took the view that opportunistic case finding of men 66 years and over as well as women aged 70 years and over was likely to be cost effective, as the recommendations allow for more people with AAAs to be identified early, before complications or rupture arise.

Other factors the committee took into account

The committee considered that the recommendations were primarily intended for general practitioners in order to facilitate diagnosis of AAA in individuals who attend primary care facilities seeking treatment for other conditions. The committee acknowledged that similar considerations could be made in secondary care settings. As a result, no healthcare setting was specified in the guideline recommendations.

The committee noted the significant advances made by the national AAA screening programme and recognised that population-based screening yields some advantages over opportunistic aortic ultrasound. Notably, invitation to and subsequent attendance at screening reduced all-cause and AAA-related mortality.

Appendices

Appendix A – Review protocols

Review protocol for risk factors for predicting presence of an abdominal aortic aneurysm

Review question 1	Which signs, symptoms and risk factors (or combinations of these) are most accurate in predicting the presence of an abdominal aortic aneurysm? What is the effectiveness of available risk assessment tools?
Objectives	To determine which signs, symptoms, risk factors or assessment tools are accurate in predicting the presence of an AAA and could be used by clinicians in the course of opportunistic screening as a prompt to initiate diagnostic imaging
Type of review	Prognostic
Language	English
Study design	Initially, the following studies designs were included in the review protocol: • Prospective observational studies using multivariate analysis; n >500 • Prospective observational studies using smaller populations (n >200) will be considered if insufficient evidence is identified Following committee discussion, the study design was retrospectively changed to include the following study designs to match the objectives of this review question • Cross-sectional studies using multivariate analysis; n >500 • Cross-sectional studies using smaller populations (n >200) will be considered if insufficient evidence is identified
Status	i) Published papers only (full text) No date restrictions ii) Expert witness to present findings from UK registry data
Population	People at risk from abdominal aortic aneurysms Subgroups of interest: by age, sex, comorbidity
Index test / factors of interest	Abdominal pain Back pain Abdominal palpation Pulsatile abdominal mass/pulsation Age Sex Other cardiovascular disease (existing or previous) – other aneurysms, atherosclerotic disease, vascular claudication Inflammatory disease Smoking Blood pressure/hypertension Dislipidaemia Hypercholesterolaemia Family history of abdominal aortic aneurysms, other aneurysms, collagen disorders Ethnicity Diabetes COPD BMI/weight/obesity

Review question 1	Which signs, symptoms and risk factors (or combinations of these) are most accurate in predicting the presence of an abdominal aortic aneurysm? What is the effectiveness of available risk assessment tools?
Endpoint	Radiological diagnosis of abdominal aortic aneurysm
Other criteria for inclusion / exclusion of studies	Exclusion: Non-English language Abstract/non-published Minimum population size of 500
Baseline characteristics to be extracted in evidence tables	Age Sex Comorbidities
Search strategies	See Appendix B
Review strategies	Double-sifting of randomly selected 20%. Appropriate NICE Methodology Checklists, depending on study designs, will be used as a guide to appraise the quality of individual studies. 20% will be appraised by a second reviewer. Data on all included studies will be extracted into evidence tables. Where statistically possible, a meta-analytic approach will be used to give an overall summary effect. All key findings from evidence will be presented in GRADE profiles and further summarised in evidence statements.
Key papers	Beede SD, Ballard DJ, James EM, Ilstrup DM, Hallet JW Jr. Positive predictive value of clinical suspicion of abdominal aortic aneurysm. Implications for efficient use of abdominal ultrasonography. Arch Intern Med. 1990 Mar;150(3):549-51 Fink HA, Lederle FA, Roth CS, Bowles CA, Nelson DB, Haas MA. The accuracy of physical examination to detect abdominal aortic aneurysm. Arch Intern Med. 2000 Mar 27;160(6):833-6 Lederle FA, Simel DL. The rational clinical examination. Does this patient have abdominal aortic aneurysm? JAMA. 1999 Jan 6;281(1):77-82 Pleumeekers HJ, Hoes AW, Hofman A, van Urk H, van der Does E, Grobbee DE. Selecting subjects for ultrasonographic screening for aneurysms of the abdominal aorta: four different strategies. Int J Epidemiol. 1999 Aug;28(4):682-6

Appendix B – Literature search strategies

Clinical search literature search strategy

Main searches

Bibliographic databases searched for the guideline

- Cumulative Index to Nursing and Allied Health Literature - CINAHL (EBSCO)
- Cochrane Database of Systematic Reviews – CDSR (Wiley)
- Cochrane Central Register of Controlled Trials – CENTRAL (Wiley)
- Database of Abstracts of Reviews of Effects – DARE (Wiley)
- Health Technology Assessment Database – HTA (Wiley)
- EMBASE (Ovid)
- MEDLINE (Ovid)
- MEDLINE Epub Ahead of Print (Ovid)
- MEDLINE In-Process (Ovid)

Identification of evidence for review questions

The searches were conducted between November 2015 and October 2017 for 31 review questions (RQ). In collaboration with Cochrane, the evidence for several review questions was identified by an update of an existing Cochrane review. Review questions in this category are indicated below. Where review questions had a broader scope, supplement searches were undertaken by NICE.

Searches were re-run in December 2017.

Where appropriate, study design filters (either designed in-house or by McMaster) were used to limit the retrieval to, for example, randomised controlled trials. Details of the study design filters used can be found in section 4.

Search strategy review question 1

Medline Strategy, searched 29th September 2016 **Database: 1946 to September Week 3 2016** **Search Strategy:**
1 Aortic Aneurysm, Abdominal/
2 Aortic Rupture/
3 (aneurysm* adj4 (abdom* or thoracoabdom* or thoraco-abdom* or aort* or spontan* or juxtarenal* or juxta-renal* or juxta renal* or paraerenal* or para-renal* or para renal* or suprarenal* or supra renal* or supra-renal* or short neck* or short-neck* or shortneck* or visceral aortic segment*)).tw.
4 or/1-3
5 prognosis.sh.
6 diagnosed.tw.
7 cohort.mp.
8 predictor:.tw.
9 death.tw.
10 exp models, statistical/
11 or/5-10
12 (sensitiv: or predictive value:).mp. or accurac:.tw.

Medline Strategy, searched 29th September 2016 Database: 1946 to September Week 3 2016 Search Strategy:
13 11 or 12
14 "signs and symptoms"/
15 ((sign or signs) adj5 symptom*).tw.
16 Risk Factors/
17 factor*.tw.
18 predict*.tw.
19 or/14-18
20 13 or 19
21 4 and 20
22 animals/ not humans/
23 21 not 22 (12444)
24 limit 23 to english language

Health Economics literature search strategy

Sources searched to identify economic evaluations

- NHS Economic Evaluation Database – NHS EED (Wiley) last updated Dec 2014
- Health Technology Assessment Database – HTA (Wiley) last updated Oct 2016
- Embase (Ovid)
- MEDLINE (Ovid)
- MEDLINE In-Process (Ovid)

Search filters to retrieve economic evaluations and quality of life papers were appended to the population and intervention terms to identify relevant evidence. Searches were not undertaken for qualitative RQs. For social care topic questions additional terms were added. Searches were re-run in September 2017 where the filters were added to the population terms.

Health economics search strategy

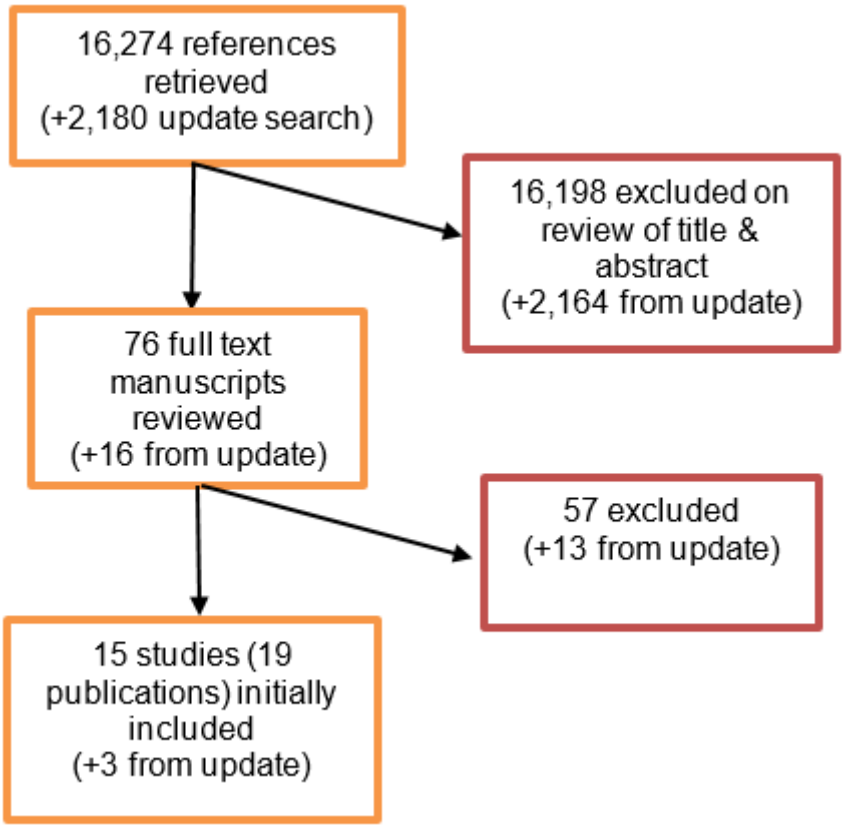
Medline Strategy
Economic evaluations
1 Economics/
2 exp "Costs and Cost Analysis"/
3 Economics, Dental/
4 exp Economics, Hospital/
5 exp Economics, Medical/
6 Economics, Nursing/
7 Economics, Pharmaceutical/
8 Budgets/
9 exp Models, Economic/
10 Markov Chains/
11 Monte Carlo Method/
12 Decision Trees/
13 econom*.tw.
14 cba.tw.
15 cea.tw.

Medline Strategy

16 cua.tw.
17 markov*.tw.
18 (monte adj carlo).tw.
19 (decision adj3 (tree* or analys*)).tw.
20 (cost or costs or costing* or costly or costed).tw.
21 (price* or pricing*).tw.
22 budget*.tw.
23 expenditure*.tw.
24 (value adj3 (money or monetary)).tw.
25 (pharmacoeconomic* or (pharmaco adj economic*)).tw.
26 or/1-25

Quality of life
1 "Quality of Life"/
2 quality of life.tw.
3 "Value of Life"/
4 Quality-Adjusted Life Years/
5 quality adjusted life.tw.
6 (qaly* or qald* or qale* or qtime*).tw.
7 disability adjusted life.tw.
8 daly*.tw.
9 Health Status Indicators/
10 (sf36 or sf 36 or short form 36 or shortform 36 or sf thirtysix or sf thirty six or shortform thirtysix or shortform thirty six or short form thirtysix or short form thirty six).tw.
11 (sf6 or sf 6 or short form 6 or shortform 6 or sf six or sfsix or shortform six or short form six).tw.
12 (sf12 or sf 12 or short form 12 or shortform 12 or sf twelve or sftwelve or shortform twelve or short form twelve).tw.
13 (sf16 or sf 16 or short form 16 or shortform 16 or sf sixteen or sfsixteen or shortform sixteen or short form sixteen).tw.
14 (sf20 or sf 20 or short form 20 or shortform 20 or sf twenty or sftwenty or shortform twenty or short form twenty).tw.
15 (euroqol or euro qol or eq5d or eq 5d).tw.
16 (qol or hql or hqol or hrqol).tw.
17 (hye or hyes).tw.
18 health* year* equivalent*.tw.
19 utilit*.tw.
20 (hui or hui1 or hui2 or hui3).tw.
21 disutili*.tw.
22 rosser.tw.
23 quality of wellbeing.tw.
24 quality of well-being.tw.
25 qwb.tw.
26 willingness to pay.tw.
27 standard gamble*.tw.
28 time trade off.tw.
29 time tradeoff.tw.
30 tto.tw.
31 or/1-30

Appendix C – Clinical evidence study selection



Appendix D – Clinical evidence tables

Full citation	**Barba A, Vega de Ceniga M, Estallo L, et al. (2013) Prevalence of abdominal aortic aneurysm is still high in certain areas of southern Europe. Annals of vascular surgery 27(8), 1068-73**
Study details	Study design: cross-sectional study Location(s): Spain Aim of the study: to report the results of a systematic AAA screening programme in 65-year old men in a defined rural area in northern Spain Study dates: January 2008 to December 2009 Sources of funding: the study was supported by research grants from the Spanish Society of Angiology and Vascular Surgery Foundation and the Research Unit from the Galdakao-Usansolo Hospital
Participants	Sample size: 781 men Inclusion criteria: 65-year old men (born in 1943) who responded to an invitation to participate were included Exclusion criteria: not reported Baseline characteristics: • Mean age: not reported • Sex: 100% male • Diabetes: 52.1% • Hypertension: 25.7% • Dyslipidaemia: 76.9%
Methods	Data collection: Ultrasound imaging was used to establish the presence of AAA (defined as an infrarenal aortic diameter of 3 cm or larger). To ascertain the presence of risk factors investigators assessed participants' medical records, performed physical examinations and obtained blood samples after a minimum of 8 hours of overnight fasting. Hypertension was defined as systolic blood pressure greater than 140 mmHg or diastolic pressure less than 90 mm Hg measured, or the participant was already taking hypotensive medication. A patient was considered diabetic if they were receiving medication or if investigators found basal glycaemia greater than 120 mg/dL or haemoglobin A1c higher than 6.5%. Hyperlipidaemia was defined as the participant receiving treatment (a supervised diet or lipid lowering medication) or if they had total cholesterol levels greater than 200 mg/dL, triglycerides greater than 150 mg/dL or low-density lipoprotein cholesterol greater than 130 mg/dL. Cardiac disease included coronary heart disease, vascular disease, cardiomyopathy, and arrhythmia. Analysis: multivariate logistic regression. It is unclear what factors were adjusted for in the analysis.
Outcomes	Risk factors: smoking status, diabetes, hypertension, family history of AAA, peripheral artery disease, coronary insufficiency, and cerebrovascular disease

Full citation	**Barba A, Vega de Ceniga M, Estallo L, et al. (2013) Prevalence of abdominal aortic aneurysm is still high in certain areas of southern Europe. Annals of vascular surgery 27(8), 1068-73**
Study Appraisal using the Joanna Briggs Institute checklist	1. Were the criteria for inclusion in the sample clearly defined? Yes 2. Were the study subjects and the setting described in detail? Yes 3. Was the exposure measured in a valid and reliable way? Yes 4. Were objective, standard criteria used for measurement of the condition? Yes 5. Were confounding factors identified? Unclear 6. Were strategies to deal with confounding factors stated? Unclear 7. Were the outcomes measured in a valid and reliable way? Yes 8. Was appropriate statistical analysis used? No – stepwise regression was not performed. Instead, only variables with p-values <0.2 in multivariate analyses were explored in the multivariate logistic regression model. Overall risk of bias: moderate Directness: directly applicable

Full citation	**Berger J S, Hochman J, Lobach I, et al. (2013) Modifiable risk factor burden and the prevalence of peripheral artery disease in different vascular territories. Journal of vascular surgery 58(3), 673-81.e1**
Study details	Study design: cross-sectional study Location(s): USA Aim of the study: to investigate the association of modifiable risk factors with peripheral vascular disease, coronary artery stenosis and AAA among 3.3 million people enrolled in a population screening programme Study dates: 2004 to 2008 Sources of funding: the study was partially funded by the an American Heart Association Fellow to Faculty Award and a Doris Duke Clinical Scientist Development Award
Participants	Sample size: 3,319,993 people; Inclusion criteria: self-referred patients who paid for vascular screening tests. No further details were provided. Exclusion criteria: patients with records that did not report abdominal aortic ultrasound results and patients with missing data were excluded. When multiple screening was performed on the same individual only the first record with complete information was included. Baseline characteristics: • Mean age: 64.1 years • Sex: 62.5% female • Diabetes: 10.8% • Hypertension: 47.0%

Full citation	**Berger J S, Hochman J, Lobach I, et al. (2013) Modifiable risk factor burden and the prevalence of peripheral artery disease in different vascular territories. Journal of vascular surgery 58(3), 673-81.e1**
	• Hyperlipidaemia: 53.3% • Family history of cardiovascular disease: 23.0%
Methods	Data collection: Ultrasound imaging was used to establish the presence of AAA (defined as an infrarenal aortic diameter of 3 cm or larger). Participants were asked to complete a questionnaire self-administered questionnaire in order to ascertain the presence of risk factors. Hypertension was defined as systolic blood pressure of 140 mm Hg or greater in upper extremity, prior physician diagnosis, or medication use. Hypercholesterolemia was defined as the participant reporting that they were diagnosed or using lipid lowering medication. Diabetes was defined as self-reported physician diagnosis or the use of diabetes medication. Current smokers were defined as people who had smoked 100 cigarettes during their lifetime and were still currently smoking. Former smokers were considered individuals who had smoked 100 cigarettes during their lifetime and were not currently smoking. Analysis: multivariate logistic regression adjusting for age, sex, ethnicity, body mass index and a family history of cardiovascular disease
Outcomes	Risk factors: smoking status, hypertension, hyperlipidaemia and diabetes. Investigators also assessed a sedentary lifestyle as a risk factor; however, this factor is not listed for inclusion in the review protocol.
Study Appraisal using the Joanna Briggs Institute checklist	1. Were the criteria for inclusion in the sample clearly defined? Yes 2. Were the study subjects and the setting described in detail? Yes 3. Was the exposure measured in a valid and reliable way? No – the presence of risk factors was ascertained by participants completing a self-administered questionnaire. 4. Were objective, standard criteria used for measurement of the condition? Yes 5. Were confounding factors identified? Yes 6. Were strategies to deal with confounding factors stated? Yes 7. Were the outcomes measured in a valid and reliable way? Yes 8. Was appropriate statistical analysis used? Unclear – Investigators did not report whether a stepwise approach was used to perform the multivariate logistic regression. Overall risk of bias: moderate Directness: directly applicable

Full citation	Bonamigo TP, and Siqueira I (2003) Screening for abdominal aortic aneurysms. Revista do Hospital das Clinicas 58(2), 63-8
Study details	Study design: cross-sectional study Location(s): Brazil Aim of the study: to assess the prevalence of AAA in southern Brazil and define risk factors associated with high prevalence of the condition Study dates: 1987 to 1993 Sources of funding: not reported
Participants	Sample size: 768 men Inclusion criteria: patients attending cardiology clinics at participating hospitals were included. All participants were male and older than 54 years of age. Exclusion criteria: Women and men younger than 54 years old were excluded Baseline characteristics: • Mean age: not reported • Sex: 100% male • Comorbidities: not reported
Methods	Data collection: Ultrasound imaging was used to establish the presence of AAA. An AAA was defined as an infrarenal aortic diameter of 3 cm or larger, or if the infrarenal aortic diameter was more than 0.5 cm greater than the supra-renal aortic diameter. The presence of risk factors was determined by examination of medical records, medical interview and physical examination. All interviews were performed by the same clinician. Hypertension and ischemic heart disease were defined as proven history of these conditions or use of drugs to treat the conditions. Analysis: multivariate logistic regression. It is unclear what factors were adjusted for in the analysis
Outcomes	Risk factors: age, smoking status, diabetes, hypertension, myocardial disease, peripheral artery disease
Study Appraisal using the Joanna Briggs Institute checklist	1. Were the criteria for inclusion in the sample clearly defined? Yes 2. Were the study subjects and the setting described in detail? Yes 3. Was the exposure measured in a valid and reliable way? Yes 4. Were objective, standard criteria used for measurement of the condition? Yes 5. Were confounding factors identified? Unclear 6. Were strategies to deal with confounding factors stated? Unclear 7. Were the outcomes measured in a valid and reliable way? Yes 8. Was appropriate statistical analysis used? Unclear – Investigators did not report whether a stepwise approach was used to perform the multivariate logistic regression. Overall risk of bias: low Directness: directly applicable

Full citation	**Chun KC, Teng KY, Chavez LA, et al. (2014) Risk factors associated with the diagnosis of abdominal aortic aneurysm in patients screened at a regional Veterans Affairs health care system. Annals of vascular surgery 28(1), 87-92**
Study details	Study design: cross-sectional study Location(s): USA Aim of the study: to evaluate risk factors associated with AAA in people undergoing AAA screening Study dates: January 2007 to December 2009 Sources of funding: not reported
Participants	Sample size: 6,142; Inclusion criteria: individuals who underwent AAA screening in a regional (Californian) screening programme Exclusion criteria: people with ultrasound measurements that were deemed inconclusive or those who had incomplete risk factor data were excluded Baseline characteristics: • >75 years: 29.7% • Sex: 99.6% male • Hypertension: 68.8% • Diabetes: 26.7% • Coronary artery disease: 29.6% • COPD: 12.5% • Peripheral Vascular disease: 10%
Methods	Data collection: Ultrasound imaging was used to establish the presence of AAA (defined as an infrarenal aortic diameter of 3 cm or larger). The presence of risk factors was determined by assessment of participants' electronic medical records. Analysis: multivariate logistic regression. It is unclear what factors were adjusted for in the analysis.
Outcomes	Risk factors: age, smoking status, myocardial infarction, hypercholesterolemia, hypertension, diabetes, coronary artery disease, COPD, statin use, peripheral vascular disease. Investigators also assessed estimated glomerular filtration rate thresholds as risk factors; however, these are not listed for inclusion in the review protocol.
Study Appraisal using the Joanna Briggs	1. Were the criteria for inclusion in the sample clearly defined? No – it was unclear what people were eligible for screening and subsequent inclusion in this study 2. Were the study subjects and the setting described in detail? No 3. Was the exposure measured in a valid and reliable way? Yes 4. Were objective, standard criteria used for measurement of the condition? Yes 5. Were confounding factors identified? Unclear 6. Were strategies to deal with confounding factors stated? Unclear

Full citation	**Chun KC, Teng KY, Chavez LA, et al. (2014) Risk factors associated with the diagnosis of abdominal aortic aneurysm in patients screened at a regional Veterans Affairs health care system. Annals of vascular surgery 28(1), 87-92**
Institute checklist	7. Were the outcomes measured in a valid and reliable way? Yes 8. Was appropriate statistical analysis used? Unclear – Investigators did not report whether a stepwise approach was used to perform the multivariate logistic regression. Overall risk of bias: moderate Directness: directly applicable

Full citation	**Corrado Giovanni, Durante Alessandro, Genchi Vincenzo, Trabattoni Loris, Beretta Sandro, Rovelli Enza, Foglia-Manzillo Giovanni, and Ferrari Giovanni (2016) Prevalence of previously undiagnosed abdominal aortic aneurysms in the area of Como: the ComoCuore "looking for AAA" ultrasonography screening. The international journal of cardiovascular imaging 32(8), 1213-7**
Study details	Study design: cross-sectional study Location(s): Italy Aim of the study: to report the results of a AAA screening programme in people 60-85 years old from the North-West region of Italy Study dates: September 2010 to November 2013 Sources of funding: not reported
Participants	Sample size: 1,555 people; 51.4 % (801/1,555) female Inclusion criteria: people between 60 and 85 years from the Lombardy region of Italy were included Exclusion criteria: people with known AAA or a history of AAA surgery were excluded Baseline characteristics: • Mean age: 68.8 years • Sex: 51.4% female • Hypertension: 49.1% • Dyslipidaemia: 29.5% • Diabetes: 6.7% • Coronary artery disease: 11.4% • Peripheral artery disease: 1.0% • Previous cerebrovascular accident: 1.1%
Methods	Data collection: Ultrasound imaging was used to establish the presence of AAA (defined as an infrarenal aortic diameter of 3 cm or larger). Investigators ascertained the presence of risk factors by asking participants to complete a self-reported questionnaire. Analysis: multivariate logistic regression. It is unclear what factors were adjusted for in the analysis.

Full citation	**Corrado Giovanni, Durante Alessandro, Genchi Vincenzo, Trabattoni Loris, Beretta Sandro, Rovelli Enza, Foglia-Manzillo Giovanni, and Ferrari Giovanni (2016) Prevalence of previously undiagnosed abdominal aortic aneurysms in the area of Como: the ComoCuore "looking for AAA" ultrasonography screening. The international journal of cardiovascular imaging 32(8), 1213-7**
Outcomes	Risk factors: age, sex, and smoking status
Study Appraisal using the Joanna Briggs Institute checklist	1. Were the criteria for inclusion in the sample clearly defined? Yes 2. Were the study subjects and the setting described in detail? Yes 3. Was the exposure measured in a valid and reliable way? No – the presence of risk factors was ascertained by participants completing a self-administered questionnaire. 4. Were objective, standard criteria used for measurement of the condition? Yes 5. Were confounding factors identified? Unclear 6. Were strategies to deal with confounding factors stated? Unclear 7. Were the outcomes measured in a valid and reliable way? Yes 8. Was appropriate statistical analysis used? No – stepwise regression was not performed. Instead, the variables that were statistically significant in univariate analysis or clinically associated with AAA were entered into the multivariate regression model Overall risk of bias: High Directness: directly applicable

Full citation	**de Carvalho ATY, Santos AJ, Gomes CAP, et al. (2012) Infrarenal abdominal aortic aneurysm: Significance of screening in patients of public hospitals in the metropolitan region of salvador - bahia, Brazil. Jornal Vascular Brasileiro 11(4), 289-300**
Study details	Study design: cross-sectional study Location(s): Brazil Aim of the study: to determine the prevalence of infrarenal AAA in people from a region in northeast Brazil (Salvador) and to identify risk factors in this population Study dates: September 2008 to October 2009 Sources of funding: authors stated that no financial support was received
Participants	Sample size: 1,350; Inclusion criteria: patients, 50 years or older ,who presented at hospitals with one or more of the following clinical conditions or risk factors were eligible for screening: diabetes systemic arterial hypertension, smoking, COPD, peripheral arterial disease, coronary insufficiency, non-ischemic congestive heart failure, dyslipidaemia, carotid stenosis, obesity, chronic kidney disease and a family history of AAA, Marfan syndrome or Ehlers–Danlos syndrome Exclusion criteria: patients with a previous diagnosis of AAA were excluded Baseline characteristics: • Mean age: 72.4 years • Sex: 66.7% female • Hypertension: 59.9% • Peripheral arterial disease: 7.6% • Coronary insufficiency: 3.9% • COPD: 3.1% • Diabetes: 46.8% • Chronic Kidney disease: 2.8% • Chronic heart failure: 3.6% • Dyslipidaemia: 15.4%
Methods	Data collection: Ultrasound imaging was used to establish the presence of AAA (defined as an infrarenal aortic diameter of 3 cm or larger). The presence of risk factors was determined by asking participants to complete a questionnaire. Analysis: multivariate logistic regression. It is unclear what factors were adjusted for in the analysis.
Outcomes	Risk factors: age, sex, smoking status, COPD, peripheral artery disease, family history of AAA, Marfan syndrome or Ehlers–Danlos syndrome
Study Appraisal using the	1. Were the criteria for inclusion in the sample clearly defined? Yes 2. Were the study subjects and the setting described in detail? Yes

Full citation	de Carvalho ATY, Santos AJ, Gomes CAP, et al. (2012) Infrarenal abdominal aortic aneurysm: Significance of screening in patients of public hospitals in the metropolitan region of salvador - bahia, Brazil. Jornal Vascular Brasileiro 11(4), 289-300
Joanna Briggs Institute checklist	3. Was the exposure measured in a valid and reliable way? No – the presence of risk factors was ascertained by participants completing a self-administered questionnaire. 4. Were objective, standard criteria used for measurement of the condition? Yes 5. Were confounding factors identified? Unclear 6. Were strategies to deal with confounding factors stated? Unclear 7. Were the outcomes measured in a valid and reliable way? Yes 8. Was appropriate statistical analysis used? Unclear Overall risk of bias: moderate Directness: directly applicable

Full citation	Derubertis BG, Trocciola SM, Ryer EJ, et al. (2007) Abdominal aortic aneurysm in women: prevalence, risk factors, and implications for screening. Journal of vascular surgery 46(4), 630-635
Study details	Study design: cross-sectional study Location(s): USA Aim of the study: to define the prevalence and risk factors associated with the development of AAA in women Study dates: May 2004 to December 2006 Sources of funding: not reported
Participants	Sample size: 10,012 women Inclusion criteria: women, over 65 years old, with at least one of the following factors were eligible for screening: hypertension, history of smoking, cardiovascular disease, or a family history of AAA. Exclusion criteria: women with a previously known AAA were excluded. Additionally, women with incomplete risk factor information were excluded. Baseline characteristics: • Mean age: 69.6 years • Sex: 100% female • Hypertension: 63.7% • Hypercholesterolemia: 63.5% • Diabetes: 13.9%

Full citation	**Derubertis BG, Trocciola SM, Ryer EJ, et al. (2007) Abdominal aortic aneurysm in women: prevalence, risk factors, and implications for screening. Journal of vascular surgery 46(4), 630-635**
	• Family history of AAA: 10.7% • Heart disease (myocardial infarction, coronary revascularisation or history of other cardiac surgery: 12.0%
Methods	Data collection: Ultrasound imaging was used to determine the presence of AAA (defined as an infrarenal aortic diameter of 3 cm or larger). The presence of risk factors was determined by asking participants to complete a questionnaire. Patients were considered to have hypertension, hypercholesterolemia, or diabetes if they reported that they had been given these diagnoses by a physician or were receiving treatment for these conditions. Cardiovascular disease was defined a history of myocardial infarction, a history of percutaneous or surgical coronary revascularization, or other unspecified cardiac surgery. Tobacco use was defined as greater than or equal to 100 cigarettes in a lifetime. A family history of AAA was defined as a first degree relative who was diagnosed with an AAA. Analysis: multivariate logistic regression adjusting for age, smoking history, family history, and ethnicity
Outcomes	Risk factors: age, ethnicity, smoking status, family history of AAA, and cardiovascular disease
Study Appraisal using the Joanna Briggs Institute checklist	1. Were the criteria for inclusion in the sample clearly defined? Yes 2. Were the study subjects and the setting described in detail? Yes 3. Was the exposure measured in a valid and reliable way? No – the presence of risk factors was ascertained by participants completing a self-administered questionnaire. 4. Were objective, standard criteria used for measurement of the condition? Yes 5. Were confounding factors identified? Yes 6. Were strategies to deal with confounding factors stated? Yes 7. Were the outcomes measured in a valid and reliable way? Yes 8. Was appropriate statistical analysis used? No – stepwise regression was not performed. Instead, the logistic regression model was developed based on the results of univariate analysis, with the inclusion of variables which had p-values ≤0.25. Overall risk of bias: high Directness: directly applicable

Full citation	**Hager J, LT, Carlsson P, and Lundgren F (2013) Lower prevalence than expected when screening 70-year-old men for abdominal aortic aneurysm. European Journal of Vascular and Endovascular Surgery 46(4), 453-459**
Study details	Study design: cross-sectional study Location(s): Sweden Aim of the study: to determine the contemporary screening-detected prevalence among 70-year-old men Study dates: 2008 to 2010 Sources of funding: authors stated that no financial support was received

Full citation	**Hager J, LT, Carlsson P, and Lundgren F (2013) Lower prevalence than expected when screening 70-year-old men for abdominal aortic aneurysm. European Journal of Vascular and Endovascular Surgery 46(4), 453-459**
Participants	Sample size: 4715 men Inclusion criteria: 70 year-old men were eligible for screening Exclusion criteria: men who had been previously been identified as having AAA were excluded Baseline characteristics: • Mean age: not reported • Sex: 100% male • Hypertension: 44.7% • Hyperlipidaemia: 31.3% • Diabetes: 15.5% • Coronary heart disease: 13.9% • COPD: 6.8% • Renal disease: 1.6% • Cerebrovascular disease: 7.5% • Claudication 1.6%
Methods	Data collection: Ultrasound imaging was used to establish the presence of AAA (defined as an infrarenal aortic diameter of 3 cm or larger). The presence of risk factors was determined by asking participants to complete a questionnaire that collected demographic information and contained questions relating to familial history of AAA, smoking habits, current medication, and the presence or absence of the following diseases: hypertension, hyperlipidaemia, diabetes, COPD, renal disease, cerebrovascular disease, claudication, coronary heart disease (angina pectoris and/or myocardial infarction), rheumatic disease, and cancer. Analysis: multivariate logistic regression. It is unclear what factors were adjusted for in the analysis.
Outcomes	Risk factors: smoking status, COPD, cerebrovascular disease, claudication, coronary artery, and hyperlipidaemia. Investigators also assessed as a risk factor; however, it is not listed for inclusion in the review protocol.
Study Appraisal using the Joanna Briggs Institute checklist	1. Were the criteria for inclusion in the sample clearly defined? Yes 2. Were the study subjects and the setting described in detail? No 3. Was the exposure measured in a valid and reliable way? No – the presence of risk factors was ascertained by participants completing a self-administered questionnaire. 4. Were objective, standard criteria used for measurement of the condition? Yes 5. Were confounding factors identified? Unclear 6. Were strategies to deal with confounding factors stated? Unclear 7. Were the outcomes measured in a valid and reliable way? Yes

Full citation	**Hager J, LT, Carlsson P, and Lundgren F (2013) Lower prevalence than expected when screening 70-year-old men for abdominal aortic aneurysm. European Journal of Vascular and Endovascular Surgery 46(4), 453-459**
	8. Was appropriate statistical analysis used? No – stepwise regression was not performed. Instead, only variables with p-values <0.1 from univariate chi-square tests were entered into the logistic regression model. Overall risk of bias: high Directness: directly applicable

Full citation	**Johnsen SH, Forsdahl SH, Singh K, et al. (2010) Atherosclerosis in abdominal aortic aneurysms: a causal event or a process running in parallel? The Tromso study. Arteriosclerosis, thrombosis, and and vascular biology 30(6), 1263-8**
Study details	Study design: cross-sectional study Location(s): Norway Aim of the study: to investigate the relationship between carotid, femoral, and coronary atherosclerosis and abdominal aortic diameter, and whether atherosclerosis was a risk marker for AAA Study dates: Sources of funding:
Participants	Sample size: 6,446 people Inclusion criteria: people between 55 and 74 years were eligible for screening. Additionally, a random sample of people over 25 years were included to make up 5% to 10% of the total study population. Exclusion criteria: not reported Baseline characteristics: • Mean age: men, 59.5 years; women, 60.7 years • Sex: 50.9% female • Coronary heart disease: men, 15.3%; women, 9.0%
Methods	Data collection: Ultrasound imaging was used to establish the presence of AAA (defined as an infrarenal aortic diameter of 3 cm or larger). Carotid ultrasonography was performed to ascertain the extent of atherosclerosis. A plaque was defined as a localised protrusion of the vessel wall into the lumen of at least 50%, compared with the adjacent intima-media thickness. In people with more than 1 plaque, the areas of all plaques were summarised to give the total plaque area. Investigators also measured blood pressure, non-fasting serum cholesterol and triglyceride levels, as well as serum high-density lipoprotein cholesterol levels. Information relating to smoking habits, angina pectoris, myocardial infarction and use of antihypertensive and lipid lowering drugs was ascertained via self-administered questionnaires. Analysis: multivariate logistic regression adjusting for age, sex, BMI, smoking, systolic blood pressure, total cholesterol and use of lipid-lowering and antihypertensive medication
Outcomes	Risk factors: atherosclerosis (measured by total plaque areas)
Study Appraisal using the Joanna Briggs Institute checklist	1. Were the criteria for inclusion in the sample clearly defined? Yes 2. Were the study subjects and the setting described in detail? Yes 3. Was the exposure measured in a valid and reliable way? Yes 4. Were objective, standard criteria used for measurement of the condition? Yes 5. Were confounding factors identified? Yes 6. Were strategies to deal with confounding factors stated? Yes 7. Were the outcomes measured in a valid and reliable way? Yes

Full citation	**Johnsen SH, Forsdahl SH, Singh K, et al. (2010) Atherosclerosis in abdominal aortic aneurysms: a causal event or a process running in parallel? The Tromso study. Arteriosclerosis, thrombosis, and and vascular biology 30(6), 1263-8**
	8. Was appropriate statistical analysis used? Unclear – Investigators did not report whether a stepwise approach was used to perform the multivariate logistic regression. Overall risk of bias: low Directness: directly applicable

Full citation	**Kent KC, Zwolak RM, Egorova NN, Greco G, et al. (2010) Analysis of risk factors for abdominal aortic aneurysm in a cohort of more than 3 million individuals. Journal of vascular surgery 52(3), 539-48** **NB – a second publication evaluating the same population was produced by the same study group:** **Greco G, Egorova NN, Gelijns AC, et al. (2010) Development of a novel scoring tool for the identification of large >5 cm abdominal aortic aneurysms. Annals of surgery 252(4), 675-82**
Study details	Study design: cross-sectional study Location(s): USA Aim of the study: to identify risk factors associated with AAA in people who underwent ultrasound screening Study dates: 2003 to 2008 Sources of funding: this study was funded by a grant to the Society for Vascular Surgery from Life Line Screening (a private screening company)
Participants	Sample size: 3,056,455 people; sex-specific proportions were not reported Inclusion criteria: self-referred patients who paid for vascular screening tests. In people with multiple screenings, only the most recent record with complete information was included. Exclusion criteria: individuals with records where gender, age and smoking states were messing, were excluded. Furthermore, people with a history of AAA repair, and people over 85 years were excluded. Baseline characteristics: • Mean age: not reported • Sex: 64.7% female • Hypertension: 65.1% • Hyperlipidaemia: 54% • Coronary heart disease: 6.8% • Carotid disease: 2.5% • History of cerebrovascular disease: 5.5%

Full citation	**Kent KC, Zwolak RM, Egorova NN, Greco G, et al. (2010) Analysis of risk factors for abdominal aortic aneurysm in a cohort of more than 3 million individuals. Journal of vascular surgery 52(3), 539-48** **NB – a second publication evaluating the same population was produced by the same study group:** **Greco G, Egorova NN, Gelijns AC, et al. (2010) Development of a novel scoring tool for the identification of large >5 cm abdominal aortic aneurysms. Annals of surgery 252(4), 675-82**
	• Peripheral arterial disease: 3.0% • Diabetes: 10.7%
Methods	Data collection: Ultrasound imaging was used to establish the presence of AAA (defined as an infrarenal aortic diameter of 3 cm or larger). Systolic and diastolic blood pressure were also taken at the time of screening. Data on risk factors were collected by asking participants to complete a self-administered questionnaire that included questions on demographics, height, weight, coronary artery disease (previous myocardial infarction or coronary revascularisation), cerebrovascular disease (previous transient ischaemic attack, stroke or carotid artery revascularisation), hypertension, hypercholesterolemia, diabetes, smoking, smoking, exercise, dietary habits, and a family history of AAA, lower extremity arterial disease, cardiac or cerebrovascular disease. Analysis: Multivariate logistic regression. It was unclear what factors were adjusted for.
Outcomes	Risk factors: age, sex, smoking status, BMI, ethnicity, hypertension, coronary artery disease, family history of AAA, hypercholesterolemia, diabetes, peripheral artery disease, and cerebrovascular disease. Investigators also assessed physical activity, as well as fruit, vegetable and nut consumption as risk factors; however, these factors are not listed for inclusion in the review protocol.
Study Appraisal using the Joanna Briggs Institute checklist	1. Were the criteria for inclusion in the sample clearly defined? Yes 2. Were the study subjects and the setting described in detail? Yes 3. Was the exposure measured in a valid and reliable way? No – the presence of risk factors was ascertained by participants completing a self-administered questionnaire. 4. Were objective, standard criteria used for measurement of the condition? Yes 5. Were confounding factors identified? Yes 6. Were strategies to deal with confounding factors stated? Yes 7. Were the outcomes measured in a valid and reliable way? Yes 8. Was appropriate statistical analysis used? No – stepwise regression was not performed. Instead, variables with p-values <0.2 in univariate analyses were included in a logistic regression model. Then only significant variables within the model (p-values <0.05) were left in the final model Overall risk of bias: high Directness: directly applicable

Full citation	**Le MTQ, Jamrozik K, Davis TME et al. (2007) Negative association between infra-renal aortic diameter and glycaemia: the Health in Men Study. European journal of vascular and endovascular surgery : the official journal of the European Society for Vascular Surgery 33(5), 599-604** **NB – other publications evaluating the same population were produced by the same study group:** **Golledge J, Clancy P, Jamrozik K, et al. (2007) Obesity, adipokines, and abdominal aortic aneurysm: Health in Men study. Circulation 116(20), 2275-9** **Jamrozik K, Norman PE, Spencer CA et al. (2000) Screening for abdominal aortic aneurysm: lessons from a population-based study. The Medical journal of Australia 173(7), 345-50**
Study details	Study design: cross-sectional study Location(s): Australia Aim of the study: to assess the relationship between both diabetes and blood glucose levels with the presence of AAA Study dates: April 1996 to January 1999 Sources of funding: not reported
Participants	Sample size: 12,203 men Inclusion criteria: men between 65 and 83 years old were eligible for screening Exclusion criteria: not reported Baseline characteristics: • Mean age: not reported • Sex: 100% male • History of cardiovascular disease: 43.8% • Hypertension: 44.0% • Dyslipidaemia: 35.8% • Diabetes: 12.1%
Methods	Data collection: Ultrasound imaging was used to establish the presence of AAA (defined as an infrarenal aortic diameter of 3 cm or larger). Information on risk factors was acquired by asking participants to complete a self-administered questionnaire which captured data on medical history, life style, height, weight, blood pressure and cardiovascular disease. Analysis: multivariate logistic regression adjusting for aortic diameter
Outcomes	Risk factors: age, BMI, smoking status, history of cardiovascular disease, hypertension, dyslipidaemia diabetes, blood pressure and family history of AAA. Investigators also assessed vigorous exercise, and place of birth as risk factors; however, these factors are not listed for inclusion in the review protocol.
Study Appraisal	1. Were the criteria for inclusion in the sample clearly defined? Yes 2. Were the study subjects and the setting described in detail? Yes

Full citation	**Le MTQ, Jamrozik K, Davis TME et al. (2007) Negative association between infra-renal aortic diameter and glycaemia: the Health in Men Study. European journal of vascular and endovascular surgery : the official journal of the European Society for Vascular Surgery 33(5), 599-604** **NB – other publications evaluating the same population were produced by the same study group:** **Golledge J, Clancy P, Jamrozik K, et al. (2007) Obesity, adipokines, and abdominal aortic aneurysm: Health in Men study. Circulation 116(20), 2275-9** **Jamrozik K, Norman PE, Spencer CA et al. (2000) Screening for abdominal aortic aneurysm: lessons from a population-based study. The Medical journal of Australia 173(7), 345-50**
using the Joanna Briggs Institute checklist	3. Was the exposure measured in a valid and reliable way? No – the presence of risk factors was ascertained by participants completing a self-administered questionnaire. 4. Were objective, standard criteria used for measurement of the condition? Yes 5. Were confounding factors identified? Yes 6. Were strategies to deal with confounding factors stated? Yes 7. Were the outcomes measured in a valid and reliable way? Yes 8. Was appropriate statistical analysis used? Yes Overall risk of bias: moderate Directness: directly applicable

Full citation	**Lederle FA, Johnson GR, Wilson SE, et al. (2000) The Aneurysm Detection and Management study screening program: Validation cohort and final results. Archives of Internal Medicine 160(10), 1425-1430** **NB – A second older publication of the same study was produced by the same authors:** **Lederle FA, Johnson GR, Wilson SE, et al. (1997) Prevalence and associations of abdominal aortic aneurysm detected through screening. Annals of Internal Medicine 126(6), 441-449**
Study details	Study design: cross-sectional study Location(s): USA Aim of the study: to assess the prevalence of positive and negative risk factors for AAA Study dates: October 1992 to July 1997 Sources of funding: not reported
Participants	Sample size: first cohort, 73,451; second cohort, 52,745; combined group, 126,196 Inclusion criteria: people who were 50 to 79 years old and had no history of AAA were included. In people with multiple screenings, only the first screening session were included. Exclusion criteria: people who reported previously being told that they had an AAA were excluded Baseline characteristics: • Mean age: 66.0 years • Sex: 97.3% male • Hypertension: 54.1% • Hyperlipidaemia: 52.3% • Coronary heart disease: 36.8% • Claudication: 6.0% • Cerebrovascular disease: 10.8% • Deep vein thrombosis: 7.0% • Diabetes: 17.7% • COPD: 13.4%
Methods	Data collection: cross-sectional data was collected from 2 separate cohorts, during 2 different time periods (October 1992 to March 1995, and April 1995 to July 1997). Ultrasound imaging was used to establish the presence of AAA. Multiple analyses considered different definitions of AAA including; an infrarenal aortic diameter of 3 cm or larger, an infrarenal aortic diameter of 4 cm or larger, and the ratio of infrarenal and suprarenal aortic diameter of 1.5 or greater. For the purpose of this review, only data relating to AAAs categorised as infrarenal aortic diameters of 3 cm or larger were considered. Before ultrasonographic examination, all participants completed a questionnaire that asked about

Full citation	**Lederle FA, Johnson GR, Wilson SE, et al. (2000) The Aneurysm Detection and Management study screening program: Validation cohort and final results. Archives of Internal Medicine 160(10), 1425-1430** **NB – A second older publication of the same study was produced by the same authors:** **Lederle FA, Johnson GR, Wilson SE, et al. (1997) Prevalence and associations of abdominal aortic aneurysm detected through screening. Annals of Internal Medicine 126(6), 441-449**
	demographic information and possible risk factors. The questionnaire asked whether they were told by a clinician that they had any of the risk factors under investigation. Analysis: Analysis: multivariate logistic regression. It is unclear what factors were adjusted for in the analysis.
Outcomes	Risk factors: age, sex, ethnicity, family history of AAA, smoking status, hypertension, hypercholesterolemia, coronary artery disease, claudication, cerebral vascular disease, atherosclerosis, diabetes, COPD. Investigators also assessed height, weight, waist circumference, deep vein thrombosis, cancer and history of abdominal imaging as risk factors; however, these factors were not listed for inclusion in the review protocol.
Study Appraisal using the Joanna Briggs Institute checklist	1. Were the criteria for inclusion in the sample clearly defined? Yes 2. Were the study subjects and the setting described in detail? Yes 3. Was the exposure measured in a valid and reliable way? No – the presence of risk factors was ascertained by participants completing a self-administered questionnaire. 4. Were objective, standard criteria used for measurement of the condition? Yes 5. Were confounding factors identified? Unclear 6. Were strategies to deal with confounding factors stated? Unclear 7. Were the outcomes measured in a valid and reliable way? Yes 8. Was appropriate statistical analysis used? No- the multivariate analysis included all variables that were considered in the self-administered questionnaire Overall risk of bias: high Directness: directly applicable

Full citation	**Makrygiannis G, Labalue P, Erpicum M, et al. (2016) Extending Abdominal Aortic Aneurysm Detection to Older Age Groups: Preliminary Results from the Liege Screening Programme. Annals of vascular surgery 36, 55-63**
Study details	Study design: cross-sectional study Location(s): Belgium Aim of the study: to report the results of a AAA screening programme in people 65-85 years old from the County of Chaudfontaine in Belgium Study dates: May to November 2014 Sources of funding: This study was funded by the Aneurysmal Pathology Foundation (APF),
Participants	Sample size: 1,101 people Inclusion criteria: men aged 65-85 years and women aged 74 to 85 years from the county of Chaudfontaine in Belgium were included Exclusion criteria: not reported Baseline characteristics: • Mean age: men, 73.6 years; women, 78.8 years • Sex: 65.6% male • Hypertension: men, 67.9%; women, 72.3% • Hyperlipidaemia: men, 62.6%; women, 62.5 % • Diabetes: men, 19.1%; women, 14.0% • Coronary artery disease: men, 17.3%; women, 7.4% • Peripheral arterial disease: men, 6.8%; women, 3.7% • COPD: men, 5.1%; women, 3.7% • Stroke: men, 7.9%; women, 8.2% • Renal insufficiency: men, 1.5%; women, 3.2%
Methods	Data collection: Ultrasound imaging was used to establish the presence of AAA (defined as an infrarenal aortic diameter of 3 cm or larger). Investigators ascertained the presence of risk factors by asking participants to complete a self-reported questionnaire. Participants were asked to report self-reported use of drugs, smoking status (current, former, and never), and history of hypercholesterolemia, diabetes mellitus, hypertension, coronary artery disease (bypass surgery and angioplasty with or without stenting), peripheral arterial occlusive disease, stroke and transient ischemic attack, chronic obstructive pulmonary disease, renal insufficiency, cancer, and inguinal hernia. Analysis: multivariate logistic regression. It is unclear what factors were adjusted for in the analysis.
Outcomes	Risk factors: age, smoking status, hypercholesterolemia, peripheral artery disease, and coronary artery disease
Study Appraisal using the Joanna	1. Were the criteria for inclusion in the sample clearly defined? Yes 2. Were the study subjects and the setting described in detail? Yes 3. Was the exposure measured in a valid and reliable way? No – the presence of risk factors was ascertained by participants completing a self-administered questionnaire.

Full citation	**Makrygiannis G, Labalue P, Erpicum M, et al. (2016) Extending Abdominal Aortic Aneurysm Detection to Older Age Groups: Preliminary Results from the Liege Screening Programme. Annals of vascular surgery 36, 55-63**
Briggs Institute checklist	4. Were objective, standard criteria used for measurement of the condition? Yes 5. Were confounding factors identified? Unclear 6. Were strategies to deal with confounding factors stated? Unclear 7. Were the outcomes measured in a valid and reliable way? Yes 8. Was appropriate statistical analysis used? Unclear – Investigators did not report whether a stepwise approach was used to perform the multivariate logistic regression. Overall risk of bias: Moderate Directness: directly applicable

Full citation	**Mark-Christensen A, Lindholt J S, Diederichsen A, et al. (2017) Association Between Diverticular Disease and Abdominal Aortic Aneurysms: Pooled Analysis of Two Population Based Screening Cohorts. European Journal of Vascular and Endovascular Surgery 54(6), 772-777**
Study details	Study design: cross-sectional study combining data from 2 Danish screening programmes Location(s): Denmark Aim of the study: to assess risk factors associated with AAA Study dates: first screening cohort, 2008 to 2010; second cohort, from 2015 onwards Sources of funding: authors state that no funding was received
Participants	Sample size: 24,632 people Inclusion criteria: people aged 65-74 from 2 different regions in Denmark were eligible for screening Exclusion criteria: authors state that no exclusion criteria were applied Baseline characteristics: • Age >70 years old: 43% • Sex: 97% male • Hypertension: 52% • Peripheral arterial disease: 10% • Diabetes: 11% • Family history of AAA: 3%
Methods	Data collection: Either ultrasound imaging or non-contrast computed-tomography were used to establish the presence of AAA (defined as an infrarenal aortic diameter of 3 cm or larger). Investigators ascertained the presence of risk factors (AAA, hypertension, peripheral arterial

Full citation	**Mark-Christensen A, Lindholt J S, Diederichsen A, et al. (2017) Association Between Diverticular Disease and Abdominal Aortic Aneurysms: Pooled Analysis of Two Population Based Screening Cohorts. European Journal of Vascular and Endovascular Surgery 54(6), 772-777**
	disease, diabetes, current smoking status, smoking status and use of oral corticosteroids) via clinical examination, medical records or patient interview. Analysis: multivariate logistic regression
Outcomes	Risk factors: age, sex, smoking status, BMI, hypertension, smoking, and family history of AAA
Study Appraisal using the Joanna Briggs Institute checklist	1. Were the criteria for inclusion in the sample clearly defined? Yes 2. Were the study subjects and the setting described in detail? Yes 3. Was the exposure measured in a valid and reliable way? Yes 4. Were objective, standard criteria used for measurement of the condition? Yes 5. Were confounding factors identified? Yes 6. Were strategies to deal with confounding factors stated? Yes 7. Were the outcomes measured in a valid and reliable way? Yes 8. Was appropriate statistical analysis used? No – Only covariates significantly associated with AAA on multivariate analysis were included in the multivariate models Overall risk of bias: Moderate Directness: directly applicable

Full citation	**Pleumeekers JCM, Hoes AW, Hofman A, et al. (1999) Selecting subjects for ultrasonographic screening for aneurysms of the abdominal aorta: Four different strategies. International Journal of Epidemiology 28(4), 682-686**
Study details	Study design: cross-sectional study Location(s): Netherlands Aim of the study: to evaluate whether the effectiveness of ultrasound screening for AAA could be increased by preselecting people who were at high risk of AAA Study dates: not reported Sources of funding: not reported
Participants	Sample size: 5,328; Inclusion criteria: people 55 years or older living in a suburb in the Netherlands were eligible for ultrasound screening Exclusion criteria: people with a history of AAA repair or people in whom it was technically impossible to visualise the abdominal aorta were excluded. Furthermore, people living in nursing homes were excluded due to limitations in transporting ultrasound equipment. Baseline characteristics: • Mean age: men, 67.7 years • Sex: 58% female • Angina: 6.8% • Intermittent claudication: 1.5% • History of myocardial infarction: 22% • History of stroke: 3.1% • Hypertension: 21.1%
Methods	Data collection: Ultrasound imaging was used to establish the presence of AAA. An AAA was defined as a distal aortic diameter of 3.5 cm or larger, or when the ratio between the distal and proximal aorta was greater than 1.5. The presence of risk factors was determined by performing physical examinations, taking blood samples and asking participants to complete a self-administered questionnaire. Claudication was defined as a history of angina. A history of myocardial infarction was considered positive if the patient reported having been hospitalised for the conditions. Hypertension was defined as use of blood pressure lowering drugs. Analysis: multivariate logistic regression adjusting for age and sex
Outcomes	Risk factors: age, sex, smoking status, hypertension (antihypertensive drug use), angina pectoris, intermittent claudication, myocardial infarction, hypercholesterolemia, peripheral arterial disease (indicated by an ankle arm index ≤0.9), and enlarged aorta on palpation. Investigators also assessed bruit over abdominal aorta as risk factors; however, this not listed for inclusion in the review protocol.
Study Appraisal using the Joanna	1. Were the criteria for inclusion in the sample clearly defined? Yes 2. Were the study subjects and the setting described in detail? Yes

Full citation	Pleumeekers JCM, Hoes AW, Hofman A, et al. (1999) Selecting subjects for ultrasonographic screening for aneurysms of the abdominal aorta: Four different strategies. International Journal of Epidemiology 28(4), 682-686
Briggs Institute checklist	3. Was the exposure measured in a valid and reliable way? No – Although the presence of some risk factors was determined by performing physical examinations, the presence of other risk factors was determined by asking participants to complete a questionnaire. 4. Were objective, standard criteria used for measurement of the condition? Yes 5. Were confounding factors identified? Yes 6. Were strategies to deal with confounding factors stated? Yes 7. Were the outcomes measured in a valid and reliable way? Yes 8. Was appropriate statistical analysis used? No – stepwise regression was not performed. Instead, only variables with p-values <0.2 in multivariate analyses were explored in the multivariate logistic regression model. Overall risk of bias: high Directness: directly applicable

Full citation	**Salvador-Gonzalez B, Martin-Baranera M, Borque-Ortega A, et al. (2016) Prevalence of Abdominal Aortic Aneurysm in Men Aged 65-74 Years in a Metropolitan Area in North-East Spain. European journal of vascular and endovascular surgery : the official journal of the European Society for Vascular Surgery 52(1), 75-81**
Study details	Study design: cross-sectional study Location(s): Spain Aim of the study: to estimate the current screening prevalence of AAA in men aged 65 to 74 years in a metropolitan area in north-east Spain and to identify associated risk factors Study dates: September 2007 to June 2010 Sources of funding: the study was part funded by a grant from the Jordi Gol Institute for Primary Care Research
Participants	Sample size: 651 men Inclusion criteria: men between 65 and 74 years old registered at healthcare facilities in Barcelona were included. Exclusion criteria: people with a life expectancy less than 2 year, limited quality of life (receiving home care, living in a care home, or with a Barthel index <90), previous diagnosis of AAA, a history of aorto-femoral surgery, and people of non-Caucasian ethnicity were excluded. Baseline characteristics: • Mean age: men, 70.2 years • Sex: 100% male • Hypertension: 53.3% • Diabetes: 24.5% • Hypercholesterolemia: 45.2% • Cardiovascular disease: 22.7% • Angor pectoris: 9.7% • Myocardial infarction: 6.9% • Cerebrovascular disease: 9.2% • Intermittent claudication: 4.8%
Methods	Data collection: Ultrasound imaging was used to establish the presence of AAA (defined as an infrarenal aortic diameter of 3 cm or larger). The presence of hypertension, diabetes, hypercholesterolemia, abdominal obesity (waist circumference >102 cm), and metabolic syndrome was determined by reviewing patient's medical records. Data on cardiovascular diseases (angor pectoris, myocardial infarction, intermittent claudication, or cerebral vascular disease) were obtained from clinical histories, and family history of AAA was ascertained from a clinical interview. Analysis: multivariate logistic regression. It is unclear what factors were adjusted for in the analysis.
Outcomes	Risk factors: smoking status and myocardial infarction

Full citation	**Salvador-Gonzalez B, Martin-Baranera M, Borque-Ortega A, et al. (2016) Prevalence of Abdominal Aortic Aneurysm in Men Aged 65-74 Years in a Metropolitan Area in North-East Spain. European journal of vascular and endovascular surgery : the official journal of the European Society for Vascular Surgery 52(1), 75-81**
Study Appraisal using the Joanna Briggs Institute checklist	1. Were the criteria for inclusion in the sample clearly defined? Yes 2. Were the study subjects and the setting described in detail? Yes 3. Was the exposure measured in a valid and reliable way? Yes 4. Were objective, standard criteria used for measurement of the condition? Yes 5. Were confounding factors identified? Unclear 6. Were strategies to deal with confounding factors stated? Unclear 7. Were the outcomes measured in a valid and reliable way? Yes 8. Was appropriate statistical analysis used? No – stepwise regression was not performed. Instead, only variables with p-values ≤0.1 in multivariate analyses were explored in the multivariate logistic regression model. Overall risk of bias: moderate Directness: directly applicable

Full citation	**Singh K, Bonaa KH, Jacobsen BK, et al. (2001) Prevalence of and risk factors for abdominal aortic aneurysms in a population-based study : The Tromso Study. American journal of epidemiology 154(3), 236-44**
Study details	Study design: cross-sectional study Location(s): Norway Aim of the study: to study the prevalence of and risk factors for abdominal aortic aneurysm, as well as the distribution of infrarenal aortic diameter, in both men and women in a general population Study dates: September 1994 to October 1995 Sources of funding: the study was supported by grants from the Norwegian Research Council and the Norwegian Council on Cardiovascular Diseases
Participants	Sample size: 6,386 Inclusion criteria: people between 55 and 74 years were eligible for screening. Additionally, a random sample of people over 25 years were included to make up 5% to 10% of the total study population. Exclusion criteria: not reported Baseline characteristics: • Mean age: not reported • Sex: 53.6% female

Full citation	**Singh K, Bonaa KH, Jacobsen BK, et al. (2001) Prevalence of and risk factors for abdominal aortic aneurysms in a population-based study : The Tromso Study. American journal of epidemiology 154(3), 236-44**
	• Comorbidities: not reported
Methods	Data collection: Ultrasound imaging was used to establish the presence of AAA. AAA was considered present if aortic diameter at renal level was equal to or greater than 3.5 cm in either the anterior-posterior or transverse plane, the infrarenal aortic diameter was more than 5 mm larger than the renal aortic diameter in either plane, and/or a localised dilatation of the aorta was present. Information relating to some risk factors was gained from physical examination; however, the presence of other risk factors was determined asking participants to complete a self-administered questionnaire. Analysis: multivariate logistic regression adjusted for age
Outcomes	Risk factors: age, BMI, smoking status, hypertension (antihypertensive drug use), blood pressure, hyperlipidaemia, and hypercholesterolemia. Investigators also assessed plasma fibrinogen, serum creatinine, blood platelet counts, white blood cell count, and physical activity as risk factors; however, these factors were not listed for inclusion in the review protocol.
Study Appraisal using the Joanna Briggs Institute checklist	1. Were the criteria for inclusion in the sample clearly defined? Yes 2. Were the study subjects and the setting described in detail? Yes 3. Was the exposure measured in a valid and reliable way? No – Although the presence of some risk factors was determined by performing physical examinations, the presence of other risk factors was determined by asking participants to complete a questionnaire. 4. Were objective, standard criteria used for measurement of the condition? 5. Were confounding factors identified? Yes 6. Were strategies to deal with confounding factors stated? Yes 7. Were the outcomes measured in a valid and reliable way? Yes 8. Was appropriate statistical analysis used? Unclear – Investigators did not report whether a stepwise approach was used to perform the multivariate logistic regression. Overall risk of bias: moderate Directness: directly applicable

Full citation	**Vardulaki KA, Walker NM, Day NE, et al. (2000) Quantifying the risks of hypertension, age, sex and smoking in patients with abdominal aortic aneurysm. British Journal of Surgery 87(2), 195-200**
Study details	Study design: cross-sectional study Location(s): UK Aim of the study: to assess the prevalence of AAA among patients with hypertension and those taking antihypertensive medication (normotensives and current hypertensives), relative to normotensive untreated subjects in a community-based sample of men and women aged between 65 and 79 years Study dates: 1988 to 1995 Sources of funding: not reported
Participants	Sample size: 5,356; (3,035/5,356) female Inclusion criteria: people between 65 and 79 years old were included. No further details were provided. Exclusion criteria: not reported Baseline characteristics: • Mean age: not reported • Sex: 56.7% male Comorbidities: not reported
Methods	Data collection: Ultrasound imaging was used to establish the presence of AAA (defined as an infrarenal aortic diameter of 3 cm or larger). Analysis: multivariate logistic regression adjusting for age, sex and smoking status. Information on demographics, medical history, family history of AAA, smoking, occupation, and medication use was obtained by asking participants to complete a self-administered questionnaire. Analysis: multivariate logistic regression adjusted for age and sex
Outcomes	Risk factors: age, sex, smoking status, blood pressure and antihypertensive medication use
Study Appraisal using the Joanna Briggs Institute checklist	1. Were the criteria for inclusion in the sample clearly defined? No 2. Were the study subjects and the setting described in detail? Yes 3. Was the exposure measured in a valid and reliable way? No – the presence of risk factors was ascertained by participants completing a self-administered questionnaire. 4. Were objective, standard criteria used for measurement of the condition? Yes 5. Were confounding factors identified? Yes 6. Were strategies to deal with confounding factors stated? Yes 7. Were the outcomes measured in a valid and reliable way? Yes 8. Was appropriate statistical analysis used? Unclear – Investigators did not report whether a stepwise approach was used to perform the multivariate logistic regression. Overall risk of bias: moderate

Full citation	**Vardulaki KA, Walker NM, Day NE, et al. (2000) Quantifying the risks of hypertension, age, sex and smoking in patients with abdominal aortic aneurysm. British Journal of Surgery 87(2), 195-200**
	Directness: directly applicable

Appendix E – GRADE tables

Age

Predictor	No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	No. of participants	Effect size (95% CI)	Quality
Men and women									
Age: 55-59 60-64 65-69 70-74 75-79 80-84 All vs. <55 (reference)	1 Kent (2010)	Cross-sectional	Very serious[1,2]	Not serious	Not serious	Not serious	3,056,455	OR[a] 2.76 (2.55, 3.00) OR[a] 5.35 (4.97, 5.76) OR[a] 9.41 (8.76. 10.12) OR[a] 14.46 (13.45. 15.55) OR[a] 20.46 (18.99. 21.99) OR[a] 28.37 (26.31. 30.59)	Low
Age: 70-74 75-79 All vs. 65-69 (reference)	1 Vardulaki (2000)	Cross-sectional	Serious[1]	N/A	Not serious	Not serious	5,356	OR[a] 1.4 (0.98, 2.1) OR[a] 1.8 (1.2, 2.7)	Moderate
Age: 66-75 >75 All vs. 55-65 (reference)	1 Pleumeekers (1999)	Cross-sectional	Very serious[1,2]	N/A	Not serious	Not serious	5,328	OR[a] 1.4 (1.1, 1.9) OR[a] 2.7 (1.8, 4.1)	Low
Age: >75 vs. ≤75	1 Chun (2014)	Cross-sectional	Serious[3]	N/A	Not serious	Not serious	6,142	OR[a] 1.62 (1.33, 1.96)	Moderate
Age: >70 vs. ≤75	1 Mark-Christensen (2017)	Cross-sectional	Serious[2]	N/A	Not serious	Not serious	24,632	OR[a] 1.41 (1.22, 1.63)	Moderate
Age: per 7 year increase	1 Lederle (2000)	Cross-sectional	Very serious[1,2]	N/A	Not serious	Not serious	122,788	OR[a] 1.58 (1.52, 1.64)	Low

Predictor	No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	No. of participants	Effect size (95% CI)	Quality
Age: per year increase	3 (De Carvalho, 2012 Corrado 2016, Makrygiannis 2016)	Cross-sectional	Serious[1]	Not serious	Not serious	Serious[4]	4,006	OR[a] 1.1 (1.0, 1.2) OR[a] 1.14 (1.06, 1.22) OR[a] 1.07 (Not significant; 95% CI not reported)	Low
Men only									
Age: 65-69 70-74 75-84 All vs. 60-64 (reference)	1 Singh (2001)	Cross-sectional	Serious[1]	N/A	Not serious	Not serious	2,962	OR[a] 2.18 (1.44, 3.29) OR[a] 2.29 (1.49, 3.52) OR[a] 3.31 (1.62, 6.73)	Moderate
Age: per year increase	2 (Le 2007, Bonamigo 2003)	Cross-sectional	Serious[1]	Not serious	Not serious	Not serious	12,971	OR[a] 1.09 (1.07, 1.11) OR[a] 1.08 (1.022, 1.139)	Moderate
Women only									
Age: per year increase	1 Derubertis (2007)	Cross-sectional	Very serious[1,2]	N/A	Not serious	Not serious	10,012	OR[a] 1.10 (1.06, 1.14)	Low
Age: 65-69 70-74 75-84 All vs. 60-64 (reference)	1 Singh (2001)	Cross-sectional	Serious[1]	N/A	Not serious	Not serious	3,424	OR[a] 1.94 (0.81, 4.65) OR[a] 4.81 (2.14, 10.84) OR[a] 4.98 (1.45, 17.07)	Moderate

a. As multivariate analyses were performed, hazard and odds ratios were reported adjusting for confounders or other factors.
1. The presence of risk factors, and covariates adjusted for, was ascertained by asking participants to complete a self-administered questionnaire, downgrade 1 level.
2. Stepwise regression was not performed. Instead, variables found to be significant in univariate analyses were input into logistic regression models, downgrade 1 level.
3. It was unclear what people were eligible for screening, downgrade 1 level.
4. 95% CI crosses the line of no effect (1) in studies with greater weighting (larger populations), downgrade 1 level.

Sex

Predictor	No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	No. of participants	Effect size (95% CI)	Quality
Men and women									
Sex: men vs. women	6 (Kent 2010, Lederle 2000, Vardulaki 2000, Pleumeekers 1999, De Carvalho 2012, Corrado 2016, 1 Mark-Christensen 2017))	Cross-sectional	Very serious[1,2]	Not serious	Not serious	Not serious	3,217464	OR[a] 5.71 (5.57, 5.85) OR[a] 2.13 (1.45, 3.12) OR[a] 5.6 (3.7, 8.4) OR[a] 6.5 (3.8, 11.2) OR[a] 9.9 (2.0, 50.0) OR[a] 8.2 (1.79, 37.91) OR[a] 21.9 (3.07, 156.26)	Low

a. As multivariate analyses were performed, hazard and odds ratios were reported adjusting for confounders or other factors.

1. The presence of risk factors was ascertained by asking participants to complete a self-administered questionnaire, downgrade 1 level.

2. Stepwise regression was not performed. Instead, variables found to be significant in univariate analyses were input into logistic regression models, downgrade 1 level.

BMI/Weight/Obesity

Predictor	No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	No. of participants	Effect size (95% CI)	Quality
Men and women									
BMI: ≥25 kg/m^2 vs. <25 kg/ m^2	1 Kent (2010)	Cross-sectional	Very serious[1,2]	N/A	Not serious	Not serious	3,056,455	OR[a] 1.20 (1.17, 1.22)	Low
BMI: ≥30 kg/m^2 vs. <30 kg/ m^2	2 (Chun 2014 & Mark-Christensen 2017)	Cross-sectional	Very serious[2,3]	Serious[4]	Not serious	Not serious	30,744	OR[a] 0.94 (0.77, 1.15) OR[a] 1.26 (1.06, 1.49)	Very low
Weight: per 16 kg	1 Lederle (2000)	Cross-sectional	Very serious[1,2]	N/A	Not serious	Serious[5]	122,788	OR[a] 1.00 (0.93, 1.07)	Very low
Men only									
BMI: per kg/m^2	1 Le (2007)	Cross-sectional	Serious[2]	N/A	Not serious	Not serious	12,203	OR[a] 1.03 (1.01, 1.05)	Moderate
BMI: per 4kg/m^2	1 Singh (2001)	Cross-sectional	Serious[2]	N/A	Not serious	Serious[5]	2,962	OR[a] 1.14 (0.94, 1.39)	Low
Women only									
BMI: per 4kg/m^2	1 Singh (2001)	Cross-sectional	Serious[1]	N/A	Not serious	Serious[5]	3,424	OR[a] 0.85 (0.65, 1.11)	Low

a. As multivariate analyses were performed, hazard and odds ratios were reported adjusting for confounders or other factors.
1. The presence of risk factors was ascertained by asking participants to complete a self-administered questionnaire, downgrade 1 level.
2. Stepwise regression was not performed. Instead, variables found to be significant in univariate analyses were input into logistic regression models, downgrade 1 level.
3. It was unclear what people were eligible for screening, downgrade 1 level.
4. Reported findings from included studies highlight inconsistent directions of effect, downgrade 1 level.
5. 95% CI crosses the line of no effect (1), downgrade 1 level.

Smoking

Predictor	No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	No. of participants	Effect size (95% CI)	Quality
Men and women									
Current smokers vs. never smokers	7 (Berger 2013, Chun 2014, Vardulaki 2000, Pleumeekers 1999, De Carvalho 2012, Corrado 2016, Makrygiannis 2016, Mark-Christensen 2017)	Cross-sectional	Very serious[1,2]	Not serious	Not serious	Not serious	3,341,7335	OR[a] 1.98 (1.86, 2.03) OR[a] 1.67 (1.33, 2.10) OR[a] 2.7 (1.7, 4.4) OR[a] 3.1 (1.7, 5.1) OR[a] 6.8 (1.6, 29.4) OR[a] 4.73 (Significant; (95% CI not reported) OR[a] 7.61 (5.76, 10.05)	Low
Ex-smokers vs. never smokers	4 (Berger 2013, Vardulaki 2000, Corrado 2016, Mark-Christensen 2017)	Cross-sectional	Serious[1]	Not serious	Not serious	Not serious	3,326,904	OR[a] 2.75 (2.68, 2.82) OR[a] 1.5 (1.0, 2.3) OR[a] 2.76 (1.12, 8.94) OR[a] 3.76 (2.88, 4.93)	Moderate
Ever smoked vs. never smoked	1 Lederle (2000)	Cross-sectional	Very serious[1,2]	N/A	Not serious	Not serious	122,788	OR[a] 2.97 (2.65, 3.32)	Low
Men only									
Current smokers vs. never smokers	4 (Singh 2001, Hager 2013, Barba 2013,	Cross-sectional	Very serious[1,2]	Not serious	Not serious	Not serious	10,134	OR[a] 7.37 (3.70, 14.69) OR[a] 8.90 (4.2, 18.6) OR[a] 3.47 (1.67, 7.22) OR[a] 6.42 (2.18, 18.89)	Low

Predictor	No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	No. of participants	Effect size (95% CI)	Quality
	Bonamigo 2003)								
Ex-smokers vs. never smokers	2 (Singh 2001, Hager 2013)	Cross-sectional	Very serious[1,2]	Not serious	Not serious	Not serious	8,585	OR[a] 3.60 (1.85, 7.03) OR[a] 3.30 (1.70, 6.60)	Low
Ever smoked vs. never smoked	1 Le (2007)	Cross-sectional	Serious[1]	N/A	Not serious	Not serious	12,203	OR[a] 2.04 (1.84, 2.26)	Moderate
Smoking frequency: 10-20 cigarettes/day >20 cigarettes/day All compared with 0 – 20 cigarettes/day (reference)	1 Salvador-Gonzalez (2016)	Cross-sectional	Serious[2]	Not serious	Not serious	Not serious	651	OR[a] 20.4 (2.6, 162.2) OR[a] 15.8 (1.7, 146.4)	Moderate
Women only									
Current smokers vs never smokers	1 Singh (2001)	Cross-sectional	Serious[1]	N/A	Not serious	Not serious	3,424	OR[a] 5.82 (2.92, 11.58)	Moderate
Ex-smokers vs never smokers	1 Singh (2001)	Cross-sectional	Serious[1]	N/A	Not serious	Serious[3]	3,424	OR[a] 1.64 (0.75, 3.58)	Low
Tobacco use (greater than or equal to 100 cigarettes in a lifetime)	1 Derubertis (2007)	Cross-sectional	Very serious[1,2]	N/A	Not serious	Not serious	10,012	OR[a] 4.02 (2.17, 7.44)	Low

a. As multivariate analyses were performed, hazard and odds ratios were reported adjusting for confounders or other factors.
1. The presence of risk factors was ascertained by asking participants to complete a self-administered questionnaire, downgrade 1 level.

Predictor	No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	No. of participants	Effect size (95% CI)	Quality
2. Stepwise regression was not performed. Instead, variables found to be significant in univariate analyses were input into logistic regression models, downgrade 1 level.									
3. 95% CI crosses the line of no effect (1), downgrade 1 level.									

Palpable aorta on abdominal examination

Predictor	No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	No. of participants	Effect size (95% CI)	Quality
Men and women									
Present vs. absent	1 Pleumeekers (1999)	Cross-sectional	Very serious[1,2]	N/A	Not serious	Not serious	5,328	OR[a] 7.0 (3.7, 13.2)	Low
a. As multivariate analyses were performed, hazard and odds ratios were reported adjusting for confounders or other factors.									
1. The presence of risk factors was ascertained by asking participants to complete a self-administered questionnaire, downgrade 1 level.									
2. Stepwise regression was not performed. Instead, variables found to be significant in univariate analyses were input into logistic regression models, downgrade 1 level.									

Cardiovascular disease

Predictor	No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	No. of participants	Effect size (95% CI)	Quality
Men and women									
Coronary artery disease	4 (Kent 2010, Lederle 2000, Chun 2014, Makrygiannis 2016)	Cross-sectional	Very serious[1,2,]	Not serious	Not serious	Not serious	3,186,486	OR[a] 1.72 (1.69, 1.76) OR[a] 1.44 (1.34, 1.55) OR[a] 1.89 (1.59, 2.29) OR[a] 2.15 (not significant; 95% CI not reported)	Low
History of myocardial infarction	1 Pleumeekers (1999)	Cross-sectional	Very serious[1,2]	N/A	Not serious	Serious[3]	5,328	OR 1.5[a] (0.9, 2.6)	Very low
Coronary insufficiency	1 De Carvalho (2012)	Cross-sectional	Serious[1]	N/A	Not serious	Not serious	1,350	OR 166.7[a] (25.6, >1,000)	Moderate
Men only									
Coronary artery disease	1 Hager (2013)	Cross-sectional	Very serious[1,2]	N/A	Not serious	Serious[3]	5,623	OR 1.7[a] (1.0, 3.0)	Very low
History of myocardial infarction	1 Salvador-Gonzalez (2016)	Cross-sectional	Serious[2]	N/A	Not serious	Not serious	651	OR 5.1[a] (1.4, 18.4)	Moderate
History of cardiovascular disease	1 Le (2007)	Cross-sectional	Serious[1]	N/A	Not serious	Not serious	12,203	OR 1.83[a] (1.58, 2.12)	Moderate
Myocardial disease	1 Bonamigo (2003)	Cross-sectional	Not serious	N/A	Not serious	Serious[3]	768	OR 1.66[a] (0.745, 3.691)	Moderate
Women only									
Cardiovascular disease (myocardial infarction or	1 Derubertis (2007)	Cross-sectional	Very serious[1,2]	N/A	Not serious	Not serious	10,012	OR 3.62[a] (2.08, 6.29)	Low

Predictor	No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	No. of participants	Effect size (95% CI)	Quality
coronary revascularization)									

a. As multivariate analyses were performed, hazard and odds ratios were reported adjusting for confounders or other factors.
1. The presence of risk factors was ascertained by asking participants to complete a self-administered questionnaire, downgrade 1 level.
2. Stepwise regression was not performed. Instead, variables found to be significant in univariate analyses were input into logistic regression models, downgrade 1 level.
3. 95% CI crosses the line of no effect (1), downgrade 1 level.

Peripheral arterial disease

Predictor	No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	No. of participants	Effect size (95% CI)	Quality
Men and women									
Present vs. absent	6 (Kent 2010, Chun 2014, Pleumeekers 1999, De Carvalho 2012, Makrygiannis 2016 Mark-Christensen 2017)	Cross-sectional	Very serious[1, 2,3]	Not serious	Not serious	Not serious	3,095,008	OR[a] 1.59 (1.54, 1.65) OR[a] 2.28 (1.74, 2.97) OR[a] 2.1 (1.3, 3.3) OR[a] 27.0 (5.8, 125.0) OR[a] 3.29 (Significant; 95% CI not reported) OR[a] 1.81 (1.51, 2.16)	Low
Men only									
Present vs. absent	2 (Barba 2013, Bonamigo 2003)	Cross-sectional	Serious[2]	Serious[4]	Not serious	Not serious	1,549	OR[a] 3.00 (1.16, 7.80) OR[a] 0.843 (0.281, 2.528)	Low

a. As multivariate analyses were performed, hazard and odds ratios were reported adjusting for confounders or other factors.
1. The presence of risk factors was ascertained by asking participants to complete a self-administered questionnaire, downgrade 1 level.
2. Stepwise regression was not performed. Instead, variables found to be significant in univariate analyses were input into logistic regression models, downgrade 1 level.
3. It was unclear what people were eligible for screening, downgrade 1 level. 4. Visual inspection of point estimates and 95% CIs across studies indicates inconsistent findings, downgrade 1 level.
4. Reported findings from included studies highlight inconsistent directions of effect, downgrade 1 level.

Atherosclerosis

Predictor	No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	No. of participants	Effect size (95% CI)	Quality
Men and women									
Atherosclerosis	1 Lederle (2000)	Cross-sectional	Very serious[1,2]	N/A	Not serious	Not serious	122,788	OR[a] 1.64 (1.52, 1.78)	Low
Atherosclerotic plaque diameter: 1.5 – 7.7 mm^2 7.8 – 12.3 mm^2 12.4 – 18.9 mm^2 19.0 – 31.1 mm^2 31.2 – 246.4 mm^2 All vs. no plaque	1 Johnsen (2010)	Cross-sectional	Not serious	N/A	Not serious	Not serious	6,142	OR[a] 0.6 (0.3, 1.2) OR[a] 1.3 (0.8, 2.2) OR[a] 1.9 (1.2, 2.9) OR[a] 1.6 (1.0, 2.5) OR[a] 1.7 (1.1, 2.6)	High

a. As multivariate analyses were performed, hazard and odds ratios were reported adjusting for confounders or other factors.
1. The presence of risk factors was ascertained by asking participants to complete a self-administered questionnaire, downgrade 1 level.
2. Stepwise regression was not performed. Instead, variables found to be significant in univariate analyses were input into logistic regression models, downgrade 1 level.
3. It was unclear what people were eligible for screening, downgrade 1 level.

Claudication

Predictor	No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	No. of participants	Effect size (95% CI)	Quality
Men and women									
Present vs. absent	2 (Lederle 2000, Pleumeekers 1999)	Cross-sectional	Very serious[1,2]	Not serious	Not serious	Not serious	128,116	OR[a] 1.35 (1.18, 1.53) OR[a] 1.9 (0.7, 5.0)	Low
Men only									
Present vs. absent	1 Hager (2013)	Cross-sectional	Very serious[1,2]	N/A	Not serious	Not serious	5,623	OR[a] 2.0 (0.7, 5.6)	Low

a. As multivariate analyses were performed, hazard and odds ratios were reported adjusting for confounders or other factors.
1. The presence of risk factors was ascertained by asking participants to complete a self-administered questionnaire, downgrade 1 level.

Predictor	No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	No. of participants	Effect size (95% CI)	Quality
2. Stepwise regression was not performed. Instead, variables found to be significant univariate analyses were input into logistic regression models, downgrade 1 level.									

Cerebrovascular disease

Predictor	No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	No. of participants	Effect size (95% CI)	Quality
Men and women									
Present vs. absent	2 (Kent 2010, Lederle 2000)	Cross-sectional	Very serious[1,2]	Not serious	Not serious	Not serious	3,179,243	OR[a] 1.18 (1.14, 1.21) OR[a] 1.28 (1.17, 1.41)	Low
Men only									
Present vs. absent	2 (Hager 2013, Barba 2013)	Cross-sectional	Very serious[1,2]	Not serious	Not serious	Not serious	6,404	OR[a] 2.0 (1.1, 3.6) OR[a] 2.37 (0.61, 9.25)	Low

a. As multivariate analyses were performed, hazard and odds ratios were reported adjusting for confounders or other factors.
1. The presence of risk factors was ascertained by asking participants to complete a self-administered questionnaire, downgrade 1 level.
2. Stepwise regression was not performed. Instead, variables found to be significant in univariate analyses were input into logistic regression models, downgrade 1 level.

Diabetes

Predictor	No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	No. of participants	Effect size (95% CI)	Quality
Men and women									
Present vs. absent	4 (Berger 2013, Kent 2010, Lederle 2000, Chun 2014)	Cross-sectional	Very serious[1,2]	Not serious	Not serious	Not serious	6,505,378	OR[a] 1.00 (1.00, 1.00) OR[a] 0.75 (0.73, 0.77) OR[a] 0.65 (0.59, 0.72) OR[a] 0.60 (0.47, 0.77)	Low
Men only									
Present vs. absent	3 (Le 2007, Barba 2013, Bonamigo 2003)	Cross-sectional	Very serious[1,2]	Not serious	Not serious	Serious[3]	13,752	OR[a] 0.79 (0.63, 0.98) OR[a] 0.38 (0.11, 1.06) OR[a] 0.135 (0.002, 1.15)	Very low

a. As multivariate analyses were performed, hazard and odds ratios were reported adjusting for confounders or other factors.
1. The presence of risk factors was ascertained by asking participants to complete a self-administered questionnaire, downgrade 1 level.
2. Stepwise regression was not performed. Instead, variables found to be significant in univariate analyses were input into logistic regression models, downgrade 1 level.
3. 95% CI crosses the line of no effect (1) in studies with greater weighting (larger populations), downgrade 1 level.

COPD

Predictor	No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	No. of participants	Effect size (95% CI)	Quality
Men and women									
Present vs. absent	3 (Lederle 2000, Chun 2014, De Carvalho 2012)	Cross-sectional	Very serious[1,2,]	Not serious	Not serious	Not serious	130,280	OR[a] 1.06 (0.97, 1.17) OR[a] 1.75 (1.41, 2.18) OR[a] 35.7 (6.3, 200.0)	Low
Men only									
Present vs. absent	1 Hager (2013)	Cross-sectional	Very serious[1,2]	N/A	Not serious	Not serious	5,623	OR[a] 2.1 (1.1, 3.9)	Low

a. As multivariate analyses were performed, hazard and odds ratios were reported adjusting for confounders or other factors.
1. The presence of risk factors was ascertained by asking participants to complete a self-administered questionnaire, downgrade 1 level.
2. Stepwise regression was not performed. Instead, variables found to be significant in univariate analyses were input into logistic regression models, downgrade 1 level.

Hypertension

Predictor	No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	No. of participants	Effect size (95% CI)	Quality
Men and women									
Hypertension (defined as blood pressure measurements or use of antihypertensive drugs)	7 (Berger 2013, Kent 2010, Lederle 2000, Chun 2014, Vardulaki 2000, Pleumeekers 1999, Mark-Christensen 2017)	Cross-sectional	Very serious[1,2]	Not serious	Not serious	Not serious	6,540,694	OR[a] 1.24 (1.21, 1.28) OR[a] 1.25 (1.21, 1.28) OR[a] 1.23 (1.14, 1.32) OR[a] 0.92 (0.75, 1.12) OR[a] 1.7 (1.3, 2.1) OR[a] 1.8 (1.1, 3.0) OR[a] 1.66 (1.43, 1.94)	Low
Men only									
Hypertension (defined as blood pressure measurements or use of antihypertensive drugs)	4 (Le 2007, Singh 2001, Bonamigo 2003, Barba 2013)	Cross-sectional	Very serious[1,2]	Not serious	Not serious	Not serious	16,714	OR[a] 1.47 (1.27, 1.71) OR[a] 1.61 (1.16, 2.24) OR[a] 0.71 (0.35, 1.47) OR[a] 2.43 (1.08, 5.45)	Low
Women only									
Hypertension (defined by taking antihypertension meds)	1 Singh (2001)	Cross-sectional	Serious[1]	N/A	Not serious	Not serious	3,424	OR[a] 2.02 (1.14, 3.57)	Moderate

a. As multivariate analyses were performed, hazard and odds ratios were reported adjusting for confounders or other factors.
1. The presence of risk factors was ascertained by asking participants to complete a self-administered questionnaire, downgrade 1 level.
2. Stepwise regression was not performed. Instead, variables found to be significant in univariate analyses were input into logistic regression models, downgrade 1 level.

Blood pressure thresholds

Predictor	No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	No. of participants	Effect size (95% CI)	Quality
Men and women									
Systolic blood pressure: ≥200 mmHg vs. <200 mmHg	1 Vardulaki (2000)	Cross-sectional	Serious[1]	N/A	Not serious	Serious[2]	5,356	OR[a] 1.1 (0.7, 1.8)	Low
Diastolic blood pressure: ≥100 mmHg vs. <100 mmHg	1 Vardulaki (2000)	Cross-sectional	Serious[1]	N/A	Not serious	Serious[2]	5,356	OR[a] 1.3 (0.8, 2.2)	Low
Men only									
Systolic blood pressure: per 1 mmHg	1 Le (2007)	Cross-sectional	Serious[1]	N/A	Not serious	Not serious	12,203	OR[a] 0.99 (0.98, 0.99)	Moderate
Systolic blood pressure: per 20 mmHg	1 Singh (2001)	Cross-sectional	Serious[1]	N/A	Not serious	Serious[2]	2,962	OR[a] 0.97 (0.85, 1.12)	Low
Diastolic blood pressure: per 1 mmHg	1 Le (2007)	Cross-sectional	Serious[1]	N/A	Not serious	Not serious	12,203	OR[a] 1.03 (1.02, 1.04)	Moderate
Women only									
Systolic blood pressure: per 20 mmHg	1 Singh (2001)	Cross-sectional	Serious[1]	N/A	Not serious	Not serious	3,424	OR[a] 1.39 (1.11, 1.73)	Moderate

a. As multivariate analyses were performed, hazard and odds ratios were reported adjusting for confounders or other factors.
1. The presence of risk factors was ascertained by asking participants to complete a self-administered questionnaire, downgrade 1 level.
2. 95% CI crosses the line of no effect (1), downgrade 1 level.

Dyslipidaemia (including hyperlipidaemia, hypercholesterolemia, and cholesterol thresholds)

Predictor	No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	No. of participants	Effect size (95% CI)	Quality
Men and women									
Hyperlipidaemia (diagnosis or use of medication)	1 Berger (2013)	Cross-sectional	Serious[1]	N/A	Not serious	Not serious	3,319,993	OR[a] 1.45 (1.41, 1.49)	Moderate
Hypercholesterolemia (present vs. absent)	3 (Kent 2010, Lederle 2000, Makrygiannis 2016)	Cross-sectional	Very serious[1,2]	Not serious	Not serious	Not serious	3,180,344	OR[a] 1.34 (1.31, 1.37) OR[a] 1.40 (1.29, 1.52) OR[a] 4.89 (Significant: 95% CI not reported)	Low
Cholesterol levels: ≥200 mg/dL vs. <200 mg/dL	1 Chun (2014)	Cross-sectional	Serious[3]	N/A	Not serious	Not serious	6,142	OR[a] 0.66 (0.49, 0.90)	Moderate
Cholesterol levels: ≥6.5 mmol/L vs. <6.5 mmol/L	1 Pleumeekers (1999)	Cross-sectional	Very serious[1,2]	N/A	Not serious	Not serious	5,328	OR[a] 1.8 (1.2, 2.7)	Low
Men only									
Dyslipidaemia (present vs. absent)	1 Le (2007)	Cross-sectional	Serious[1]	N/A	Not serious	Not serious	12,203	OR[a] 1. 42 (1.22, 1.65)	Moderate
Hyperlipidaemia (not defined)	1 Hager (2013)	Cross-sectional	Very serious[1,2]	N/A	Not serious	Serious[4]	5,623	OR[a] 1.2 (0.8, 2.0)	Very low
Serum total cholesterol: per 1mmol/L increase	1 Singh (2001)	Cross-sectional	Serious[1]	N/A	Not serious	Not serious	2,962	OR[a] 1.19 (1.04, 1.35)	Moderate
Women only									
Serum total cholesterol: per 1mmol/L increase	1 Singh (2001)	Cross-sectional	Serious[1]	N/A	Not serious	Serious[4]	3,424	OR[a] 1.18 (0.96, 1.44)	Low

a. As multivariate analyses were performed, hazard and odds ratios were reported adjusting for confounders or other factors.
1. The presence of risk factors was ascertained by asking participants to complete a self-administered questionnaire, downgrade 1 level.
2. Stepwise regression was not performed. Instead, variables found to be significant in univariate analyses were input into logistic regression models, downgrade 1 level.

Predictor	No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	No. of participants	Effect size (95% CI)	Quality
3. It was unclear what people were eligible for screening, downgrade 1 level. 4. 95% CI crosses the line of no effect (1), downgrade 1 level.									

Family history of AAA

Predictor	No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	No. of participants	Effect size (95% CI)	Quality
Men and women									
Family history of AAA	3 (Kent 2010, Lederle 2000, Mark-Christensen 2017)	Cross-sectional	Very serious[1,2]	Not serious	Not serious	Not serious	3,203,875	OR[a] 3.80 (3.66, 3.95) OR[a] 1.93 (1.71, 2.18) OR[a] 2.17 (1.62, 2.90)	Low
Family history of AAA, Marfan syndrome or Ehlers–Danlos syndrome	1 De Carvalho (2012)	Cross-sectional	Serious[1]	N/A	Not serious	Not serious	1,350	OR[a] 500.0 (6.5, >1000)	Moderate
Men only									
Family history of AAA	2 (Le 2007, Barba 2013)	Cross-sectional	Very serious[1,1]	N/A	Not serious	Not serious	12,984	OR[a] 1.88 (1.17, 2.89) OR[a] 3.17 (0.82, 12.24)	Low
Women only									
Family history of AAA	1 Derubertis (2007)	Cross-sectional	Very serious[1,2]	N/A	Not serious	Serious[3]	10,012	OR[a] 1.95 (0.90, 4.22)	Very low

a. As multivariate analyses were performed, hazard and odds ratios were reported adjusting for confounders or other factors.
1. The presence of risk factors was ascertained by asking participants to complete a self-administered questionnaire, downgrade 1 level.
2. Stepwise regression was not performed. Instead, variables found to be significant in univariate analyses were input into logistic regression models, downgrade 1 level.
3. 95% CI crosses the line of no effect (1), downgrade 1 level.

Ethnicity

Predictor	No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	No. of participants	Effect size (95% CI)	Quality
Men and women									
Ethnicity: Hispanic African American Asian All vs. white (reference)	1 Kent (2010)	Cross-sectional	Very serious[1,2]	N/A	Not serious	Not serious	3,056,455	OR[a] 0.69 (0.62, 0.77) OR[a] 0.72 (0.66, 0.78) OR[a] 0.72 (0.59, 0.75)	Low
Ethnicity: Black vs. white	1 Lederle (2000)	Cross-sectional	Very serious[1,2]	N/A	Not serious	Not serious	122,788	OR[a] 0.62 (0.53, 0.73)	Low
Women only									
Ethnicity: Native American vs. white	1 Derubertis (2007)	Cross-sectional	Very serious[1,2]	N/A	Not serious	Serious[3]	10,012	OR[a] 1.41 (0.43, 4.63)	Very low

a. As multivariate analyses were performed, hazard and odds ratios were reported adjusting for confounders or other factors.
1. The presence of risk factors was ascertained by asking participants to complete a self-administered questionnaire, downgrade 1 level.
2. Stepwise regression was not performed. Instead, variables found to be significant in univariate analyses were input into logistic regression models, downgrade 1 level.
3 95% CI crosses the line of no effect (1), downgrade 1 level.

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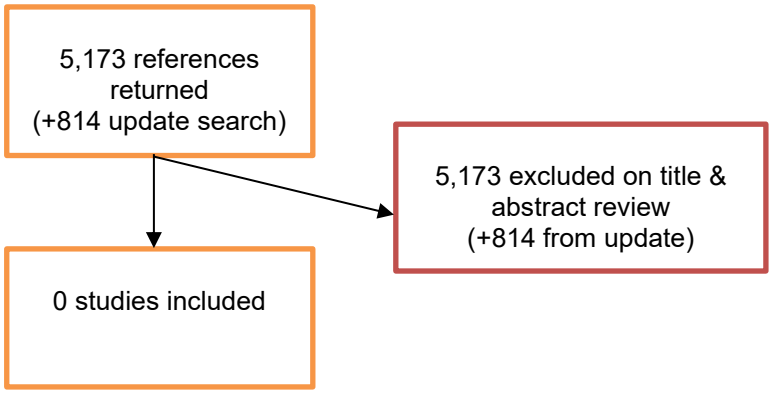
Appendix F – Economic evidence study selection



Appendix G – Excluded studies

Clinical studies

No.	Study	Reason for exclusion
1	Xiong Jiang, Wu Zhongyin, Chen Chen, Wei Yingqi, and Guo Wei (2016) Association between diabetes and prevalence and growth rate of abdominal aortic aneurysms: A meta-analysis. International journal of cardiology 221, 484-95	Systematic review which included studies that employed multiple study designs. Individual studies were assessed to establish if they met criteria for inclusion in this NICE review.
2	Alcorn H G, Wolfson Jr, S K, Sutton-Tyrrell K, et al. (1996) Risk factors for abdominal aortic aneurysms in older adults enrolled in the Cardiovascular Health Study. Arteriosclerosis, Thrombosis, and and Vascular Biology 16(8), 963-970	Authors reported percentages with adjusted and unadjusted p values. No relative risks, odds ratios or hazard ratios were reported.
3	Baumgartner I, Hirsch AT, Abola B, et al. (2008) Cardiovascular risk profile and outcome of patients with abdominal aortic aneurysm in out-patients with atherothrombosis: data from the Reduction of Atherothrombosis for Continued Health (REACH) Registry. Journal of vascular surgery 48(4), 808-14	Wrong study design: case-control. Furthermore, primary aortic imaging was not performed: investigators ascertained the presence of AAA by reviewing documentation by the treating physician.
4	Beede S D, Ballard D J, James E M, et al. (1990) Positive predictive value of clinical suspicion of abdominal aortic aneurysm. Implications for efficient use of abdominal ultrasonography. Archives of internal medicine 150(3), 549-51	Sample size of less than 500 participants. Furthermore, multivariate analysis was not performed.
5	Cao H, Hu X, Zhang Q et al. (2014) Homocysteine level and risk of abdominal aortic aneurysm: a meta-analysis. PloS one 9(1), e85831	Systematic review and meta-analysis of case controls.
6	Chabok M, Nicolaides A, Aslam M, Farahmandfar M, Humphries K, Kermani N Z, Coltart J, and Standfield N (2016) Risk factors associated with increased prevalence of abdominal aortic aneurysm in women. The British journal of surgery 103(9), 1132-8	Conference abstract
7	Chiu HY, Lo PC, Huang WF et al. (2016) Increased risk of aortic aneurysm (AA) in relation to the severity of psoriasis: A national population-based matched-cohort study. Journal of the American Academy of Dermatology 75(4), 747-54	Not specific to AAA: study included a mixed population of people with AAA and thoracic aortic aneurysms.
8	Cho IJ, Jang SY, Chang HJ et al. (2014) Aortic aneurysm screening in a high-risk population: a non-contrast computed tomography study in korean males with hypertension. Korean circulation journal 44(3), 162-9	Not specific to AAA: study included a mixed population of people with AAA and thoracic aortic aneurysms.
9	Cornuz J, Pinto C S, Tevaearai H, and Egger M (2004) Risk factors for asymptomatic abdominal aortic aneurysm: Sytematic review	Systematic review including studies which employed various study designs (including case-controls, screening studies and cohort

No.	Study	Reason for exclusion
	and meta-analysis of population-based screening studies. European Journal of Public Health 14(4), 343-349	studies). Individual studies were assessed to determine if they met inclusion criteria for this review question.
10	De Rango , P , Farchioni L, Fiorucci B, and Lenti M (2014) Diabetes and abdominal aortic aneurysms. European Journal of Vascular and Endovascular Surgery 47(3), 243-261	Systematic review including studies which employed various study designs (including case-controls, screening studies and cohort studies). Individual studies were assessed to determine if they met inclusion criteria for this review question.
11	Duncan JL, Harrild KA, Iversen L et al. (2012) Long term outcomes in men screened for abdominal aortic aneurysm: prospective cohort study. BMJ (Clinical research ed.) 344, e2958	Wrong study design: cohort study
12	Durieux R, Van Damme , H , Labropoulos N et al. (2014) High Prevalence of abdominal aortic aneurysm in patients with three-vessel coronary artery disease. European Journal of Vascular and Endovascular Surgery 47(3), 273-278	Population screening study in which patients undergoing coronary angiography were assessed for the presence of AAA. Authors stated that patients with known AAA or with a history of previous AAA surgery were intentionally included for screening.
13	Elkalioubie A, Haulon S, Duhamel A et al. (2015) Meta-Analysis of Abdominal Aortic Aneurysm in Patients With Coronary Artery Disease. The American journal of cardiology 116(9), 1451-6	Systematic review of prospective and retrospective observational studies. These study designs were not specified in the review protocol.
14	Fernandez-Garcia C E, Burillo E, Lindholt J S, Martinez-Lopez D, Pilely K, Mazzeo C, Michel J B, Egido J, Garred P, Blanco-Colio L M, and Martin-Ventura J L (2017) Association of ficolin-3 with abdominal aortic aneurysm presence and progression. Journal of thrombosis and haemostasis : JTH 15(3), 575-585	Out of scope: study assesses the use of a genetic biomarker for indicating the presence/absence of AAA
15	Fink H A, Lederle F A, Roth C S et al. (2000) The accuracy of physical examination to detect abdominal aortic aneurysm. Archives of Internal Medicine 160(6), 833-836	Wrong study design: case-control. Additionally, investigators did not assess which risk factors were associated with the presence of aneurysms. Finally, the sample size was less than 500 participants.
16	Forsdahl SH, Singh K, Solberg S et al. (2009) Risk factors for abdominal aortic aneurysms: a 7-year prospective study: the Tromso Study, 1994-2001. Circulation 119(16), 2202-8	Wrong study design: cohort study
17	Flessenkaemper I H, Loddenkemper R, Roll S, et al. (2015) Screening of COPD patients for abdominal aortic aneurysm. International Journal of COPD 10, 1085-1091	Multivariate analysis was not performed.
18	Goessens B, Visseren FL, Algra A, et al. (2006) Screening for asymptomatic cardiovascular disease with noninvasive imaging in patients at high-risk and low-risk according to the European Guidelines on Cardiovascular Disease Prevention: the SMART study. Journal of vascular surgery 43(3), 525-32	Multivariate analysis was not performed: the prevalence of atherosclerotic risk factors were reported as percentages.

No.	Study	Reason for exclusion
19	Golledge J, Mallat Z, Tedgui A et al. (2011) Serum secreted phospholipase A2 is associated with abdominal aortic aneurysm presence but not progression. Atherosclerosis 216(2), 458-60	Wrong study design: case control. Men with AAA were identified and their serum secretory phospholipase A levels were compared with those of randomly selected healthy controls.
20	Golledge J, Clancy P, Yeap BB, et al. (2013) Increased serum angiopoietin-2 is associated with abdominal aortic aneurysm prevalence and cardiovascular mortality in older men. International journal of cardiology 167(4), 1159-63	Wrong study design: case control. Men with AAA were identified and their serum angiopoietin-2 levels were compared with those of randomly selected healthy controls.
21	Hafez H, Druce P S, and Ashton H A (2008) Abdominal Aortic Aneurysm Development in Men Following a "normal" Aortic Ultrasound Scan. European Journal of Vascular and Endovascular Surgery 36(5), 553-558	Multivariate analysis/regression was not performed.
22	Harrison Seamus C, Holmes Michael V, Burgess Stephen, Asselbergs Folkert W, Jones Gregory T, Baas Annette F, van 't Hof, F N, de Bakker , Paul I W, Blankensteijn Jan D, Powell Janet T, Saratzis Athanasios, de Borst , Gert J, Swerdlow Daniel I, van der Graaf , Yolanda , van Rij , Andre M, Carey David J, Elmore James R, Tromp Gerard, Kuivaniemi Helena, Sayers Robert D, Samani Nilesh J, Bown Matthew J, and Humphries Steve E (2017) Genetic Association of Lipids and Lipid Drug Targets With Abdominal Aortic Aneurysm: A Meta-analysis. JAMA cardiology	Out of scope:Genome wide association study assessing the use of a genetic biomarker for indicating the presence/absence of AAA
23	Henriksen N A, Sorensen L T, Jorgensen L N, and Lindholt J S (2013) Lack of association between inguinal hernia and abdominal aortic aneurysm in a population-based male cohort. The British journal of surgery 100(11), 1478-82	Wrong study design: case-control
24	Hernesniemi JA, Vanni V, and Hakala T (2015) The prevalence of abdominal aortic aneurysm is consistently high among patients with coronary artery disease. Journal of vascular surgery 62(1), 232-240.e3	Systematic review including studies which employed various study designs (including case-controls, screening studies and cohort studies). Individual studies were assessed to determine if they met inclusion criteria for this review question.
25	Jahangir E, Lipworth L, Edwards T L, Kabagambe E K, Mumma M T, Mensah G A, Fazio S, Blot W J, and Sampson U K (2015) Smoking, sex, risk factors and abdominal aortic aneurysms: a prospective study of 18 782 persons aged above 65 years in the Southern Community Cohort Study. Journal of epidemiology and community health 69(5), 481-488	Wrong study design: cohort study
26	Iribarren C, Darbinian J A, Go A S, et al. (2007) Traditional and novel risk factors for clinically diagnosed abdominal aortic aneurysm: the Kaiser multiphasic health	Wrong study design: cohort study

No.	Study	Reason for exclusion
	checkup cohort study. Annals of epidemiology 17(9), 669-78	
27	Joergensen T M. M, Houlind K, Green A, and Lindholt J S (2014) Abdominal aortic diameter is increased in males with a family history of abdominal aortic aneurysms: Results from the Danish viva-trial. European Journal of Vascular and Endovascular Surgery 48(6), 669-675	Multivariate analysis was not performed association between risk factors and AAA diagnosis. Instead univariate was performed to assess associations. Linear regression was performed estimate the mean aneurysm diameters in various subgroups of people.
28	Lederle F A, and Simel D L (1999) Does this patient have abdominal aortic aneurysm?. Journal of the American Medical Association 281(1), 77-82	Systematic review assessing the sensitivity, negative predictive value and positive predictive value of abdominal palpation for detecting abdominal aortic aneurysms. None of the included studies had sample sizes of 500 participants or larger.
29	Lederle F A, Johnson G R, Wilson S E, Aneurysm Detection, Management Veterans Affairs Cooperative, and Study (2001) Abdominal aortic aneurysm in women. Journal of vascular surgery 34(1), 122-6	Multivariate analysis/regression was not performed: The number of AAAs in women was not large enough to generate valid multivariate models for AAAs in women with all variables included in the questionnaire.
30	Lederle F A, Nelson D B, and Joseph A M (2003) Smokers' relative risk for aortic aneurysm compared with other smoking-related diseases: a systematic review. Journal of vascular surgery 38(2), 329-34	Not specific to AAA.
31	Lederle F A, Larson J C, Margolis K L, et al. J D (2008) Abdominal aortic aneurysm events in the women's health initiative: Cohort study. BMJ 337(7677), 1037-1040	Wrong study design: cohort study
32	Iede A J, Fowkes F G. R, Carson M N, Leng G C, and Allan P L (1997) Smoking, atherosclerosis and risk of abdominal aortic aneurysm. European Heart Journal 18(4), 671-676	Wrong study design: nested case-control.
33	Lindblad B, Borner G, and Gottsater A (2005) Factors associated with development of large abdominal aortic aneurysm in middle-aged men. European Journal of Vascular and Endovascular Surgery 30(4), 346-352	Wrong study design: nested case-control.
34	Long A, Bui H T, Barbe C, et al. (2010) Prevalence of abdominal aortic aneurysm and large infrarenal aorta in patients with acute coronary syndrome and proven coronary stenosis: a prospective monocenter study. Annals of vascular surgery 24(5), 602-8	Sample size of less than 500 participants.
35	Majeed K, Hamer A W, White S C, et al. (2015) Prevalence of abdominal aortic aneurysm in patients referred for transthoracic echocardiography. Internal medicine journal 45(1), 32-9	Investigators included patients with known AAA for screening. Additionally, risk factors (echocardiographic parameters) assessed in this study are not listed in the review protocol.
36	Mattes E, Davis T M. E, Yang D, et al. (1997) Prevalence of abdominal aortic aneurysms in	Sample size of less than 500 participants.

No.	Study	Reason for exclusion
	men with diabetes. Medical Journal of Australia 166(12), 630-633	
37	Moxon J V, Jones R E, Norman P E, et al. (2016) Plasma ferritin concentrations are not associated with abdominal aortic aneurysm diagnosis, size or growth. Atherosclerosis 251, 19-24	The risk factor (body iron levels) assessed in this study is not listed in the review protocol.
38	Ogata T, MacKean G L, Cole C W, et al. (2005) The lifetime prevalence of abdominal aortic aneurysms among siblings of aneurysm patients is eightfold higher than among siblings of spouses: an analysis of 187 aneurysm families in Nova Scotia, Canada. Journal of vascular surgery 42(5), 891-7	Sample size of less than 500 participants. Furthermore, multivariate analysis/regression was not performed.
39	Robson J C, Kiran A, Maskell J, et al. (2013) The relative risk of aortic aneurysm in patients with giant cell arteritis compared with the general population of the UK. Annals of the Rheumatic Diseases , no pagination	Wrong study design: cohort study
40	Rodin M B, Daviglus M L, Wong G C, et al. (2003) Middle age cardiovascular risk factors and abdominal aortic aneurysm in older age. Hypertension (Dallas, and Tex. : 1979) 42(1), 61-8	Wrong study design: cohort study
41	Ruff A L, Teng K, Hu B, et al. (2015) Screening for abdominal aortic aneurysms in outpatient primary care clinics. The American journal of medicine 128(3), 283-8	Study did not assess risk factors associated with AAA. Instead, investigators assessed risk factors associated with the decisions to perform ultrasound or computed-tomography imaging.
42	Sakalihasan N, Defraigne J, Kerstenne MA, et al. (2014) Family members of patients with abdominal aortic aneurysms are at increased risk for aneurysms: analysis of 618 probands and their families from the Liege AAA Family Study. Annals of vascular surgery 28(4), 787-97	The study employed multiple methodological designs. Initially, a case-control design was employed to establish whether people diagnosed with AAA had a family history of AAA. A cross-sectional design was then used to explore the prevalence of aneurysms in family members (n<500) of people diagnosed with AAA. Finally, multivariate analysis was not performed.
43	Shantikumar S, Ajjan R, Porter K E, et al. (2010) Diabetes and the Abdominal Aortic Aneurysm. European Journal of Vascular and Endovascular Surgery 39(2), 200-207	Systematic review including studies which employed various study designs (including case-controls, screening studies and cohort studies). Individual studies were assessed to determine if they met inclusion criteria for this review question.
44	Sidloff D A, Stather P W, Choke E, et al. (2014) A systematic review and meta-analysis of the association between markers of hemostasis and abdominal aortic aneurysm presence and size. Journal of vascular surgery 59(2), 528-535.e4	Systematic review of case-controls
45	Solberg S, Forsdahl S H, Singh K et al. (2010) Diameter of the infrarenal aorta as a risk factor for abdominal aortic aneurysm: the Tromso Study, 1994-2001. European journal	Wrong study design: cohort study

No.	Study	Reason for exclusion
	of vascular and endovascular surgery : the official journal of the European Society for Vascular Surgery 39(3), 280-4	
46	Stackelberg O, Bjorck M, Sadr-Azodi O, et al. (2013) Obesity and abdominal aortic aneurysm. The British journal of surgery 100(3), 360-6	Wrong study design: cohort study
47	Stackelberg O, Bjorck M, Larsson S C, Orsini N, and Wolk A (2014) Sex differences in the association between smoking and abdominal aortic aneurysm. The British journal of surgery 101(10), 1230-7	Wrong study design: cohort study
48	Stackelberg O, Bjorck M, Larsson S C, et al. (2013) Fruit and vegetable consumption with risk of abdominal aortic aneurysm. Circulation 128(8), 795-802	Wrong study design: cohort study
49	Stackelberg Otto, Wolk Alicja, Eliasson Ken, Hellberg Anders, Bersztel Adam, Larsson Susanna C, Orsini Nicola, Wanhainen Anders, and Bjorck Martin (2017) Lifestyle and Risk of Screening-Detected Abdominal Aortic Aneurysm in Men. Journal of the American Heart Association 6(5),	Wrong study design: cohort study
50	Svensjo S, Bjorck M, Gurtelschmid M et al. (2011) Low prevalence of abdominal aortic aneurysm among 65-year-old Swedish men indicates a change in the epidemiology of the disease. Circulation 124(10), 1118-23	Population screening study in which people identified from a national registry were screened for AAAs. Authors stated that people with previously known AAA or a history of AAA surgery were included in the analysis.
51	Svensjo S, Bjorck M, and Wanhainen A (2014) Editor's choice: five-year outcomes in men screened for abdominal aortic aneurysm at 65 years of age: a population-based cohort study. European journal of vascular and endovascular surgery : the official journal of the European Society for Vascular Surgery 47(1), 37-44	Wrong study design: cohort study
52	Takagi H, Umemoto T, and Group Alice (2015) A meta-analysis of circulating homocysteine levels in subjects with versus without abdominal aortic aneurysm. International angiology : a journal of the International Union of Angiology 34(3), 229-37	Systematic review of case-controls.
53	Takagi H, and Umemoto T (2015) A meta-analysis of the association of obesity with abdominal aortic aneurysm presence. International Angiology 34(4), 383-391	Systematic review including studies which employed various study designs (including case-controls, screening studies and cohort studies). Individual studies were assessed to determine if they met inclusion criteria for this review question.
54	Takagi H, and Umemoto T (2015) A meta-analysis of the association of primary abdominal wall hernia with abdominal aortic	Systematic review including studies which employed various study designs (including case-controls, screening studies and cohort

No.	Study	Reason for exclusion
	aneurysm. International angiology : a journal of the International Union of Angiology 34(3), 219-28	studies). Individual studies were assessed to determine if they met inclusion criteria for this review question.
55	Takagi H, and Umemoto T (2015) A contemporary meta-analysis of the association of diabetes with abdominal aortic aneurysm. International Angiology 34(4), 375-382	Systematic review including studies which employed various study designs (including case-controls, screening studies and cohort studies). Individual studies were assessed to determine if they met inclusion criteria for this review question.
56	Takeuchi Hidemi, Okuyama Michihiro, Uchida Haruhito A, Kakio Yuki, Umebayashi Ryoko, Okuyama Yuka, Fujii Yasuhiro, Ozawa Susumu, Yoshida Masashi, Oshima Yu, Sano Shunji, and Wada Jun (2016) Chronic Kidney Disease Is Positively and Diabetes Mellitus Is Negatively Associated with Abdominal Aortic Aneurysm. PloS one 11(10), e0164015	Wrong study design: retrospective case-control
57	Thompson A R, Golledge J, Cooper J A, et al. (2009) Sequence variant on 9p21 is associated with the presence of abdominal aortic aneurysm disease but does not have an impact on aneurysmal expansion. European Journal of Human Genetics 17(3), 391-394	Wrong study design: case-control
58	Tornwall M E, Virtamo J, Haukka J K, et al. (2001) Life-style factors and risk for abdominal aortic aneurysm in a cohort of Finnish male smokers. Epidemiology 12(1), 94-100	Wrong study design: cohort study
59	Ulug P, Powell J T, Sweeting M J, Bown M J, Thompson S G, and Group Swan Collaborative (2016) Meta-analysis of the current prevalence of screen-detected abdominal aortic aneurysm in women. The British journal of surgery 103(9), 1097-104	Conference abstract
60	van Laarhoven C J, Borstlap A C, van Berge Henegouwen, D P, et al. (1993) Chronic obstructive pulmonary disease and abdominal aortic aneurysms. European journal of vascular surgery 7(4), 386-90	Sample size less than 500 participants
61	van de Luijtgaarden , Koen M, Rouwet Ellen V, Hoeks Sanne E, Stolker Robert J, Verhagen Hence Jm, and Majoor-Krakauer Danielle (2017) Risk of abdominal aortic aneurysm (AAA) among male and female relatives of AAA patients. Vascular medicine (London, and England) 22(2), 112-118	Study employed multiple study designs. First a case-control study design was used to assess risk factors of people with confirmed AAA. Subsequently, first degree relatives of people with AAA were asked how many relatives they had with AAA.
62	Van Vlijmen-Van Keulen, C J, Pals G, et al. (2002) Familial abdominal aortic aneurysm: A systematic review of a genetic background. European Journal of Vascular and Endovascular Surgery 24(2), 105-116	Systematic review including studies which employed various study designs (including case-controls, screening studies and cohort studies). Individual studies were assessed to determine if they met inclusion criteria for this review question.

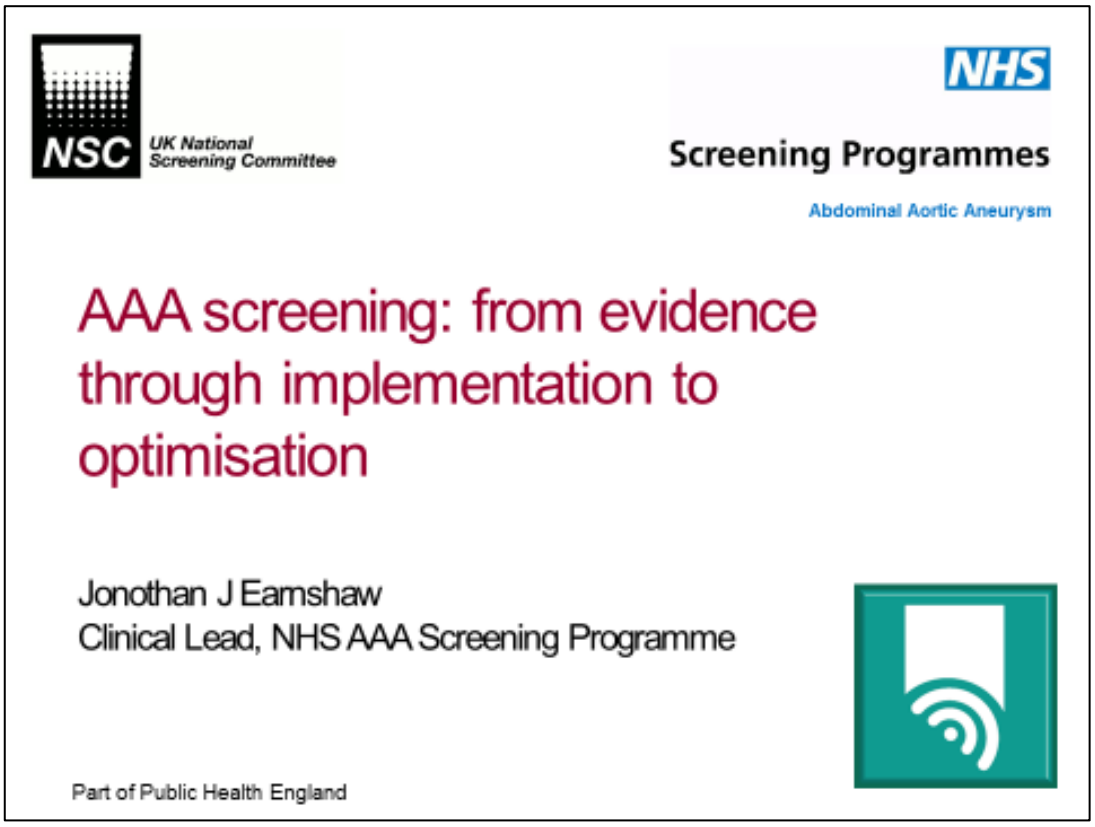
No.	Study	Reason for exclusion
63	Wang Lu, Djousse Luc, Song Yiqing, Akinkuolie Akintunde O, Matsumoto Chisa, Manson JoAnn E, Gaziano J Michael, and Sesso Howard D (2017) Associations of Diabetes and Obesity with Risk of Abdominal Aortic Aneurysm in Men. Journal of obesity 2017, 3521649	Wrong study design: cohort study in which participants were not screened. Instead investigators ascertained the presence or absence of AAA by asking patients to complete a self-reported questionnaire.
64	Wang Yunpeng, Shen Guanghui, Wang Haiyang, Yao Ye, Sun Qingfeng, Jing Bao, Liu Gaoyan, Wu Jia, Yuan Chao, Liu Siqi, Liu Xinyu, Li Shiyong, and Li Haocheng (2017) Association of high sensitivity C-reactive protein and abdominal aortic aneurysm: a meta-analysis and systematic review. Current medical research and opinion 33(12), 2145-2152	Systematic review of case-control studies
65	Wilmink Antonius B. M, Vardulaki Katerina A, Hubbard Catherine S. F, et al. Scott Alan P, and Quick Clive R. G (2002) Are antihypertensive drugs associated with abdominal aortic aneurysms?. Journal of vascular surgery 36(4), 751-7	Wrong study design: nested case-control
66	Wong DR, Willett WC, and Rimm Eric B (2007) Smoking, hypertension, alcohol consumption, and risk of abdominal aortic aneurysm in men. American journal of epidemiology 165(7), 838-45	Wrong study design: cohort study
67	Wong YYE, Flicker L, Yeap BB, McCaul KA, (2013) Is hypovitaminosis D associated with abdominal aortic aneurysm, and is there a dose-response relationship?. European journal of vascular and endovascular surgery : the official journal of the European Society for Vascular Surgery 45(6), 657-64	Sample size less than 500 participants. Additionally, the risk factor (vitamin D levels) assessed in this study is not listed in the review protocol.
68	Xiong Jiang, Wu Zhongyin, Chen Chen, Wei Yingqi, and Guo Wei (2016) Association between diabetes and prevalence and growth rate of abdominal aortic aneurysms: A meta-analysis. International journal of cardiology 221, 484-95	Systematic review which included studies that employed multiple study designs. Individual studies were assessed to establish if they met criteria for inclusion in this NICE review.
69	Zarrouk M, Keshavarz K, Lindblad B, et al. (2013) APC-PCI complex levels for screening of AAA in patients with peripheral atherosclerosis. Journal of thrombosis and thrombolysis 36(4), 495-500	Multivariate or Cox regression was not performed. Instead, investigators performed linear regression to assess the relationship between activated protein C (APC) - protein C inhibitor (PCI) complex levels and aortic diameter

Economic studies

No full text papers were retrieved. All studies were excluded at review of titles and abstracts.

Appendix H – Expert testimony from National Abdominal Aortic Aneurysm Screening Programme

The Clinical Lead of the UK NHS AAA screening programme provided expert testimony to the committee in the form of a presentation. The presentation covered developments since the inception of the screening programme, advantages and disadvantages of screening, challenges faced, and plans for the future. The presentation slides can be found below:



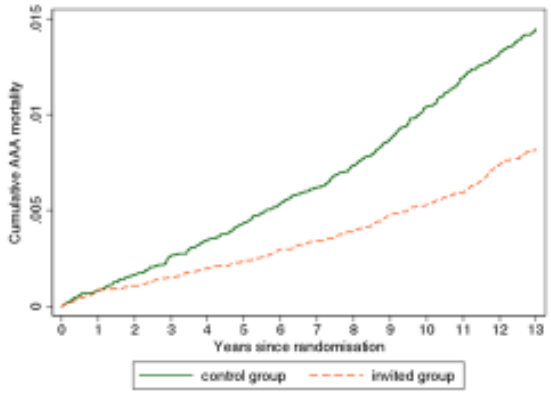
NHS
Screening Programmes

Abdominal aortic aneurysm

Still a major killer in elderly people

4000 deaths in England in 2007

Ultrasound screening 65 year old men reduces AAA-fatality rate by almost 50% after 10 years (MASS Trial)



NHS
Screening Programmes

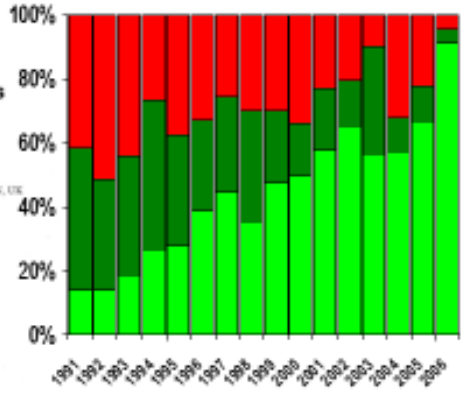
Meta-analysis of RCTs out to 10 years

Takagi et al. Angiology 2017

- Invitation to screening reduced AAA-related mortality: hazard ratio 0.66, 0.47 to 0.93
- Invitation to screening reduced all cause mortality: 0.98, 0.097 to 0.99
- Attendance at screening reduced AAA-related mortality: 0.4, 0.31 to 0.51
- Attendance at screening reduced all cause mortality: 0.6, 0.47 to 0.75
- Non attendance did not increase AAA-related mortality: 1.19, 0.82 to 1.72
- Non attendance increased all cause mortality: 1.41, 1.23 to 1.63

Gloucestershire Aneurysm Screening Programme

NHS Screening Programmes



Vascular Surgical Society

A single normal ultrasonographic scan at age 65 years rules out significant aneurysm disease for life in men

P. Cross, E. Shaw, J. J. Earnshaw, K. R. Poskitt*, M. R. Whyman* and B. P. Heather

Background: Screening for abdominal aortic aneurysm (AAA) has been carried out in Gloucestershire since 1990. All men in the county are offered aortic ultrasonography in their 65th year. Men with an aortic diameter of less than 26 mm are considered 'normal' and no follow-up is arranged. The aim of this study was to ascertain if men with 'normal' aortic diameters at age 65 years ever develop a clinically significant aneurysm.

Methods: A cohort study was performed on 223 65-year-old men who had an aorta of less than 26 mm in diameter in 1988. These men had repeat ultrasonography in 1993 and 2000. The causes of death in men who died during this interval were investigated.

Results: Eight men were lost to follow-up. As far as it was possible to ascertain, none of the 86 men who died over the 12-year interval did so from ruptured AAA. There was no clinically significant increase in mean aortic diameter in the remaining 129 men who had three serial ultrasonographic scans over the 12-year interval.

Conclusion: A single, 'normal' ultrasound scan at age 65 years effectively rules out the risk of clinically significant aneurysm disease for life in men.

Paper accepted 10 March 2001

British Journal of Surgery 2001, **88**, 941–944

NHS Screening Programmes

NHS AAA Screening Programme

Working party formed to advise NSC 2003

NSC recommended Programme to Department of Health 2007

Funding agreed 2008

NHS
Screening Programmes

Implementation

2009 - 2013

41 Local Programmes

Population ~1 million men

Every man aged 65 in England on, or after 1st April 2013 has been invited for AAA screening

NHS
Screening Programmes

NHS AAA Screening Programme

Mobile screening team, portable ultrasound scanners

Trained screeners, quality assurance

Outcomes:

<3cm reassured and discharged

3-4.4 offered annual surveillance

4.5-5.4cm offered 3-monthly surveillance

>5.4cm referred for intervention

Bespoke IT (AAA SMaRT)

NHS

Headline results for England

Screening Programmes

August 2017

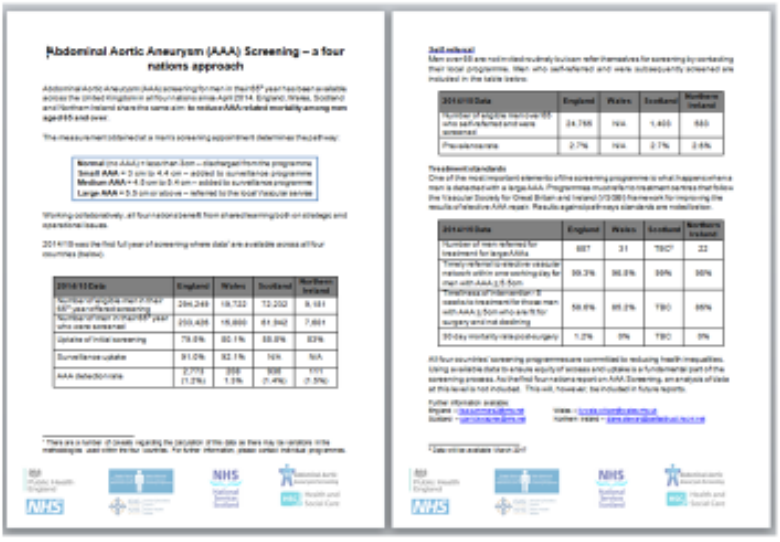
- 1,588, 036 men invited
- 1,254, 187 men screened (uptake 78.9%)
- Over 15,850 AAA (>3cm) detected
- Prevalence 1.26%
- Almost 13,000 men in surveillance
- Some 3653 men referred for surgery
- Over 2500 men treated (1.8% mortality)

results available https://www.gov.uk/topic/population-screening-programmes/abdominal-aortic-aneurysm

NHS

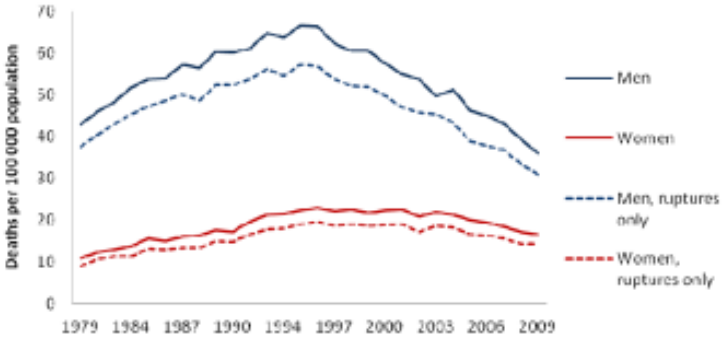
Screening Programmes

A 4 nations approach



NHS
Screening Programmes

Reducing AAA-related mortality

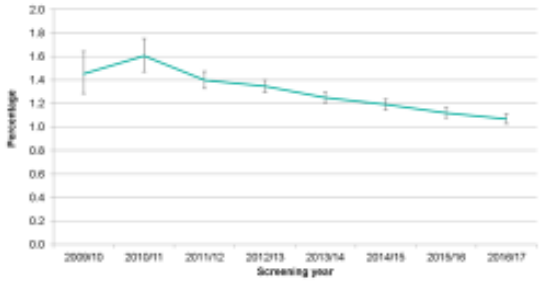


Anjum et al. BJS 2012

NHS
Screening Programmes

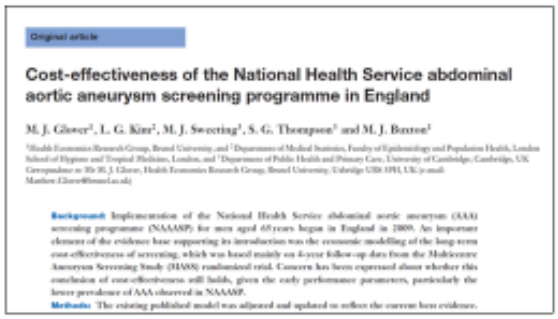
Reducing prevalence

Screening year	Tested	Aneurysm	% aneurysm
2009/10	17,133	249	1.45
2010/11	30,549	490	1.60
2011/12	98,529	1,378	1.40
2012/13	183,034	2,463	1.35
2013/14	235,409	2,941	1.25
2014/15	224,517	2,674	1.19
2015/16	227,543	2,549	1.12
2016/17	223,371	2,387	1.07



NHS
Screening Programmes

Cost effectiveness of AAA screening



Original article

Cost-effectiveness of the National Health Service abdominal aortic aneurysm screening programme in England

M. J. Glover[1], L. G. Kim[2], M. J. Sweeting[2], S. G. Thompson[2] and M. J. Buxton[1]

[1]Health Economics Research Group, Brunel University, and [2]Department of Medical Statistics, Faculty of Epidemiology and Population Health, London School of Hygiene and Tropical Medicine, London, and [3]Department of Public Health and Primary Care, University of Cambridge, Cambridge, UK

Correspondence to: Dr M. J. Glover, Health Economics Research Group, Brunel University, Uxbridge UB8 3PH, UK (e-mail: Matthew.Glover@brunel.ac.uk)

Background: Implementation of the National Health Service abdominal aortic aneurysm (AAA) screening programme (NAAASP) for men aged 65 years began in England in 2009. An important element of the evidence base supporting its introduction was the economic modelling of the long-term cost-effectiveness of screening, which was based mainly on 4-year follow-up data from the Multicentre Aneurysm Screening Study (MASS) randomized trial. Concern has been expressed about whether this conclusion of cost-effectiveness still holds, given the early performance parameters, particularly the lower prevalence of AAA observed in NAAASP.

Methods: The existing published model was adjusted and updated to reflect the current best evidence.

BJS, 2015

AAA screening of 65 year old men remains cost effective to a prevalence of 0.35%

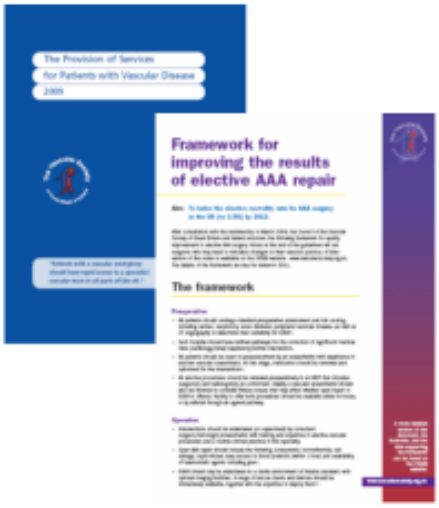
NHS
Screening Programmes

Death from AAA rupture in surveillance

	Number of men	Ruptures (N)	Follow-up (person-years)	Incidence rate per 100 person-years (95% CI)
Overall	12,788	16	23,818	0.07 (0.04, 0.11)
Last known aortic measurement				
Grouping 1				
<3.0cm	-	0	916	0 -
3.0-4.4cm	-	6	20,140	0.03 (0.01, 0.07)
4.5-5.4cm	-	10	2,766	0.36 (0.19, 0.67)
5.5cm+	-	0	3	0 -
Grouping 2				
3.0-4.9cm	-	10	21,774	0.05 (0.02, 0.09)
5.0-5.4cm	-	6	1,132	0.53 (0.24, 1.18)
5.5cm+	-	0	3	0 -

Risk of death from AAA rupture in 11,133 men in surveillance in NAAASP

Other benefits: remodelling of vascular services in England



Networking – several smaller hospitals collaborating with a single intervention centre

Preimplementation quality assurance

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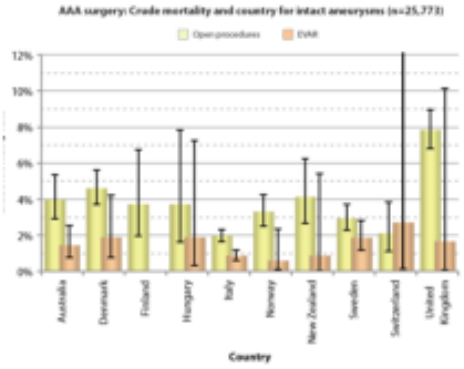
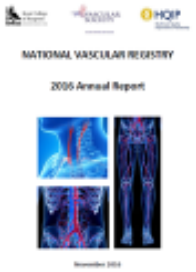
Effect of vascular remodelling



Vascunet report 2008
Elective AAA mortality 7.4%



NVR 2016
Elective AAA mortality
Open (n=1316) 3%
EVAR (n=2882) 0.4%

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Other benefits: secondary prevention in men in surveillance

Improved 5-year survival in patients with AAA with regular prescription for aspirin, statins and antihypertensive drugs

Original article

Cardiovascular risk prevention and all-cause mortality in primary care patients with an abdominal aortic aneurysm

BJS 2016; 103: 1626

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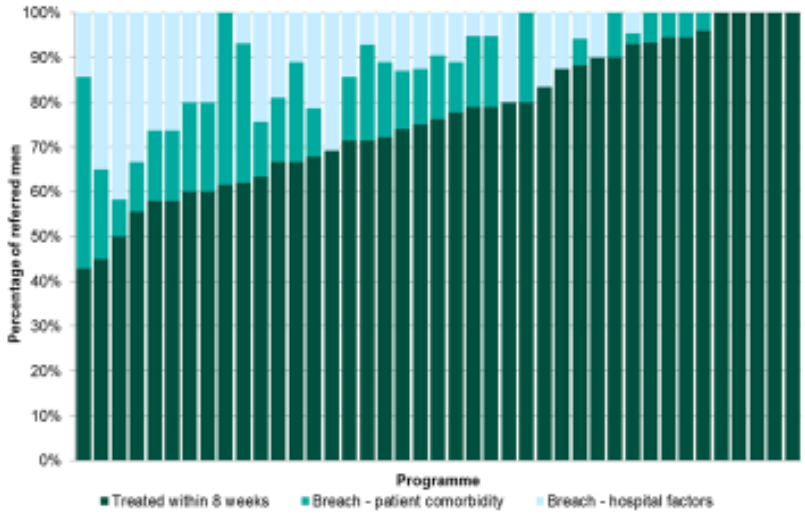
Accelerated treatment: 8-week waits 2015/16



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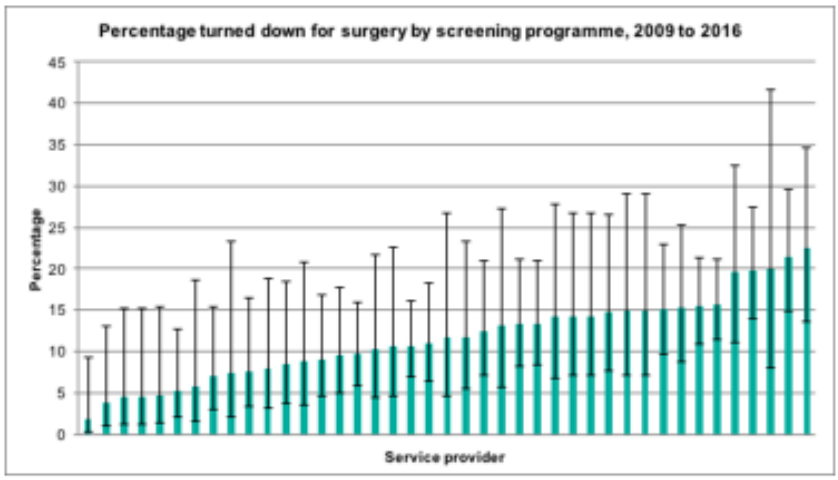
Turn down rates by local programme



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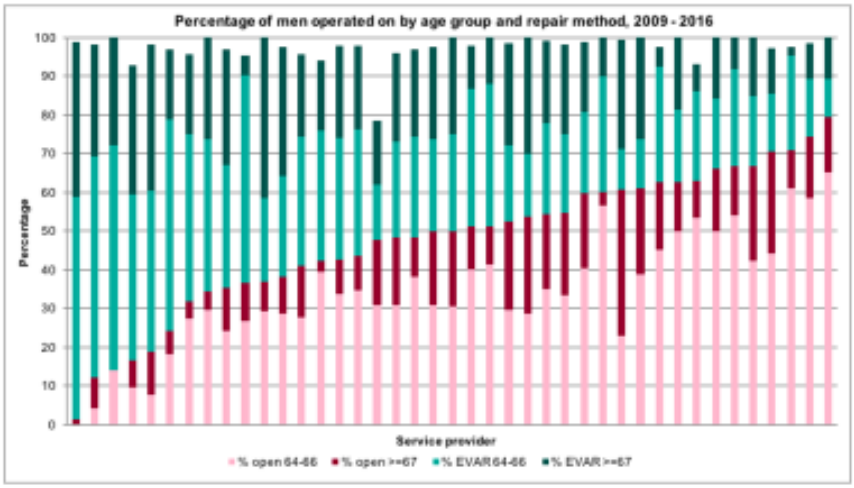
Procedures by local programme



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Other benefits: research

- AAA growth rates
- Optimal management of men in surveillance
- Referral thresholds
- Epidemiology of AAA

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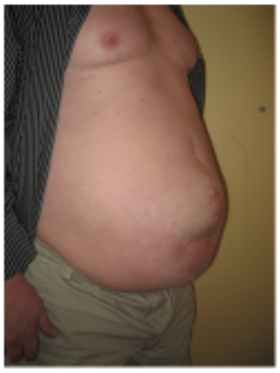
Disbenefits of AAA screening

- Every 10,000th man invited will die after elective AAA repair, who would not have suffered a ruptured AAA.
- Men with small and medium AAA are inconvenienced and medicalised
- Non fatal consequences of AAA treatment
- Men who do not attend are high risk
- Screening does not abolish rupture



NSC UK National Screening Committee

NHS Screening Programmes

Abdominal Aortic Aneurysm

After implementation completed – whole programme review 2015

Part of Public Health England

NHS Screening Programmes

Programme optimisation

- Reduce surveillance intervals
- Improve uptake
- ?introduce surveillance for men with subaneurysmal aorta

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Surveillance intervals
(RESCAN Collaborators), JAMA, 2013

Maintaining risk of rupture less than 1%,

the following surveillance intervals

are acceptable:

3-4cm – several years

4-4.9cm – annual

5-5.4cm – six months


Surveillance Intervals for Small Abdominal Aortic Aneurysms
A Meta-analysis

NHS
Screening Programmes

Surveillance intervals: proposal

- Change 3 to 4.4cm from annual to biennial (saves 10,000 scans/annum)
- Leave 4.5 to 5.4cm at 3 months, until more data on safety
- Discuss with IT suppliers, and Advisory Board
- Final decision after NICE guidelines approved (2018)

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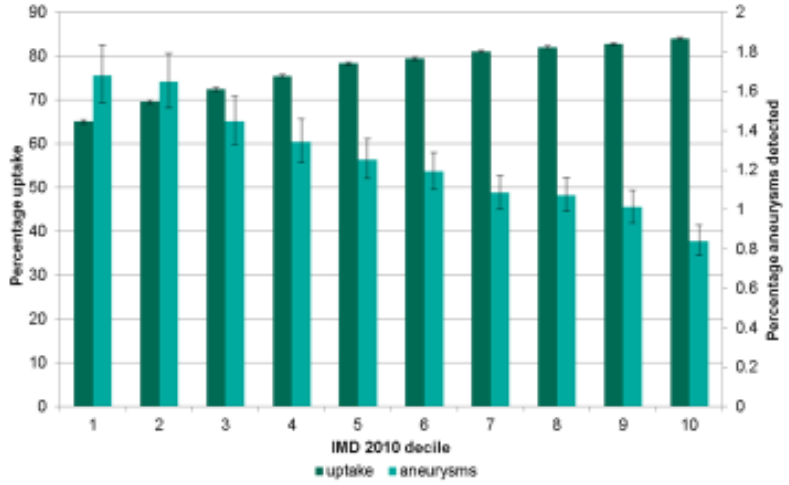
Uptake of screening and aneurysms detected by decile of deprivation



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Equality, fairness and inclusion programme: proposal

- Annual local programme reports
- Toolkit for local programmes
- Local learning to update toolkit
- Aim to improve uptake by 10%

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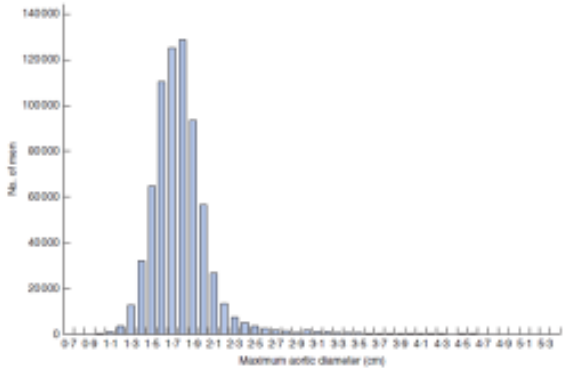
Subaneurysmal aorta 2.6-2.9cm



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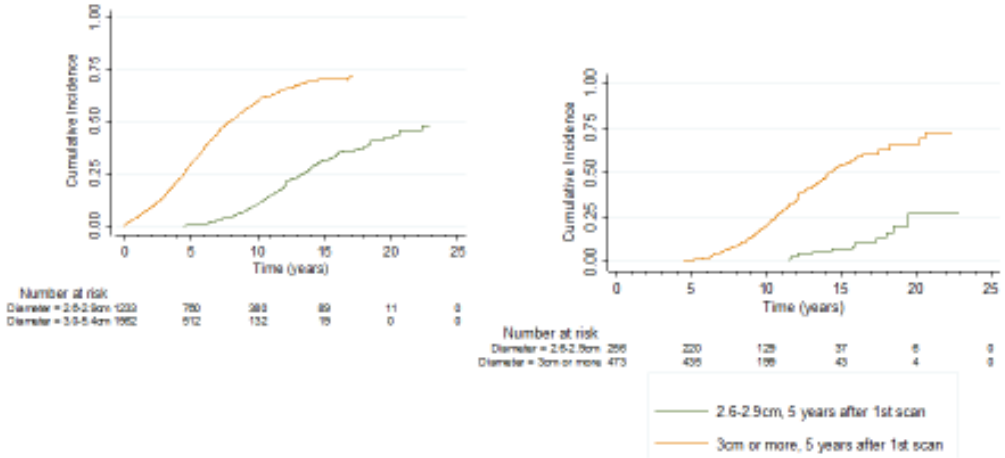
Subaneurysmal aorta in Glos:
risk of developing a 5.5cm AAA



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Subaneurysmal aorta (2.6-2.9cm) at age 65 years

66% reach 3cm by age 70

10% reach 5.5cm after 10 years

25% reach 5.5cm after 15 years

Number who rupture?

Number who reach 5.5cm that have treatment?

Number that survive treatment?

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Subaneurysmal aorta (2.6-2.9cm) at age 65 years

66% reach 3cm by age 70

10% reach 5.5cm after 10 years

25% reach 5.5cm after 15 years

Number who rupture?

Number who reach 5.5cm that have treatment?

Number that survive treatment?

Canadian rapid review 2016:
not enough evidence to recommend surveillance for men age 65 with a subaneurysmal aorta

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Subaneurysmal aorta: proposal
endorsed by NSC 23.6.17

- Approve research within programme into harms of being in surveillance – quality of life studies using AAA SMaRT
- Modelling and retrospective review of outcomes of men with subaneurysmal aorta at 65 years who develop a 5.5cm AAA during surveillance
- Cost benefit analysis

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Horizon scanning

- RCT of metformin for AAA growth
- Targetted screening for women?
- Debate about referral thresholds
- Programme enhancement ?
  ABPIs/cholesterol/ECG (triple vascular screening: VIVA trial)

- When to stop surveillance

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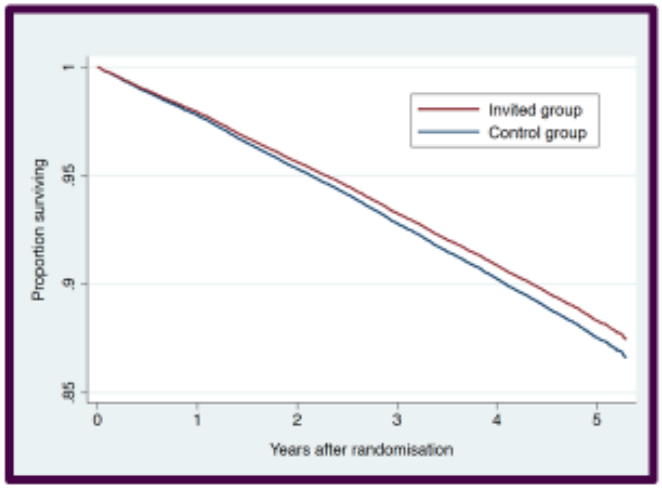
VIVA trial 2017



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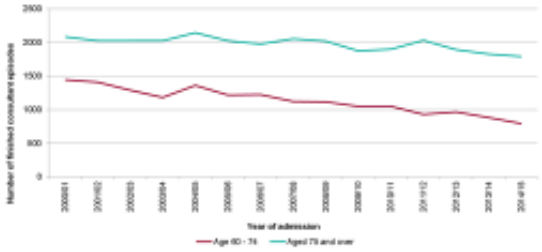
Conclusion

NHS AAA Screening Programme is feasible and cost effective.

Referral threshold safe

Still room for optimisation

On target to reduce deaths by up to 50%



Appendix I – Glossary

Abdominal Aortic Aneurysm (AAA)

A localised bulge in the abdominal aorta (the major blood vessel that supplies blood to the lower half of the body including the abdomen, pelvis and lower limbs) caused by weakening of the aortic wall. It is defined as an aortic diameter greater than 3 cm or a diameter more than 50% larger than the normal width of a healthy aorta. The clinical relevance of AAA is that the condition may lead to a life-threatening rupture of the affected artery. Abdominal aortic aneurysms are generally characterised by their shape, size and cause:

- Infrarenal AAA: an aneurysm located in the lower segment of the abdominal aorta below the kidneys.
- Juxtarenal AAA: a type of infrarenal aneurysm that extends to, and sometimes, includes the lower margin of renal artery origins.
- Suprarenal AAA: an aneurysm involving the aorta below the diaphragm and above the renal arteries involving some or all of the visceral aortic segment and hence the origins of the renal, superior mesenteric, and celiac arteries, it may extend down to the aortic bifurcation.

Abdominal compartment syndrome

Abdominal compartment syndrome occurs when the pressure within the abdominal cavity increases above 20 mm Hg (intra-abdominal hypertension). In the context of a ruptured AAA this is due to the mass effect of a volume of blood within or behind the abdominal cavity. The increased abdominal pressure reduces blood flow to abdominal organs and impairs pulmonary, cardiovascular, renal, and gastro-intestinal function. This can cause multiple organ dysfunction and eventually lead to death.

Cardiopulmonary exercise testing

Cardiopulmonary Exercise Testing (CPET, sometimes also called CPX testing) is a non-invasive approach used to assess how the body performs before and during exercise. During CPET, the patient performs exercise on a stationary bicycle while breathing through a mouthpiece. Each breath is measured to assess the performance of the lungs and cardiovascular system. A heart tracing device (Electrocardiogram) will also record the hearts electrical activity before, during and after exercise.

Device migration

Migration can occur after device implantation when there is any movement or displacement of a stent-graft from its original position relative to the aorta or renal arteries. The risk of migration increases with time and can result in the loss of device fixation. Device migration may not need further treatment but should be monitored as it can lead to complications such as aneurysm rupture or endoleak.

Endoleak

An endoleak is the persistence of blood flow outside an endovascular stent - graft but within the aneurysm sac in which the graft is placed.

- Type I – Perigraft (at the proximal or distal seal zones): This form of endoleak is caused by blood flowing into the aneurysm because of an incomplete or ineffective seal at either end of an endograft. The blood flow creates pressure within the sac and significantly increases the risk of sac enlargement and rupture. As a result, Type I endoleaks typically require urgent attention.
- Type II – Retrograde or collateral (mesenteric, lumbar, renal accessory): These endoleaks are the most common type of endoleak. They occur when blood bleeds into the sac from small side branches of the aorta. They are generally considered benign because they are usually at low pressure and tend to resolve spontaneously over time without any need for intervention. Treatment of the endoleak is indicated if the aneurysm sac continues to expand.
- Type III – Midgraft (fabric tear, graft dislocation, graft disintegration): These endoleaks occur when blood flows into the aneurysm sac through defects in the endograft (such as graft fractures, misaligned graft joints and holes in the graft fabric). Similarly to Type I endoleak, a Type III endoleak results in systemic blood pressure within the aneurysm sac that increases the risk of rupture. Therefore, Type III endoleaks typically require urgent attention.
- Type IV– Graft porosity: These endoleaks often occur soon after AAA repair and are associated with the porosity of certain graft materials. They are caused by blood flowing through the graft fabric into the aneurysm sac. They do not usually require treatment and tend to resolve within a few days of graft placement.
- Type V – Endotension: A Type V endoleak is a phenomenon in which there is continued sac expansion without radiographic evidence of a leak site. It is a poorly understood abnormality. One theory that it is caused by pulsation of the graft wall, with transmission of the pulse wave through the aneurysm sac to the native aneurysm wall. Alternatively it may be due to intermittent leaks which are not apparent at imaging. It can be difficult to identify and treat any cause.

Endovascular aneurysm repair

Endovascular aneurysm repair (EVAR) is a technique that involves placing a stent –graft prosthesis within an aneurysm. The stent-graft is inserted through a small incision in the femoral artery in the groin, then delivered to the site of the aneurysm using catheters and guidewires and placed in position under X-ray guidance.

- Conventional EVAR refers to placement of an endovascular stent graft in an AAA where the anatomy of the aneurysm is such that the ‘instructions for use’ of that particular device are adhered to. Instructions for use define tolerances for AAA anatomy that the device manufacturer considers appropriate for that device. Common limitations on AAA anatomy are infrarenal neck length (usually >10mm), diameter (usually ≤30mm) and neck angle relative to the main body of the AAA
- Complex EVAR refers to a number of endovascular strategies that have been developed to address the challenges of aortic proximal neck fixation associated with complicated aneurysm anatomies like those seen in juxtarenal and suprarenal AAAs. These strategies include using conventional infrarenal aortic stent grafts outside their ‘instructions for use’, using physician-modified endografts, utilisation of customised fenestrated endografts, and employing snorkel or chimney approaches with parallel covered stents.

Goal directed therapy

Goal directed therapy refers to a method of fluid administration that relies on minimally invasive cardiac output monitoring to tailor fluid administration to a maximal cardiac output or other reliable markers of cardiac function such as stroke volume variation or pulse pressure variation.

Post processing technique

For the purpose of this review, a post-processing technique refers to a software package that is used to augment imaging obtained from CT scans, (which are conventionally presented as axial images), to provide additional 2- or 3-dimensional imaging and data relating to an aneurysm's, size, position and anatomy.

Permissive hypotension

Permissive hypotension (also known as hypotensive resuscitation and restrictive volume resuscitation) is a method of fluid administration commonly used in people with haemorrhage after trauma. The basic principle of the technique is to maintain haemostasis (the stopping of blood flow) by keeping a person's blood pressure within a lower than normal range. In theory, a lower blood pressure means that blood loss will be slower, and more easily controlled by the pressure of internal self-tamponade and clot formation.

Remote ischemic preconditioning

Remote ischemic preconditioning is a procedure that aims to reduce damage (ischaemic injury) that may occur from a restriction in the blood supply to tissues during surgery. The technique aims to trigger the body's natural protective functions. It is sometimes performed before surgery and involves repeated, temporary cessation of blood flow to a limb to create ischemia (lack of oxygen and glucose) in the tissue. In theory, this "conditioning" activates physiological pathways that render the heart muscle resistant to subsequent prolonged periods of ischaemia.

Tranexamic acid

Tranexamic acid is an antifibrinolytic agent (medication that promotes blood clotting) that can be used to prevent, stop or reduce unwanted bleeding. It is often used to reduce the need for blood transfusion in adults having surgery, in trauma and in massive obstetric haemorrhage.