National Institute for Health and Care Excellence

Draft for consultation

Abdominal aortic aneurysm: diagnosis and management

Evidence review I: CT angiography with post-processing techniques

NICE guideline <number>

Evidence reviews

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Disclaimer

The recommendations in this guideline represent the view of NICE, arrived at after careful consideration of the evidence available. When exercising their judgement, professionals are expected to take this guideline fully into account, alongside the individual needs, preferences and values of their patients or service users. The recommendations in this guideline are not mandatory and the guideline does not override the responsibility of healthcare professionals to make decisions appropriate to the circumstances of the individual patient, in consultation with the patient and/or their carer or guardian.

Local commissioners and/or providers have a responsibility to enable the guideline to be applied when individual health professionals and their patients or service users wish to use it. They should do so in the context of local and national priorities for funding and developing services, and in light of their duties to have due regard to the need to eliminate unlawful discrimination, to advance equality of opportunity and to reduce health inequalities. Nothing in this guideline should be interpreted in a way that would be inconsistent with compliance with those duties.

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ISBN:

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Is CT angiography with post-processing techniques effective compared to CT angiography alone in planning surgery for an unruptured abdominal aortic aneurysm?

Is CT angiography with post-processing techniques effective compared to CT angiography alone in planning surgery for a ruptured abdominal aortic aneurysm?

Introduction

The aim of these review questions was to determine the effectiveness of post-processing techniques for computed tomography angiography (CTA), when planning surgery for either an unruptured or ruptured abdominal aortic aneurysm (AAA).

PICO table

Table 1: Inclusion criteria

Parameter	Inclusion criteria
Population	People with a confirmed unruptured or ruptured AAA in whom surgery is planned
Interventions	CTA with post-processing techniques or workstations. Post-processing techniques of interest include: multiplanar formatting automated/semi-automated systems for aneurysm-sizing slice thickness
Comparators	CTA alone
Outcomes	Mortality Further AAA expansion AAA rupture Complications of surgery Resource use and cost

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 broad search strategy was used to gather all studies that examine the diagnosis, surveillance or monitoring of AAAs. This was a 'bulk' search that covered multiple review questions. The reviewer sifted the database to identify all studies that met the set of criteria Table 1, with the full protocol given in Appendix A.

Studies were included if they assessed the effectiveness of CT angiography with post-processing techniques in people with an unruptured or ruptured AAA. Randomised and quasi-randomised controlled trials were considered for inclusion, and studies were excluded if they were:

- not in English

- not full reports of the study (for example, published only as an abstract)
- published before the year 2000
- not peer-reviewed.

Clinical evidence

Included studies

From a database of 12,786 abstracts, 45 were identified as being potentially relevant. Following full-text review of these articles, 0 were identified as meeting the criteria for inclusion in this review.

An update search was conducted in December 2017, to identify any relevant studies published during guideline development. The search found 2,598 abstracts; all of which were not considered relevant to this review question. As a result no additional studies were included.

Excluded studies

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

Economic evidence

Included studies

A literature search was conducted jointly for all review questions in this guideline 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, 0 were identified as being potentially relevant to the use of post-processing techniques with CT angiography. No full texts were retrieved, and so 0 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

Health economic modelling was not prioritised for these review questions, therefore no model was developed for it.

Evidence statements

No evidence was identified for these review questions.

Recommendations

The committee decided not to make any recommendations on post-processing techniques.

Rationale and impact

Why the committee didn't make any recommendations

No evidence was identified demonstrating whether or not post-processing techniques affected postoperative outcomes of people undergoing elective or emergency AAA repair. As post-processing techniques are an established part of clinical practice, and are used at the clinician's discretion, the committee agreed that there was no need to make recommendations in this area.

Impact of the recommendations on practice

As post-processing techniques are established in practice, a lack of recommendations on these will not have an impact.

The committee's discussion of the evidence

Interpreting the evidence

The outcomes that matter most

Despite the lack of any evidence, the committee discussed mortality and complications, in particular in relation to endovascular AAA repair (EVAR), and these were considered to be relevant for this review question.

The quality of the evidence

No evidence was identified.

Benefits and harms

The committee noted that the use of post-processing techniques and other CT angiography data analysis tools can make assessment of aneurysm anatomy more accurate compared with estimations made when reviewing axial datasets without using these tools. It also agreed that more accurate anatomical information would result in better-sized devices for repair, and would therefore result in better outcomes.

The committee noted that, despite the theoretical and anecdotal advantages of using post-processing techniques for planning EVAR, there is no evidence from randomised controlled trials to support their use. At the same time no evidence was identified that indicated any disadvantage of using these techniques.

The committee agreed that the time associated with the use of CT post-processing techniques is more than offset by the additional data and benefits that this analysis provides. This also remains true in emergency EVAR where this activity can be done in parallel with other acute patient preparation.

Cost effectiveness and resource use

Post-processing software packages are extensively available and are already widely embedded in clinical radiology practice. As a result, the committee agreed that there would be few or no resource implications of using post-processing techniques because these techniques are now considered to be standard in most hospitals.

Other factors the committee took into account

The committee considered that most hospitals already have this technology available on their picture archiving and communication systems (PACS systems) (for the reasons outlined

above). At the same time, the committee was mindful that any recommendation stating that hospitals “offer” post-processing techniques would be unjustified in the face of lack of evidence of their effect. The committee also considered that a recommendation to “consider” the use of post-processing techniques would also be meaningless given their already wide use.

Appendices

Appendix A – Review protocols

Review protocol for review question 10: Is computed tomographic angiography (CTA) with post-processing techniques effective compared to CTA alone in planning surgery for an unruptured abdominal aortic aneurysm?

Review question 10	Is computed tomographic angiography (CTA) with post-processing techniques effective compared to CTA alone in planning surgery for an unruptured abdominal aortic aneurysm?
Objectives	To determine if CTA with post-processing techniques or CTA alone is more effective for surgical planning in people with an unruptured abdominal aortic aneurysm and in improving the surgical outcomes
Type of review	Intervention
Language	English only
Study design	Systematic reviews of study designs listed below Randomised controlled trials Quasi-randomised controlled trials
Status	Published papers only (full text) No date restrictions
Population	People with a confirmed unruptured abdominal aortic aneurysm in whom surgery is planned Subgroups: position of aneurysm, people who are obese
Intervention	CTA with post-processing techniques or workstations Post-processing techniques of interest include: • multiplanar formatting • automated/semi-automated systems for aneurysm-sizing • slice thickness
Comparator	CTA alone
Outcomes	Downstream effects reflecting the technical and clinical success of surgery: • Mortality • Further AAA expansion • AAA rupture • Complications of surgery • Resource use and cost
Other criteria for inclusion / exclusion of studies	Exclusion: • Non-English language • Abstract/non-published • Publication before the year 2000
Baseline characteristics to be extracted in evidence tables	• Age • Sex • Size of aneurysm • Position of aneurysm • Comorbidities
Search strategies	See Appendix B
Review strategies	• Appropriate NICE Methodology Checklists, depending on study designs, will be used as a guide to appraise the quality of individual studies.

Review question 10	**Is computed tomographic angiography (CTA) with post-processing techniques effective compared to CTA alone in planning surgery for an unruptured abdominal aortic aneurysm?**
	• 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	None identified

Review protocol for review question 22: Is CT angiography with post-processing techniques effective compared to CT angiography alone in planning surgery for a ruptured abdominal aortic aneurysm?

Review question 22	**Is CT angiography with post-processing techniques effective compared to CT angiography alone in planning surgery for a ruptured abdominal aortic aneurysm?**
Objectives	To determine if CTA with post-processing techniques or CTA alone is more effective for surgical planning in people with a ruptured abdominal aortic aneurysm and in improving the surgical outcomes
Type of review	Intervention
Language	English only
Study design	Systematic reviews of study designs listed below: • Randomised controlled trials • Quasi-randomised controlled trials
Status	• Published papers only (full text) No date restrictions
Population	People with a ruptured AAA in whom surgery is planned Subgroups: position of aneurysm, people who are obese
Intervention	CTA with post-processing techniques or workstations Post-processing techniques of interest include: • multiplanar formatting automated/semi-automated systems for aneurysm-sizing • slice thickness
Comparator	CTA alone
Outcomes	Downstream effects reflecting the technical and clinical success of surgery: • Mortality • Further AAA expansion • AAA rupture • Complications of surgery • Resource use and cost
Other criteria for inclusion / exclusion of studies	Exclusion: Non-English language Abstract/non-published
Baseline characteristics to be extracted in evidence tables	• Age • Sex • Size of aneurysm • Position of aneurysm • Comorbidities
Search strategies	See Appendix B

Review question 22	**Is CT angiography with post-processing techniques effective compared to CT angiography alone in planning surgery for a ruptured abdominal aortic aneurysm?**
Review strategies	• Appropriate NICE Methodology Checklists, depending on study designs, will be used as a guide to appraise the quality of individual studies. • 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	None identified

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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 questions 10 and 22

Medline Strategy, searched 13th April 2016 **Database: Ovid MEDLINE(R) 1946 to March Week 5 2016** **Search Strategy:**
1 Aortic Aneurysm, Abdominal/
2 (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.
3 Aortic Rupture/
4 (AAA or RAAA).tw.
5 (endovascular* adj4 aneurysm* adj4 repair*).tw.
6 (endovascular* adj4 aort* adj4 repair*).tw.
7 (EVAR or EVRAR or FEVAR or F-EAVAR or BEVAR or B-EVAR).tw.
8 (Anaconda or Zenith Dynalink or Hemobahn or Luminex* or Memoth-erm or Wallstent).tw.
9 (Viabahn or Nitinol or Hemobahn or Intracoil or Tantalum).tw.

Medline Strategy, searched 13th April 2016
Database: Ovid MEDLINE(R) 1946 to March Week 5 2016
Search Strategy:

10 or/1-9
11 X-Rays/
12 (x-ray* or x ray* or xray* or x-radiation* or x radiation* or roentgen ray* or grenz ray* or radiograph*).tw.
13 Aortography/
14 aortograph*.tw.
15 Tomography, X-Ray Computed/ (
16 (cat scan* or ct scan* or cine ct or cine-ct or tomodensitomet*).tw.
17 ((computed or computer assisted or computeriz* or computeris* or electron beam* or axial*) adj4 tomograph*).tw.
18 Four-Dimensional Computed Tomography/
19 (4d ct or 4dct or 4-dimensional CT or four dimensional CT).tw.
20 exp Tomography, Spiral Computed/
21 ((helical or spiral) adj4 ct*).tw.
22 exp Magnetic Resonance Imaging/
23 (nmr tomograph* or mr tomograph* or nmr imag* or mri scan* or functional mri* or fmri* or zeugmatograph* or cine-mri* or cinemri*).tw.
24 (proton spin adj4 tomograph*).tw.
25 ((chemical shift or magnetic resonance or magneti* transfer) adj4 imag*).tw.
26 exp Angiography/
27 (angiograph* or arteriograph*).tw.
28 exp Ultrasonography/
29 (ultrasound* or ultrason* or sonograph* or echograph* or echotomograph*).tw.
30 exp Echocardiography/
31 echocardiograph*.tw.
32 Finite element analysis/
33 (finite adj4 element* adj4 analys*).tw.
34 (finite adj4 element* adj4 comput*).tw.
35 FEA.tw.
36 ((wall adj4 stress adj4 analys*) or (wall adj4 stress adj4 comput*)).tw.
37 exp Computer simulation/
38 Software/
39 Image interpretation, computer-assisted/ or Radiographic image interpretation, computer-assisted/
40 Imaging Three-Dimensional/
41 exp Image enhancement/
42 Stress, mechanical/
43 (stress* adj4 mechanical*).tw.
44 (scan* or imag*).tw.
45 Watchful waiting/
46 (watchful adj4 waiting*).tw.
47 Mass screening/
48 screen*.tw.
49 Population surveillance/
50 surveillan*.tw.

Medline Strategy, searched 13th April 2016 **Database: Ovid MEDLINE(R) 1946 to March Week 5 2016** **Search Strategy:**
51 ((period* or test* or frequen* or regular* or routine* or rate or optimal* or optimis* or optimiz* or repeat* or interval*) adj4 (test* or monitor* or observ* or measur* or assess* or screen* or re-screen* or rescreen* or exam* or evaluat*)).tw.
52 ((aneursym* or sign* or diameter or risk*) adj4 (grow* or siz* or measur* or expan* or ruptur* or tear* or progress* or enlarg* or dilat* or bulg* or evaluat*)).tw.
53 Patient Selection/
54 ((patient or subject or criteria or treatment*) adj4 select*).tw.
55 ((follow-up or follow up) adj4 (visit* or repeat* or monitor* or assess* or care*)).tw.
56 Aftercare/
57 (aftercare or after-care).tw.
58 Disease progression/
59 ((disease or illness or condition) adj4 (progress* or worsen* or exacerbat* or deterior* or course or duration or trajector* or improv* or recur* or relaps* or remission)).tw.
60 or/11-59
61 10 and 60
62 animals/ not humans/
63 61 not 62
64 limit 63 to english language
Note: RCT, Systematic Review and Observational study filters appended to strategy.

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/

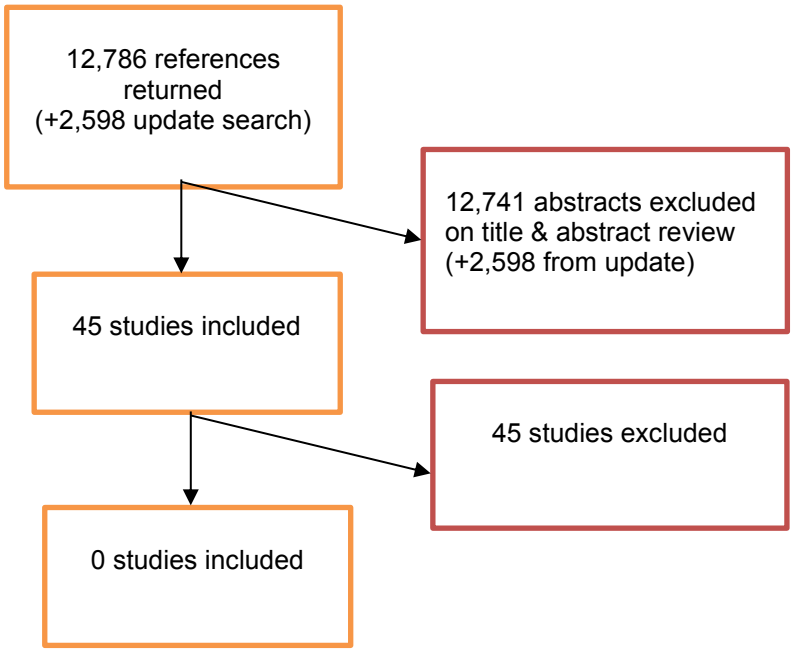
Medline Strategy

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.
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

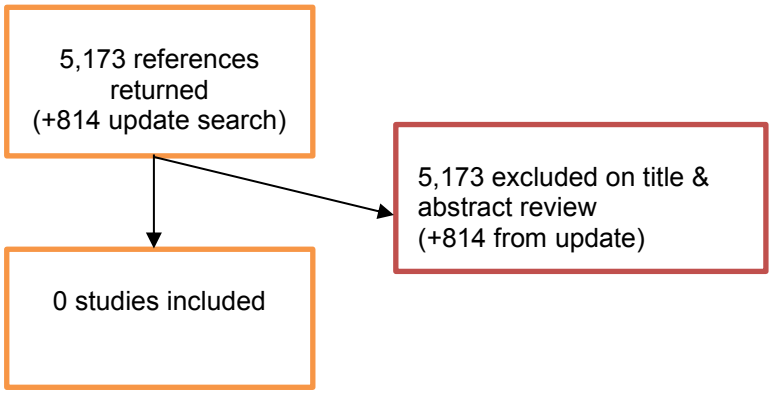
Quality of life
1 "Quality of Life"/
2 quality of life.tw.
3 "Value of Life"/
4 Quality-Adjusted Life Years/
5 quality adjusted life.tw.
6 (qaly* or qald* or qale* or qtime*).tw.
7 disability adjusted life.tw.
8 daly*.tw.
9 Health Status Indicators/
10 (sf36 or sf 36 or short form 36 or shortform 36 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.

Medline Strategy
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 – Economic evidence study selection



Appendix E – Excluded studies

Clinical studies

Short Title	Title	Reason for exclusion
Ahmed (2014)	MDCT interpretation of the ascending aorta with semiautomated measurement software: improved reproducibility compared with manual techniques	Not a relevant intervention and/or comparator
Albrecht (1997)	Pre-operative classification of abdominal aortic aneurysms with spiral CT: the axial source images revisited	Published before 2000 or systematic review containing only papers published before 2000
Bandyk (1989)	Preoperative imaging of aortic aneurysms. Conventional and digital subtraction angiography, computed tomography scanning, and magnetic resonance imaging	Published before 2000 or systematic review containing only papers published before 2000
Beebe (1995)	Aortic aneurysm morphology for planning endovascular aortic grafts: limitations of conventional imaging methods	Published before 2000 or systematic review containing only papers published before 2000
Beebe (1997)	Imaging modalities for aortic endografting	Published before 2000 or systematic review containing only papers published before 2000
Beebe (2000)	Endograft planning without preoperative arteriography: a clinical feasibility study	Not a relevant study design
Beebe (2004)	Computed tomography scanning for endograft planning: evolving toward three-dimensional, single source imaging	Not a relevant study design
Bell (1982)	Routine aortography before abdominal aortic aneurysmectomy. A prospective study	Published before 2000 or systematic review containing only papers published before 2000
Bendick (2003)	Efficacy of ultrasound scan contrast agents in the noninvasive follow-up of aortic stent grafts	No relevant outcomes reported
Brambilla (2015)	Cumulative radiation dose and radiation risk from medical imaging in patients subjected to endovascular aortic aneurysm repair	Not a relevant intervention and/or comparator No relevant outcomes reported
Broeders (1997)	Preoperative sizing of grafts for transfemoral endovascular aneurysm management: A prospective comparative study of spiral CT angiography, arteriography, and conventional CT imaging	Published before 2000 or systematic review containing only papers published before 2000
Broeders (1999)	Preoperative imaging of the aortoiliac anatomy in endovascular aneurysm surgery	Published before 2000 or systematic review containing only papers published before 2000
Carrell (2010)	Feasibility and limitations of an automated 2D-3D rigid image registration system for complex endovascular aortic procedures	Not a relevant intervention and/or comparator

Short Title	Title	Reason for exclusion
Coenegrachts (2003)	Prediction of aortoiliac stent graft length: comparison of a semiautomated computed tomography angiography method and calibrated aortography	Not a relevant intervention and/or comparator
Corriere (2014)	Influence of computed tomography angiography reconstruction software on anatomic measurements and endograft component selection for endovascular abdominal aortic aneurysm repair	Not a relevant study design
de Bruijne (2003)	Localization and segmentation of aortic endografts using marker detection	Not a relevant study design
de Bruijne (2004)	Interactive segmentation of abdominal aortic aneurysms in CTA images	Not a relevant study design
Diehm (2005)	Automated software supported versus manual aorto-iliac diameter measurements in CT angiography of patients with abdominal aortic aneurysms: assessment of inter- and intraobserver variation	Not a relevant study design
Diehm (2008)	Sixty-four-detector CT Angiography of Infrarenal Aortic Neck Length and Angulation: Prospective Analysis of Interobserver Variability	Not a relevant study design
Diethrich (1997)	Will contrast aortography become obsolete in the preoperative evaluation of abdominal aortic aneurysm for endovascular exclusion?	Published before 2000 or systematic review containing only papers published before 2000
Duquette (2012)	3D segmentation of abdominal aorta from CT-scan and MR images	Not a relevant study design No relevant outcomes reported
Durham (1993)	Magnetic resonance angiography in the preoperative evaluation of abdominal aortic aneurysms	Not a relevant intervention and/or comparator Published before 2000 or systematic review containing only papers published before 2000
Eide (2009)	DynaCT during EVAR--a comparison with multidetector CT	Not a relevant intervention and/or comparator
Eide (2011)	DynaCT in pre-treatment evaluation of aortic aneurysm before EVAR	Not a relevant intervention and/or comparator
Engellau (2003)	Measurements before endovascular repair of abdominal aortic aneurysms. MR imaging with MRA vs. angiography and CT	No relevant outcomes reported Measurement not of maximum diameter
Eriksson (1981)	Preoperative evaluation of abdominal aortic aneurysms: is there a need for aortography?	Not a relevant intervention and/or comparator
Errington (1997)	Complete pre-operative imaging assessment of abdominal aortic aneurysm with spiral CT angiography	Published before 2000 or systematic review containing only papers published before 2000
Evancho (1985)	Comparison of NMR imaging and aortography for preoperative evaluation of abdominal aortic aneurysm	Not a relevant intervention and/or comparator

Short Title	Title	Reason for exclusion
		Published before 2000 or systematic review containing only papers published before 2000
Fitzgerald (1996)	Pre-operative computed tomography in abdominal aortic aneurysms	Published before 2000 or systematic review containing only papers published before 2000
Fukuhara (2004)	Evaluation of abdominal aortic aneurysm for endovascular stent-grafting with volume-rendered CT images of vessel lumen and thrombus	Not a relevant intervention and/or comparator
Garret (2003)	Intravascular ultrasound aids in the performance of endovascular repair of abdominal aortic aneurysm	No relevant outcomes reported
Gomes (1994)	Preoperative assessment of abdominal aortic aneurysm: the value of helical and three-dimensional computed tomography	Published before 2000 or systematic review containing only papers published before 2000
Goshima (2013)	Preoperative planning for endovascular aortic repair of abdominal aortic aneurysms: feasibility of nonenhanced MR angiography versus contrast-enhanced CT angiography	No relevant outcomes reported
Hayashi (2005)	Multidetector-row CT evaluation of aortic disease	Study not available
Higashiura (2008)	Impact of 3-dimensional-computed tomography workstation for precise planning of endovascular aneurysm repair	Not a relevant study design
Hilfiker (1999)	In vitro image characteristics of an abdominal aortic stent graft: CTA versus 3D MRA	Published before 2000 or systematic review containing only papers published before 2000
Ho (2004)	Abdominal aortic aneurysms at multi-detector row helical CT: optimization with interactive determination of scanning delay and contrast medium dose	Not a relevant intervention and/or comparator
Imai (2001)	A system for computer-assisted design of stent-grafts for aortic aneurysms using 3-D morphological models	Not a relevant intervention and/or comparator
Kaladji (2010)	Sizing for endovascular aneurysm repair: clinical evaluation of a new automated three-dimensional software	Not a relevant study design
Karcaaltincaba (2005)	Four- and eight-channel aortoiliac CT angiography: a comparative study	Not a relevant intervention and/or comparator
Kauffmann (2015)	Source of errors and accuracy of a two-dimensional/three-dimensional fusion road map for endovascular aneurysm repair of abdominal aortic aneurysm	Not a relevant intervention and/or comparator
Kim (2010)	Uncertainty and validation of health economic decision models	Not a relevant study design

Short Title	Title	Reason for exclusion
Mora (2015)	Maximum Diameter of Native Abdominal Aortic Aneurysm Measured by Angio-Computed Tomography: Reproducibility and Lack of Consensus Impacts on Clinical Decisions	Not a relevant intervention and/or comparator
Morin-Roy (2014)	Impact of contrast injection and stent-graft implantation on reproducibility of volume measurements in semiautomated segmentation of abdominal aortic aneurysm on computed tomography	Not a relevant intervention and/or comparator
Sobocinski (2013)	The benefits of EVAR planning using a 3D workstation	Not a relevant study design

Economic studies

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

Appendix F – 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.