National Institute for Health and Care Excellence

Draft for consultation

Abdominal aortic aneurysm: diagnosis and management

Evidence review P: Time period for transfer to regional vascular services

NICE guideline <number>

Evidence reviews

May 2018

Draft for Consultation

Commissioned by the National Institute for Health and Care Excellence

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:

Contents

The time period for transfer to regional vascular services

Review question

Within what time period should people with suspected ruptured or symptomatic unruptured abdominal aortic aneurysms be transferred from a nonspecialist setting to a regional vascular services?

Introduction

This review question aims to determine:

- whether there is a difference in patient morbidity and mortality following different transfer periods.
- the maximum transfer timethat is acceptable to people with abdominal aortic aneurysms (AAA)s and clinicians.

PICO

Table 1: Inclusion criteria

Parameter	Inclusion criteria
Population	People with a suspected or confirmed ruptured or symptomatic unruptured AAA who need to be transferred to a regional vascular service
Intervention	Transfer times of varying durations 'Time from' is the time measured from any of the following starting points: • symptom onset • clinician assessment in a nonspecialist setting 'Time to' is the time to any of the following endpoints: • time to leaving nonspecialist setting • time to arrival in specialist unit • time to assessment by a specialist • time to a definitive diagnosis • time to assessment for surgery • time to surgical intervention • time to arrival of ambulance
Comparator	Each other
Outcome	• Mortality • Resource use, including length of hospital stay, and cost • Exclusion: • Non-English language • Abstract/non-published

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 'bulk' search was performed covering 2 review questions relating topatient transfer. 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.

Studies were considered for inclusion if they were were randomised controlled trials, quasi-randomised controlled trials, non-randomised controlled trials, before-and-after studies or systematic reviews (of the aformentoned study types) exploring differences in patient morbidity and mortality following different transfer periods.

Studies were excluded if they:

- 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

Initial literature searches identified 572 abstracts. Of these, 4 were identified as being potentially relevant. Following full-text review of the 4 articles, no studies were included.

An update search was conducted in December 2017, to identify any relevant studies published during guideline development. The search found 10 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.

Summary of clinical studies included in the evidence review

No studies were included following full text review.

Quality assessment of clinical studies included in the evidence review

No studies were included following full text review.

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 the review question. No full texts were retrieved, and 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 identified.

Excluded studies

No studies were retrieved for full-text review.

Evidence statements

No evidence was identified for this review question.

Recommendations

P1. When people with a suspected ruptured or symptomatic unruptured AAA have been accepted by a regional vascular service for emergency assessment, ensure that they leave the referring unit within 30 minutes of the decision to transfer.

P2. Emergency departments, ambulance services and regional vascular services should collaborate to:

- provide a protocol for the safe and rapid transfer of people with a suspected ruptured or symptomatic unruptured AAA who need emergency assessment at a regional vascular service
- train clinical staff involved in the care of people with a suspected ruptured or symptomatic unruptured AAA in the transfer protocol
- review the transfer protocol at least every 3 years.

Research recommendations

RR7. Within what time period should people with suspected ruptured or symptomatic unruptured AAAs be transferred from a nonspecialist setting to a regional vascular service?

Rationale and impact

Why the committee made the recommendations

There was no evidence on how quickly people should be transferred to regional vascular units. In the absence of evidence, the committee adapted recommendations from the NICE guideline on service delivery for major trauma. They agreed, based on their experience of emergency transfer, that the timing specified for people with major trauma was appropriate for people with AAA and manageable for referring units.

Impact of the recommendations on practice

The recommendations on transfer speed will minimise variations in transfer times across the NHS. The timeframe recommended is the same as for major trauma, and the committee agreed that this is a reasonably similar situation.

The committee's discussion of the evidence

Interpreting the evidence

The outcomes that matter most

The committee agreed that the outcomes that matter most are incidence of aneurysm rupture (in people with symptomatic unruptured AAA) and mortality.

The quality of the evidence

The committee noted that, although there is no evidence on appropriate timeframes within which people with suspected or confirmed emergency AAAs should be transferred to a regional vascular service, non-evidence-based transfer policies have been adopted across NHS trusts. The transfer policies vary between trusts. In light of this, the committee agreed that it was important to recommend a standard that all trusts can work towards. The committee noted that the NICE guideline covering organisation and provision of major trauma services (NICE guideline NG40) made recommendations relating to the transfer of major trauma patients between emergency departments. The committee noted that the consensus recommendations in NICE guideline NG40 were drafted in the context of penetrating or blunt force trauma. They believed that this context was similar enough to ruptured AAA to adopt a similar logic – that there is a need to avoid any delay in specialist assessment and/or treatment. The committee were also in agreement that recommendations outlining a need for transfer protocols were important to ensure that emergency departments are suitably prepared for people with suspected ruptured AAA. For this reason, the committee decided to borrow and amend recommendations from NICE guideline NG40. The committee chose to tailor recommendations and not cross-refer to NICE NG40 as they felt that the recommendations would have greater strength within the AAA guideline. The committee were also mindful that future evidence may suggest that optimal transfer times differ between people with AAA and those who experience major trauma. As a result, they recommended research specific to people with ruptured AAA as they believed that there would be some value in reviewing any evidence on this population separately.

Benefits and harms

The committee considered that a clear benefit of the recommendations is that they provide a framework for standardising transfer policies across the country. This, in turn, will improve patients' chances of survival. The committee noted that harms may arise from transferring people with suspected ruptured AAA across long distances, only to find out that they do not have a rupture. The committee considered that the chances of this type of situation happening in practice are small.

Cost effectiveness and resource use

The committee believed that the recommendations would have negligible impact on resources as the recommendation relating to transfer times is in line with pre-existing national standards for emergency transfers. The committee were in agreement that recommending the implementation of a transfer protocol would not impact on resources as there is formal training required: the training proposed by the committee is related to processes, as opposed to skill- or knowledge-based training.

Other factors the committee took into account

The committee discussed whether it was possible to specify the duration of patient transfers (travel times). It was noted that there was no direct evidence on people with ruptured aneurysms or indirect evidence that was applicable. Furthermore, the committee acknowledged that centralisation of specialist services can affect transfer times in ways that are out of the control of clinicians.

Appendices

Appendix A – Review protocol

Review protocol for assessing the time period for transfer to regional vascular services

Review question 17	Within what time period should people with suspected ruptured or symptomatic unruptured abdominal aortic aneurysms be transferred from a nonspecialist setting to a regional vascular service?
Objectives	Is there a difference in patient morbidity and mortality following different transfer periods? What is the maximum time that is acceptable to patients and clinicians?
Type of review	Intervention
Language	English only
Study design	Systematic reviews of study designs listed below Randomised controlled trials Quasi-randomised controlled trials Non-randomised controlled trials Before-and-after studies
Status	Published papers only (full text) No date restrictions
Population	People with a suspected or confirmed ruptured or symptomatic unruptured abdominal aortic aneurysm who need to be transferred to a regional vascular service
Intervention	Transfer times of varying durations 'Time from' is the time measured from any of the following starting points: • symptom onset • clinician assessment in a nonspecialist setting 'Time to' is the time to any of the following endpoints: • time to leaving nonspecialist setting • time to arrival in specialist unit • time to assessment by a specialist • time to a definitive diagnosis • time to assessment for surgery • time to surgical intervention • time to arrival of ambulance
Comparator	Each other
Outcomes	Mortality Resource use, including length of hospital stay, and cost
Other criteria for inclusion / exclusion of studies	Exclusion: Non-English language Abstract/non-published (i only)
Baseline characteristics to be extracted in evidence tables	Age Sex Size of aneurysm Comorbidities Details about setting
Search strategies	See Appendix B

Review question 17	Within what time period should people with suspected ruptured or symptomatic unruptured abdominal aortic aneurysms be transferred from a nonspecialist setting to a regional vascular service?
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

1

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 17

Medline Strategy, searched 4th October 2017 **Database: Ovid MEDLINE(R) <1946 to September Week 3 2017>** **Search Strategy:**	
1	Aortic Rupture/
2	RAAA.tw.
3	1 or 2
4	Aortic Aneurysm, Abdominal/
5	(Aneurysm* adj4 (abdom* or thoracoabdom* or thoraco-abdom* or aort* or spontan*)).tw.
6	((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*) adj4 aneur?sm*).tw.
7	AAA.tw.
8	or/4-7
9	(aort* adj4 (balloon* or dilat* or bulg* or expan*)).tw.

10 (ruptur* or tear* or bleed* or trauma* or burst* or large* or big*).tw.
11 symptom*.tw.
12 or/9-11
13 8 and 12
14 3 or 13
15 Patient transfer/
16 "Transportation of Patients"/
17 "continuity of patient care"/ or patient handoff/
18 ((clinical or patient* or intershift* or nurs* or physician* or shift or staff*) adj4 (handover* or hand-off or handoff or hand off)).tw.
19 (transition* adj4 care).tw.
20 og.fs.
21 Ambulances/
22 ambulance*.tw.
23 (emergency adj4 (unit* or vehicle* or paramedic* or transport* or transfer*)).tw.
24 ((transfer* or transport* or travel* or move* or moving or continuity or transition* or hando* or journey* or arriv*) adj4 (hospital* or intrahospital* or emergenc* or paramedic* or facilit* or "cardiothoracic unit*" or "vascular unit*" or "vascular centre*" or "vascular center*" or "vascular service*" or "endovascular unit*" or "specialist unit*" or "specialist centre*" or "specialist center*" or "specialist service*" or "endovascular centre*" or "endovascular center*" or "endovascular service*" or "primary care" or "secondary care" or "tertiary care" or "tertiary centre*" or "tertiary center*" or "referral centre*" or "referral center*" or centrali* or regionali*)).tw.
25 (patient* adj4 (transfer* or transport* or travel* or move* or moving or continuity or transition* or hando* or journey* or arriv*)).tw.
26 ((transfer* or transport* or travel* or transition* or hando* or journey* or arriv*) adj4 (quick* or delay* or slow* or fast* or speed* or time* or length* or duration or mode)).tw.
27 ((interfacilit* or inter facilit* or intrafacilit* or intra facilit* or inter hospital* or interhospital* or intrahospital* or intra hospital*) adj4 (transfer* or travel* or move* or moving)).tw.
28 Time-to-treatment/
29 "time to treatment".tw.
30 "door to treatment".tw.
31 antifibrinolytic agents/
32 (antifibrinoly* or antiplasmin*).tw.
33 ((plasmin or fibrinoly*) adj4 inhibitor*).tw.
34 Tranexamic Acid/
35 ((tranexam* or tranex-am* or tranex am* or tranexan* or tranex-an* or tranex an*) adj4 acid*).tw.
36 TXA.tw.
37 or/15-36
38 14 and 37
39 animals/ not humans/
40 38 not 39
41 limit 40 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)

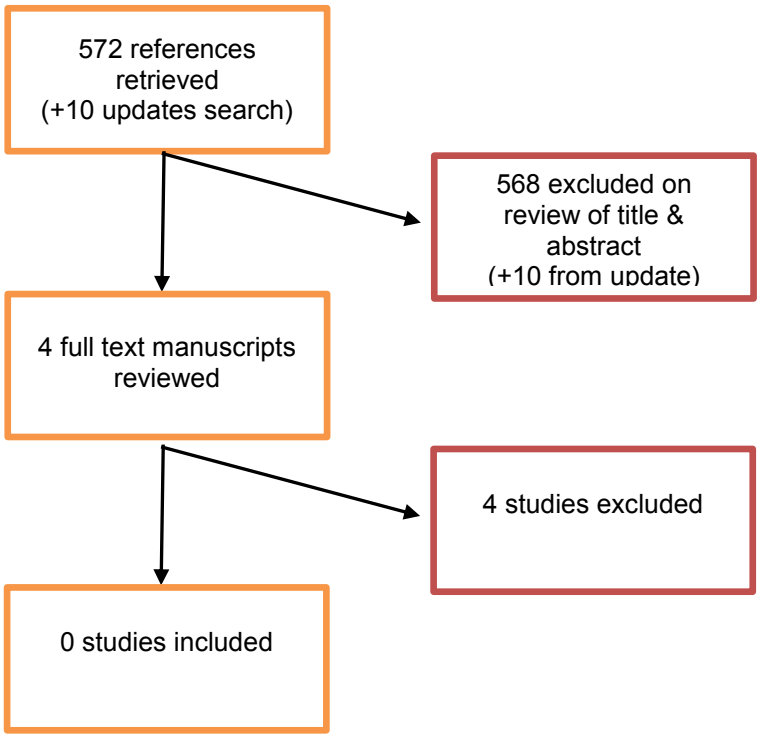
Search filters to retrieve economic evaluations and quality of life papers were appended to the population and intervention terms to identify relevant evidence. Searches were not undertaken for qualitative RQs. For social care topic questions additional terms were added. Searches were re-run in September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

Health economics search strategy

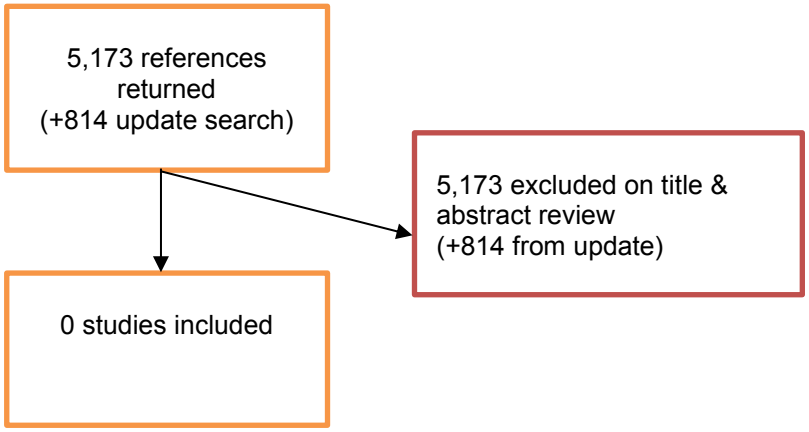
Medline Strategy
Economic evaluations 1 Economics/ 2 exp "Costs and Cost Analysis"/ 3 Economics, Dental/ 4 exp Economics, Hospital/ 5 exp Economics, Medical/ 6 Economics, Nursing/ 7 Economics, Pharmaceutical/ 8 Budgets/ 9 exp Models, Economic/ 10 Markov Chains/ 11 Monte Carlo Method/ 12 Decision Trees/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

Medline Strategy
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 – Economic evidence study selection



Appendix E – Excluded studies

Clinical studies

No.	Study	Reason for exclusion
1	Farooq M M, Freischlag J A, Seabrook G R, Moon M R, Aprahamian C, and Towne J B (1996) Effect of the duration of symptoms, transport time, and length of emergency room stay on morbidity and mortality in patients with ruptured abdominal aortic aneurysms. Surgery 119(1), 9-14	Retrospective observational study that did not explore predefined transport times. Instead, authors calculated the median time interval between symptom onset and surgical intervention then they compared outcomes of patients with times below and above the median. No differences were observed between groups.
2	Mell Matthew W, Wang Nancy E, Morrison Doug E, and Hernandez-Boussard Tina (2014) Interfacility transfer and mortality for patients with ruptured abdominal aortic aneurysm. Journal of vascular surgery 60(3), 553-7	This retrospective study did not assess factors associated with suitability for transfer. Instead, investigators assessed factors associated with likelihood of transfer by comparing patients with ruptured aneurysms who were transferred to other hospitals and those who were not transferred. It is unclear whether the patients were transferred to specialist vascular units. Furthermore, the assessed risk factors were focussed on a USA context and were not relevant to those specified in the review protocol: for example, type of healthcare insurance, state (California vs. Florida, or New York), teaching hospital, high-tech hospital.
3	Pasternak J, Nikolic D, Popovic V, and Vucaj-Cirilovic V (2012) The importance of timing in surgical treatment of unruptured symptomatic aneurysm of abdominal aorta. Bratislavske lekarske listy 113(11), 652-6	Retrospective observational study that did not explicitly assess the impact on transfer times on mortality. Instead, authors compared timing of surgical treatment in patients who were already admitted at specialist vascular units.
4	Ten Bosch, Jan A, Koning Sam W, Willigendael Edith M, Van Sambeek , Marc R, Stokmans Rutger A, Prins Martin H, and Teijink Joep A (2016) Symptomatic abdominal aortic aneurysm repair: to wait or not to wait. The Journal of cardiovascular surgery 57(6), 830-838	Retrospective observational study.

Economic studies

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

Appendix F – Research recommendation

Research recommendation	Within what time period should people with suspected ruptured or symptomatic unruptured abdominal aortic aneurysms be transferred from a nonspecialist setting to a regional vascular service?
Population	People with a suspected or confirmed ruptured or symptomatic unruptured abdominal aortic aneurysm who need to be transferred to a regional vascular service
Timeframes of interest	Transfer times of varying durations: • time from symptom onset • time from clinician assessment (in a nonspecialist setting) • time to leaving nonspecialist setting • time to arrival in specialist unit • time to assessment by a specialist • time to a definitive diagnosis • time to assessment for surgery • time to surgical intervention • time to arrival of ambulance
Endpoints	• Mortality • Complications • Resource use, including length of hospital stay, and cost
Study design	Observational studies

Potential criterion	Explanation
Importance to patients, service users or the population	AAA rupture is a serious condition that poses an immediate threat to life. People who present with ruptured AAA usually elderly, and have multiple pre-existing medical conditions that are exacerbated by hypotension caused by profuse bleeding. As a result, it is crucial that emergency departments and ambulance services minimise any delay in getting patients to regional vascular services so they can receive aortic intervention. Currently, the optimal timeframe in which patients need to receive treatment for AAA rupture is unknown. Identifying this timeframe will ensure that a quality standard can be set and maintained within the NHS.
Relevance to NICE guidance	Medium priority: in the absence of evidence, the committee chose to draft recommendations by adopting and adapting recommendations from NICE guidance on organisation and provision of major trauma services (NICE guideline NG40). Observational data specific to people with rupture AAA would help determine whether different timeframes for transfer should be outlined.
Current evidence base	No evidence was found that assessed whether outcomes of patients with ruptured AAA varied according to the timeframe in which they were transferred to specialist centres to receive aortic intervention.
Equality	No specific equality concerns are relevant to this research recommendation.
Feasibility	There is a sufficiently large and well defined population available that large observational studies should be feasible

Appendix G – 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.