

# E-vita open plus for treating complex aneurysms and dissections of the thoracic aorta

Medical technologies guidance

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[www.nice.org.uk/guidance/mtg16](https://www.nice.org.uk/guidance/mtg16)

## Your responsibility

This guidance represents the view of NICE, arrived at after careful consideration of the evidence available. When exercising their judgement, healthcare professionals are expected to take this guidance fully into account, and specifically any special arrangements relating to the introduction of new interventional procedures. The guidance does not override the individual responsibility of healthcare professionals to make decisions appropriate to the circumstances of the individual patient, in consultation with the patient and/or guardian or carer.

All problems (adverse events) related to a medicine or medical device used for treatment or in a procedure should be reported to the Medicines and Healthcare products Regulatory Agency using the [Yellow Card Scheme](#).

Commissioners and/or providers have a responsibility to implement the guidance, in their local context, in light of their duties to have due regard to the need to eliminate unlawful discrimination, advance equality of opportunity, and foster good relations. Nothing in this guidance should be interpreted in a way that would be inconsistent with compliance with those duties. Providers should ensure that governance structures are in place to review, authorise and monitor the introduction of new devices and procedures.

Commissioners and providers have a responsibility to promote an environmentally sustainable health and care system and should [assess and reduce the environmental impact of implementing NICE recommendations](#) wherever possible.

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# 1 Recommendations

NICE medical technologies guidance addresses specific technologies notified to NICE by sponsors. The 'case for adoption' is based on the claimed advantages of introducing the specific technology compared with current management of the condition. This case is reviewed against the evidence submitted and expert advice. If the case for adopting the technology is supported, then the technology has been found to offer advantages to patients and the NHS. The specific recommendations on individual technologies are not intended to limit use of other relevant technologies which may offer similar advantages.

- 1.1 The case for adopting the E-vita open plus for treating complex aneurysms and dissections of the thoracic aorta, in a carefully selected group of people, is supported by the evidence.
- 1.2 Using the E-vita open plus could remove the need for a second procedure and the associated risk of serious complications, and it should therefore be considered for people:
  - who would otherwise need a 2-stage repair procedure because their aortic disease extends into or beyond the distal part of their aortic arch (into the proximal descending aorta), **but**
  - who would not need additional intervention (such as stent grafting) in the descending aorta.
- 1.3 The E-vita open plus is estimated to generate cost savings compared with current 2-stage repair from about 2 years after the procedure. The estimated cost saving per patient at 5 years after the procedure is around £13,334 when compared with 2-stage repair involving open insertion of a vascular graft, £10,225 when compared with 2-stage repair involving endovascular stent grafting and £12,536 when compared with open surgical debranching followed by endoluminal stent grafting. At 10 years after the procedure, the estimated cost savings range from around £22,704 to £29,210 across the 3 comparators (see [section 5.23](#)). **[2018]**

## 2 The technology

### Description of the technology

- 2.1 The E-vita open plus (JOTEC GmbH) is an endoluminal stent graft system designed for treating aneurysms and dissections of the thoracic aorta. The device is a 1-piece polyester fabric tube which combines a conventional vascular graft attached to an endovascular stent graft that allows treatment of the ascending aorta at the same time as the arch and descending aorta. The E-vita open plus supersedes its immediate predecessor device, the E-vita open. The 2 devices are similar in design and function but the E-vita open plus is impermeable to blood, and fibrin glue is not needed to seal the stent graft.
- 2.2 The E-vita open plus is a single-use device with a shelf life of 2 years. It is supplied sterile and pre-loaded in its delivery system. The device is available in a range of sizes with varying diameters and lengths. The delivery system consists of a release handle, nested catheters and a positioning aid. A luer connector is also incorporated to allow flushing of the inner guide catheter. A stiff guide wire is used to aid tracking of the device delivery. Radiopaque markers are integrated into the fabric of the graft for radiological imaging.
- 2.3 The E-vita open plus received a CE mark in October 2008 for the repair or replacement of the thoracic aorta in cases of complex aneurysms or dissections that involve the ascending aorta, the aortic arch and the descending aorta.
- 2.4 The E-vita open plus is used in a single-stage procedure known as a 'frozen elephant trunk'. The thoracic aorta is surgically opened with access through a median sternotomy approach. The distal stent graft portion of the device is self-expanding, containing nitinol springs, and is used to treat the upper part of the descending aorta. The vascular graft part of the device (for repair of the arch and ascending aorta) is invaginated in the distal stent graft portion. The stent graft, in its delivery system, is inserted into the descending aorta and deployed by retracting a retaining sheath. Once the stent graft is in place, the delivery system is removed and the proximal vascular graft component is drawn out a short distance (5 mm to 10 mm). The stent graft is then surgically anastomosed to the

distal aorta. The vascular graft portion of the device is then drawn out fully and used to repair the ascending aorta and arch in a standard surgical fashion. The aortic branch vessels are attached to the vascular graft using a patch and the graft is anastomosed to the ascending aorta.

2.5 The cost of the E-vita open plus stated in the sponsor's submission was £10,500 excluding VAT.

2.6 The claimed benefits of the E-vita open plus in the case for adoption presented by the sponsor are:

- repair of the ascending aorta, arch and descending aorta in a single-stage procedure
- a reduction in pain and discomfort
- elimination of the psychological distress associated with the anticipation of a second procedure
- a reduction in treatment times and costs
- a reduction in total end-organ ischaemia
- a reduction in incisional complications and infections
- a reduction in anaesthetic use and the elimination of the need for additional epidural pain management
- a reduction in both total length of stay and intensive care unit length of stay
- a reduction in rehabilitation time
- an earlier return to normal activities and work.

## Current management

2.7 The management of thoracic aortic aneurysms and dissections is determined by the location, severity and rate of change of the disease, as well as the clinical circumstances. Thoracic aortic aneurysms result from a weakening of the aortic

wall, leading to localised dilation. People with thoracic aneurysms are often observed with clinical and imaging surveillance. Invasive treatment may be offered depending upon the size and rate of enlargement of the aneurysm.

- 2.8 Aortic dissections result from a tear in the inner layer of the aorta. Blood flows through the tear, separating the layers of the wall. Acute aortic dissections are less than 2 weeks old, and chronic dissections have been present for longer than 2 weeks. Management of aortic dissections depends primarily on their location. Emergency surgery is usually offered for a Stanford type A aortic dissection, which affects the ascending thoracic aorta and often also the arch and descending aorta. Stanford type B dissections, typically involving the descending thoracic aorta, are often managed with conservative medical treatment. Elective surgical repair is sometimes undertaken, but endovascular repair with stent grafts is more commonly used.
- 2.9 There are 3 main current methods of surgically treating complex aneurysms and dissections of the thoracic aorta, 2 of which involve a 2-stage 'elephant trunk' procedure. Both approaches are similar in their first stage but use alternative repair techniques to complete the second stage. During the first stage, the ascending aorta and arch are repaired with a vascular graft through a median sternotomy. During this procedure a free-floating extension of the arch graft prosthesis (the 'elephant trunk') is left unattached in the descending aorta. Attaching it (and extending it as necessary) may be done by an endovascular procedure during which a stent graft is inserted into the descending aorta with access via the femoral artery (thoracic endovascular aortic repair – TEVAR). Alternatively the descending aorta may be repaired in a second surgical procedure some weeks or months later, by extending the 'elephant trunk' as necessary, through a lateral thoracotomy approach. The third method involves 'debranching' of the head and neck vessels from the aortic arch by creating a surgical anastomosis between the ascending aorta and the head and neck vessels using a vascular graft. This then allows an endoluminal stent graft to be inserted into the aortic arch and descending aorta either as a hybrid procedure (during the same operation) or at a second-stage operation.

## 3 Clinical evidence

### Summary of clinical evidence

- 3.1 Full details of all clinical outcomes considered by the committee are available in the [assessment report overview](#).
- 3.2 The key clinical outcomes for the E-vita open plus presented in the decision problem were:
- completion and success of technical procedure(s)
  - mortality
  - major complications, for example stroke, paraplegia, renal failure, myocardial infarction and other events that may delay discharge
  - length of intensive care unit stay
  - total length of hospital stay
  - freedom from further interventions
  - long-term survival rates
  - incidence of junctional endoleak
  - device-related adverse events.
- 3.3 The sponsor identified 13 papers relevant to the E-vita open plus. Most of these were derived from the International E-vita Open Registry, which is reported to contain data on 70% to 80% of patients in 11 European centres who have received the E-vita open or open plus devices to treat their complex aortic disease. The sponsor excluded 10 (of the 13) papers from further consideration, either because the data were already included in a more recent report on the entire register dataset at the time of publication (Jakob et al. 2011), or because they reported on small numbers of patients or on animal studies. The external assessment centre excluded a further 2 papers from its evaluation: a small study

with limited follow-up, and a study using the same data as the paper by Jakob et al. (2011). The external assessment centre judged that the principal clinical evidence for the E-vita open plus was presented in the observational study on the International E-vita Open Registry by Jakob et al. (2011).

3.4 Jakob et al. (2011) reported observational data, gathered between January 2005 and December 2010, for 274 patients with complex aortic disease enrolled in the International E-vita Open Registry from, at the time, 8 European centres. This comprised the entire dataset at the time of publication. Details of the 274 patients treated, in terms of condition and interventions, are shown in tables 1 and 2. Outcomes were presented as proportions and survival analysis was carried out using the Kaplan–Meier technique. Stent-graft deployment and arch replacement were carried out under selective antegrade cerebral perfusion during a mean time of 75 minutes. Median length of hospital stay was 19 days (range 12 to 29). Adverse events are shown in table 3. For patients with dissections the false lumen was assessed postoperatively and at a median time of 59 months (range 28 to 99) after surgery. The false lumen thrombosed fully in 83% (62 of 75) of patients with acute aortic dissection, and 72% (68 of 94) of patients with chronic aortic dissection. After follow-up these figures rose to 93% and 92% respectively. For patients with aneurysms, complete exclusion of the aneurysm was achieved in 77% of cases (61 of 79). The overall 5-year survival rate was 74%. Of the 233 patients surviving the procedure initially, secondary endovascular intervention was needed in 13% (29) and surgery downstream was needed in 3% (6) of cases.

**Table 1 Conditions for patients enrolled in the International E-vita Open Registry (Jakob et al. 2011)**

Condition	Included patients (n=274)	Emergency surgery	Previous proximal repair
Presenting with acute aortic dissection	88 (32%)	77 (88%)	-
Presenting with chronic aortic dissection	102 (37%)	-	71 (70%)
Presenting with thoracic aortic aneurysm	84 (31%)	-	-
Underlying condition of Marfan's syndrome	12 (5%)	-	-

**Table 2 Interventions for patients enrolled in the International E-vita Open Registry (Jakob et al. 2011)**

Interventions received during treatment with the E-vita open plus	Included patients (n=274)	Emergency surgery	Previous proximal repair
Arch replacement with E-vita open plus	151 (55%)	-	-
Arch replacement with other prosthesis	123 (45%)	-	-
Additional coronary artery bypass graft	43 (16%)	-	-

3.5 The sponsor presented limited evidence on clinical outcomes for 2-stage procedures to allow comparison with those for the E-vita open plus. The external assessment centre therefore carried out a systematic review and meta-analysis of available data for the comparator procedures. The review identified 10 papers and the meta-analysis provided pooled estimates of outcome rates with 95% confidence intervals for in-hospital and 30 day mortality, stroke, bleeding, paraplegia and renal failure, which were the main complications reported in the literature. The external assessment centre was unable to calculate single outcome estimates for the combined 2-stage procedures because of a lack of data. It judged that direct comparisons between the E-vita open plus and the comparators would therefore be complex and that the figures did not take into account factors such as survival from stage 1 to 2 or the impact of the combined outcomes for each procedure. Long-term survival rates could not be included in the meta-analysis because no confidence intervals were reported and individual patient data were not available. The pooled estimate data for the comparators are shown in table 3.

**Table 3 Adverse events for the E-vita open plus, as reported in Jakob et al. (2011), and comparators**

	Stage	E-vita open plus (Jakob et al. 2011),	2-stage open surgical repair with vascular graft placement,	2-stage repair with endovascular stent graft placement	Open surgical 'debranching' with endoluminal stent graft placement (2-stage procedure)
In-hospital mortality	1	41 (15.0%; 11.0% to 19.7%)	8.5% (6.4% to 11.1%)	8.9% (3.4% to 21.4%)	13.5% (4.5% to 28.8%)
In-hospital mortality	2	-	8.0% (5.6% to 11.2%)	9.6% (4.4% to 19.8%)	3.7% (0.1% to 19.0%)

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	Stage	E-vita open plus (Jakob et al. 2011),	2-stage open surgical repair with vascular graft placement,	2-stage repair with endovascular stent graft placement	Open surgical 'debranching' with endoluminal stent graft placement (2-stage procedure)
30-day mortality	1	33 (12.0%; 8.4% to 16.5%)	7.5% (5.4% to 10.5%)	-	-
30-day mortality	2	-	5.9% (1.6% to 19.0%)	3.2% (0.08% to 16.7%)	-
Re-exploration for bleeding	1	38 (13.9%; 10.0% to 18.5%)	4.6% (2.8% to 7.4%)	4.2% (0.1% to 21.1%)	8.1% (1.7% to 21.9%)
Re-exploration for bleeding	2	-	3.7% (1.7% to 7.8%)	5.6% (0.1% to 27.3%)	-
Stroke	1	16 (5.8%; 3.4% to 9.3%)	3.4% (2.3% to 4.9%)	7.4% (3.3% to 16.1%)	8.1% (1.7% to 21.9%)
Stroke	2	-	3.9% (1.1% to 13.0%)	-	3.7% (0.1% to 19.0%)
Paraplegia	1	22 (8.0%; 5.1% to 11.9%)	-	4.2% (0.1% to 21.1%)	-
Paraplegia	2	-	4.1% (1.6% to 9.8%)	7.8% (3.0% to 19.1%)	-
Renal failure (permanent)	1	10 (3.6%; 1.8% to 6.6%)	8.5% (3.4% to 19.6%)	12.5% (2.7% to 32.4%)	-
Renal failure (permanent)	2	-	6.0% (1.1% to 27.6%)	-	-

95% confidence intervals were calculated by the external assessment centre, and pooled outcome estimates for the comparator technologies were taken from the external assessment centre's meta-analysis.

3.6 During consultation, an additional clinical report was identified that presented

more recent data from the International E-vita Open Registry (Jakob and Tsagakis, 2013). The paper reported outcomes for in-hospital mortality, stroke, paraplegia and 5-year survival rates for a total of 416 patients from 11 international centres. No outcomes were reported for 30-day mortality, bleeding or renal failure. Figures for 5-year survival rates were reported for 3 subgroups but no overall figure was reported or could be calculated from the data presented. The external assessment centre determined that, overall, there was insufficient information available, in terms of completeness or long-term follow-up, to provide additional reliable estimates of outcome rates beyond those derived from the Jakob et al. (2011) study (see section 3.4).

## Committee considerations

- 3.7 The committee considered that the clinical evidence was limited because it was restricted to observational studies. However, it considered that the evidence was sufficient, when taken together with clinical expert advice, to conclude that the E-vita open plus is effective for use in a selected group of people (see sections 3.10 to 3.11).
- 3.8 The committee considered that the pooled estimates of outcomes for the comparators produced by the external assessment centre indicated that more bleeding would be likely to occur with the E-vita open plus (13.9%) than with the comparators (ranging from 4.2% to 8.1% at stage 1, and from 3.7% to 5.6% at stage 2). The committee was advised that bleeding was a complication experienced with both the E-vita open plus and the comparators and that excess bleeding with the E-vita open plus may have reflected incorrect choice of device size during early experiences of its use. It was mindful that bleeding is a complication which is normally controlled at the time of surgery, without patients experiencing long-lasting adverse consequences, in contrast to the other major adverse events (stroke, paraplegia and renal failure) which may have serious consequences for patients in the long term.
- 3.9 The committee was advised that patient selection would be important in realising the claimed benefits of the E-vita open plus. The committee heard expert clinical advice that the E-vita open plus is primarily suitable for people needing aortic arch repair and that the device enables repair to the arch to be completed more

rapidly than by other techniques. Expert advice also confirmed that in people whose aortic disease extends less than 10 cm into the descending aorta (based on the size of the stent graft portion of the device), the E-vita open plus would allow a complex repair in a single procedure.

- 3.10 The committee concluded that in people with aneurysms or acute aortic dissections needing repair of the aortic arch and ascending aorta, if the disease extends less than 10 cm into the descending aorta, the E-vita open plus would be a suitable treatment. The committee recognised that the E-vita open plus might be suitable for use in other people with more extensive disease in the descending aorta that would need multiple stent grafts. However, it decided that the potential benefits of the technology for these people were not clear, based on the evidence presented. The committee therefore considered that making a recommendation for use of the technology in those with more extensive disease in the descending thoracic aorta was not possible.
- 3.11 The committee was advised that many people for whom treatment with the E-vita open plus would be suitable have progressive aortic disease that would need further interventions, regardless of whether the repair was carried out in a single or 2-stage procedure. It was advised that this is significantly more likely in people with connective tissue disorders such as Marfan's syndrome than in those with atherosclerotic disease.
- 3.12 The committee judged that the main advantage of the E-vita open plus is the avoidance of a second procedure with its associated serious risks, which include stroke, renal failure, paraplegia and bleeding. The committee was advised by clinical experts that some people decide not to return for a second procedure because of negative experiences from the first operation. The committee considered that the opportunity to repair the aorta in a single procedure would confer significant benefits to these people.
- 3.13 The committee was advised by clinical experts that the estimate in the scope for the number of people in England (50 to 100 per year) eligible for treatment was reasonable.
- 3.14 The committee considered the paper by Jakob and Tsagakis (2013), but judged that the outcomes it reported did not add to the evidence base for the E-vita

open plus: no data for 30-day mortality, bleeding or renal failure were reported. It considered that the included outcome data did not differ significantly from those reported by Jakob et al. (2011) and would not alter the outcomes from the external assessment centre's cost analysis.

## 4 NHS considerations

### System impact

- 4.1 The sponsor stated that using the E-vita open plus could allow repair of the thoracic aorta in a single procedure, when a 2-stage procedure would otherwise be necessary. It claimed that this would consequently reduce overall length of stay in hospital and reduce the risk of complications needing hospital treatment. The clinical evidence consisted of the study by Jakob et al. (2011), which contained no comparative data about resource use during other aortic repair techniques. The review and meta-analysis carried out by the sponsor focused on clinical outcomes rather than resource implications.

### Committee considerations

- 4.2 The committee was satisfied that a second repair procedure could be avoided by using the E-vita open plus in a selected group of people and that this could reduce associated NHS resource use.
- 4.3 The committee was advised that aortic repair using the E-vita open plus is a highly specialised procedure, carried out in a small number of centres, in a small patient group. Despite these limitations, the committee considered that the potential benefits of releasing operating theatre and clinical time by avoiding the need for a second procedure could be significant. It recognised that the resources needed for treating complications associated with a second procedure (some of which would be severe and would result in long-term disability) would also be released.

## 5 Cost considerations

### Cost evidence

- 5.1 Neither the sponsor nor the external assessment centre identified any relevant published economic evidence for the E-vita open plus or for the comparator techniques.
- 5.2 The sponsor submitted a de novo analysis comparing the use of the E-vita open plus against a 2-stage classical 'elephant trunk' procedure in terms of overall costs, in-hospital mortality and adoption rates. The population was a cohort of 3,500 people with aneurysms, dissections and other specified lesions of the thoracic aorta. The model consisted of 2 decision trees over a 1-year time horizon:
- a current practice model using the classical 'elephant trunk' procedure
  - an intervention model comparing current practice against use of the E-vita open plus at a 40% adoption rate.
- 5.3 The first stage of the current practice arm was divided into 2 options: woven graft or branched graft. For patients undergoing stage 2, the options were woven graft (open surgery) or endovascular stent graft. Following clarification from the sponsor, these options were further defined as follows:
- Woven graft at stages 1 and 2 referred to 2-stage open surgical repair with vascular graft placement.
  - Woven graft followed by stent graft at stage 2 referred to 2-stage repair with open surgical graft placement in the ascending aorta and arch and endovascular stent graft placement in the descending aorta.
  - Branched graft followed by woven or stent graft at stage 2 referred to open surgical 'debranching' of the head and neck vessels with endoluminal stent graft placement in the aortic arch and either a vascular graft or endovascular stent graft in the descending aorta.

- 5.4 The sponsor carried out 1- and 2-way sensitivity analyses to include base-case, worst-case and best-case scenarios in its analysis.
- 5.5 The key assumptions used in the model were:
- In-hospital and 30-day mortality was 15% for the E-vita open plus, based on data from the paper by Jakob et al. (2011).
  - The remaining 85% of patients treated would not experience other complications.
  - Mortality rates were 20% for woven graft and 30% for branched graft at stage 2.
  - The number of inpatient days for the classical elephant trunk procedure was 10 at stage 1 and 15 at stage 2.
  - The number of inpatient days for the endovascular stent procedure was 10 at stage 1 and 8 at stage 2.
  - The number of inpatient days for the E-vita open plus was 4 in the intensive care unit and 6 in a surgical ward.
- 5.6 Technology costs were provided by the sponsor. The cost of the E-vita open plus was £10,500 and the comparator costs were £200 for a woven graft for stages 1 and 2, £1,000 for a branched graft, and £5,000 for an endovascular stent graft. Consumable costs (mainly for the guide wire, estimated to be £130) were not included because the sponsor considered these to be the same for the technology and comparators. Cost estimates for clinical time and resource use were sourced from published literature, the Personal Social Services Research Unit (PSSRU) unit costs of health and social care manual, and NHS reference costs.
- 5.7 The cost of a surgeon was estimated to be £399 per hour and the costs of a perfusionist and anaesthetist were each estimated to be £87 per hour (registrar rate). The cost for theatre time, including nursing and consumables, was estimated to be £24 per hour, and £30 per hour for corresponding intensive care unit costs. These were derived from the NHS tariff for admitted patient case and outpatient procedures but no codes were specified. The sponsor used a daily

cost for an intensive care unit stay of £1,500, taken from a report in The Lancet. The cost of a surgical ward inpatient stay was taken to be £420 per day, based on 2 different tariff codes. The cost of death cited by the sponsor (£8,000) was taken from a cancer network publication.

- 5.8 The sponsor carried out 1-way sensitivity analyses varying the adoption rate from 20% to 100% (in the modelled population of 3,500 patients assumed to be eligible for the E-vita open plus). The proportion of woven or branched grafts used at stage 1 was varied from 60% to 95% from a base-case estimate of 85%. The proportional suitability for a second stage operation was varied from a base case of 80% to 60% and 95%, and the proportion of patients having each stage 2 procedure was varied from a 50% base case to 40% and 100%. The sponsor also carried out a 2-way sensitivity analysis varying the in-hospital death rate at stage 1 of the classical elephant trunk procedure and for the E-vita open plus.
- 5.9 The sponsor presented the results of its de novo analysis as an average cost per patient, assuming a 100% adoption level (rather than the 40% adoption level described in the model decision tree in section 5.2) for the E-vita open plus compared with current practice. The cost for the E-vita open plus was £25,689 and the overall cost presented for the comparators was £30,241, indicating a cost saving per patient of £4,553 if the E-vita open plus was used. The cost per patient varied across the different comparators, ranging from £26,691 for woven graft (stage 1) with endovascular stent (stage 2) to £36,016 for branched graft (stage 1) with woven graft (stage 2).
- 5.10 The sponsor's sensitivity analysis showed little variation in the cost savings generated for the E-vita open plus at different adoption levels, with an average cost saving of around £4,358. The sponsor reported that varying the parameters for second-stage suitability and in-hospital death had an impact on the cost savings, but that this was relatively small. Varying the suitability of a second stage operation produced higher cost savings per patient if the level of suitability was raised. The sponsor did not consider the subgroups defined in the scope in its de novo analysis because of a lack of available data on the comparators.
- 5.11 The external assessment centre considered that the sponsor's de novo cost model was flawed because it did not include the short- or long-term costs of

complications and because some of the costs and clinical parameters were inaccurate or inappropriate. Specifically, the external assessment centre considered that a per-patient, rather than a cohort, approach would have been more useful and that the estimated cohort of 3,500 patients was too large.

- 5.12 The external assessment centre carried out additional modelling to address these issues, constructing short- and long-term models that included the costs of complications (stroke, paraplegia, renal failure and bleeding). Both models compared per-patient costs for the E-vita open plus and the 3 comparators defined in the scope. A decision tree was constructed for each procedure in each model. In-hospital mortality was modelled at each stage of each procedure. The time horizon for the short-term model was 1 year, as the external assessment centre considered that stage 2 procedures were likely to be carried out within 6 months of stage 1. The long-term model had a 20 year time horizon, based on the UK life expectancy of the average age (65 years) of those receiving treatment described in published literature. Lifetime costs of complications were included in this model.
- 5.13 In the short-term model for each comparator, patients with no complications or bleeding at stage 1 were assumed to proceed to the second stage procedure, whereas it was assumed that those who had a stroke, renal failure or paraplegia would not. In the long-term model, the annual costs of care for stroke, paraplegia and renal failure were taken from published literature and discounted at 3.5%. The discounted annual cost was multiplied by a survival probability for 65 to 85 years and the weighted annual costs were summed to estimate the lifetime cost of the complications.
- 5.14 The external assessment centre estimated the probabilities of the outcomes at each stage from the register data for the E-vita open plus and from its meta-analysis of the clinical evidence on the comparator procedures. The probability of paraplegia at stage 1 was assumed to be the same for 2-stage repair with vascular graft and 2-stage repair with endovascular stent graft. For open debranching, the probability of paraplegia and that of renal failure at stage 1 was taken from hybrid procedure estimates. Operating times and total lengths of stay for all the comparators were sourced from published literature. Operating time for the E-vita open plus and details of the surgical team involved for each procedure were taken from the sponsor's model. The team included a consultant surgeon,

- consultant anaesthetist, associate specialist, perfusionist and 2 specialist nurses. A consultant radiologist was included for stage 2 procedures involving stent grafts.
- 5.15 The external assessment centre used technology and comparator costs from the sponsor's model but derived more precise estimates for staff and ward stay costs than those used by the sponsor (as described in section 5.7). Costs for each professional in the surgical team were taken from PSSRU 2012 unit costs. The costs for an intensive care unit and surgical ward stay were sourced from NHS reference costs at £1,410 per day and £383 per day respectively.
- 5.16 Complications were assumed to incur additional in-hospital management costs and a single cost figure was applied across all procedures (£2,155). The annual cost for stroke care was estimated to be £9,597 at 2012 prices, from the [NICE guideline on atrial fibrillation: diagnosis and management](#). The annual cost of paraplegia was estimated to be £14,580, based on published literature and inflated to 2012 prices. The annual cost for renal failure used was £32,961, taken from the [NICE guideline on renal replacement therapy and conservative management](#) and inflated to 2012 prices.
- 5.17 Costs for multiple stents were included in the analysis and sourced from the sponsor's submission. However, the external assessment centre was not able to model the probable outcomes from using multiple stents, citing a lack of available clinical evidence.
- 5.18 Results of the short-term model showed that treatment with the E-vita open plus could generate a cost saving of £280 per patient when compared against 2-stage repair with vascular graft. The E-vita open plus incurred costs when compared against 2-stage repair with endovascular stent graft (£4,760) and also when compared against open debranching with endoluminal stent graft (£7,663).
- 5.19 Results from the long-term model, which included the lifetime costs of complications, showed that treatment with the E-vita open plus could generate significant cost savings when compared with all 3 comparator procedures. The estimated saving per patient 20 years after the procedure was £41,213 when compared against 2-stage repair with vascular graft, £39,392 when compared against 2-stage repair with endovascular stent graft and £51,778 when compared

against open debranching with endoluminal stent graft.

- 5.20 The external assessment centre carried out a deterministic sensitivity analysis to investigate the impact of uncertainty on the likelihood and costs of complications. The probabilities of in-hospital mortality and paraplegia were varied separately based on their 95% confidence intervals from the external assessment centre's meta-analysis of the clinical evidence. The overall management costs and the annual costs of complications were varied separately using minimum and maximum ranges identified in the literature, if available. The proportion of days spent in an intensive care unit and the cost of an intensive care unit day were also varied to reflect uncertainty in the number of organs needing support. Results of the sensitivity analysis showed that varying the probability of in-hospital mortality and paraplegia for the E-vita open plus, or the management or annual costs of complications, did not substantially change the expected cost savings in the base-case estimate. In the short-term model, varying the proportion of days spent in the intensive care unit did change the observed cost savings. At a 20% level, the E-vita open plus incurred costs when compared with all 3 comparators. At a 60% level, there were cost savings for the E-vita open plus compared against 2-stage repair with vascular graft. Varying the cost of intensive care unit stay affected the short-term model results in a similar way, but neither variable substantially altered the cost savings in the long term.
- 5.21 The external assessment centre acknowledged some limitations in its model. Complications were assumed to occur only in the short term, because data were not available about their occurrence in the longer term. However, clinical expert advice indicated that the majority of complications would occur during or shortly after the intervention. The external assessment centre recognised that a more complex model (such as Markov or discrete event simulation) might have facilitated a more refined analysis and noted that the sensitivity analysis did not account for the possibility of multiple complications occurring in individual patients.
- 5.22 The external assessment centre developed a profile of year-on-year costs for the long-term model from year 1 to year 20. The E-vita open plus was estimated to be cost saving at and beyond 2 years after the procedure compared with all 3 comparator procedures. For example, when compared with 2-stage repair with vascular grafting, the base-case cost savings per person treated with the E-vita

open plus were £6,057 at 2 years after the procedure, £13,822 at 5 years, and £24,948 at 10 years. When compared with 2-stage repair with endovascular stent grafting, the cost savings were £1,471 at 2 years after the procedure, £9,847 at 5 years, and £21,847 at 10 years. When compared with open surgical debranching with endoluminal stent grafting, the cost savings were £726 at 2 years after the procedure, £12,003 at 5 years, and £28,158 at 10 years.

5.23 For the guidance review, the external assessment centre revised the model to reflect 2018 costs. The major changes in the update relate to acute care costs of adverse events and staff costs. In the original model, the acute care cost of adverse events was calculated as £2,155; in the revised model, the costs depend on the type of adverse event and range from £498 for bleeding to £11,663 for paraplegia. Staff costs in the revised model were taken from the Personal Social Services Research Unit (PPSRU) 2017 and were often cheaper. Base-case results for the 2018 revised model show that estimated cost savings per patient at 5 years after the procedure are:

- £13,334 compared with 2-stage repair involving open insertion of a vascular graft.
- £10,225 compared with 2-stage repair involving endovascular stent grafting.
- £12,536 compared with open surgical debranching followed by endoluminal stent grafting.

These saving increase across the 3 comparators in the longer term. Further details of the 2018 revised model are in the revised model summary. **[2018]**

## Committee considerations

5.24 The committee recognised the difficulties of cost modelling based on the limited clinical evidence. It considered that the external assessment centre's critique of the sponsor's cost analysis was generally valid and judged its additional modelling to be sufficiently robust to provide a reasonable estimate of potential cost savings.

5.25 The committee heard clinical expert advice that 10% to 20% of people treated

with the E-vita open plus might need a second procedure. It was advised that reintervention was likely for people with connective tissue disorders regardless of whether they had a 1- or 2-stage procedure initially. The external assessment centre had been unable to include the possibility of reintervention in its model, citing a lack of data on which to base estimates. The external assessment centre advised the committee that including the assumption that 10% to 20% of people would need reintervention would not substantially change the findings from the long-term model.

- 5.26 The committee recognised that the E-vita open plus could incur costs in the short term when compared with most methods of current practice. However, the opportunity to avoid a second stage procedure by using the E-vita open plus would reduce resource use. The committee accepted the external assessment centre's year-on-year costs profile and concluded that the E-vita open plus was likely to have a cost advantage from year 2 onwards.

## 6 Conclusions

- 6.1 The committee concluded that use of the E-vita open plus would be likely to provide benefits compared with current practice for a small group of people with disease of the ascending aorta, aortic arch and the proximal descending aorta. Benefits would be conferred by eliminating the need for a second procedure and the associated risk of serious complications. Patients would need to be selected carefully based on the extent of their thoracic aortic disease.
- 6.2 The committee recognised that some people for whom treatment with the E-vita open plus would be suitable would have progressive aortic disease needing reintervention in the future, regardless of the method of repair used initially. This would be significantly more likely in people with connective tissue disorders such as Marfan's syndrome than in those with atherosclerotic conditions.
- 6.3 The committee concluded that using the E-vita open plus in the NHS was likely to save money compared with current standard practice in the longer term, from about 2 years after the intervention.

## 7 Committee members and NICE lead team

### Medical technologies advisory committee members

The medical technologies advisory committee is a standing advisory committee of NICE. A list of the committee members who took part in the discussions for this guidance appears below.

Committee members are asked to declare any interests in the technology to be evaluated. If it is considered there is a conflict of interest, the member is excluded from participating further in that evaluation.

The [minutes of each medical technologies advisory committee meeting](#), which include the names of the members who attended and their declarations of interests, are posted on the NICE website.

**Professor Bruce Campbell (Chair)**

Consultant Vascular Surgeon, Exeter

**Dr Peter Groves (Vice Chair)**

Consultant Cardiologist, Cardiff and Vale NHS Trust

**Professor Dilly Anumba**

Chair of Obstetrics and Gynaecology/Honorary Consultant Obstetrician and Gynaecologist, University of Sheffield

**Ms Susan Bennett**

Lay member

**Dr Keith Blanshard**

Consultant Interventional Radiologist, University Hospitals of Leicester NHS Trust

**Professor Nigel Brunskill**

Professor of Renal Medicine, University of Leicester

**Mr Andrew Chukwuemeka**

Consultant Cardiothoracic Surgeon, Imperial College Healthcare NHS Trust

**Professor Daniel Clark**

Head of Clinical Engineering, Nottingham University Hospitals NHS Trust

**Professor Tony Freemont**

Professor of Osteoarticular Pathology, University of Manchester

**Professor Peter Gaines**

Consultant Interventional Radiologist, Sheffield Vascular Institute and Sheffield Hallam University

**Professor Shaheen Hamdy**

Professor of Neurogastroenterology, University of Manchester

**Mr Matthew Campbell-Hill**

Lay member

**Dr Jerry Hutchinson**

Independent Medical Technology Adviser

**Dr Cynthia Iglesias**

Senior Research Fellow in Health Economics, University of York

**Dr Greg Irving**

General Practitioner, University of Liverpool

**Professor Mohammad Ilyas**

Professor of Pathology, University of Nottingham

**Dr Eva Kaltenthaler**

Reader in Health Technology Assessment, ScHARR, University of Sheffield

**Dr Paul Knox**

Reader in Vision Science, University of Liverpool

**Mrs Jacqui Nettleton**

Programme Director, Commissioning, Western Sussex Hospitals NHS Trust

**Mrs Karen Partington**

Chief Executive, Lancashire Teaching Hospitals NHS Foundation Trust

**Professor Brian J Pollard**

Professor of Anaesthesia, University of Manchester; Consultant Anaesthetist, Central Manchester University Hospitals

**Mr Brian Selman**

Managing Director, Selman & Co

**Professor Wendy Tindale**

Scientific Director, Sheffield Teaching Hospitals NHS Foundation Trust

**Professor Allan Wailoo**

Professor of Health Economics, School of Health and Related Research (ScHARR), University of Sheffield

**Mr John Wilkinson**

Director of Devices, MHRA

**Dr Janelle Yorke**

Lecturer and Researcher in Nursing, University of Manchester

## **NICE lead team**

Each medical technology assessment is assigned a lead team of a NICE technical analyst and technical adviser, an expert adviser, a technical expert, a patient expert (if appropriate), a non-expert member of the medical technologies advisory committee and a representative of the external assessment centre.

**Joanne Higgins**

Technical Analyst

**Mark Campbell**

Associate Director

**Bernice Dillon**

Technical Adviser

**Stephen Large**

Lead Expert Adviser

**Jorge Mascaro**

Lead Expert Adviser

**Jacqui Nettleton**

Non-Expert MTAC Member

**Muralikrishnan Radhakrishnan Kartha**

External Assessment Centre Representative

**Janet Peacock**

External Assessment Centre Representative

**Rachel Clough**

External Assessment Centre Representative

## 8 Sources of evidence considered by the committee

The external assessment centre report for this assessment was prepared by King's Imaging Technology Evaluation Centre (KITEC):

- Clough R, Keevil S, Lewis C et al. E-vita open plus for treating complex aneurysms and dissections of the thoracic aorta (June 2013).

Submissions from the following sponsor:

- JOTEC GmbH.

The following individuals gave their expert personal view on the E-vita open plus by providing their expert comments on the draft scope and assessment report:

- Mr Marcus Brooks, nominated by the Vascular Society of Great Britain and Ireland.
- Mr Stephen Large, ratified by the Society of Cardiothoracic Surgery of Great Britain and Ireland.
- Professor Peter Taylor, ratified by the Vascular Society of Great Britain and Ireland.
- Professor Matt Thompson, ratified by the British Society for Endovascular Therapy.

The following individuals gave their expert personal view on the E-vita open plus in writing by completing a patient questionnaire or expert adviser questionnaire provided to the committee:

- Prof John Brennan, nominated by the Vascular Society of Great Britain and Ireland.
- Mr Marcus Brooks, nominated by the Vascular Society of Great Britain and Ireland.
- Mr Graham Cooper, ratified by the Society of Cardiothoracic Surgery of Great Britain and Ireland.
- Dr Mo Hamady, ratified by the British Society of Interventional Radiology.
- Mr Michael Jenkins, nominated by the Vascular Society of Great Britain and Ireland.

- Mr Stephen Large, ratified by the Society of Cardiothoracic Surgery of Great Britain and Ireland.
- Mr Jorge Mascaro, ratified by the Society of Cardiothoracic Surgery of Great Britain and Ireland.
- Professor Matt Thompson, ratified by the British Society for Endovascular Therapy.
- Prof Olaf Wendler, ratified by the Royal College of Surgeons.

## Update information

**October 2018:** This guidance has been updated to include a review of the cost model using more recent values. Updated costs identified during the guidance review are denoted as [2018].

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## Accreditation

