Statistical analysis plan for EVAR trials 10-15 year follow-up

5th January 2016

(Approved by the Data Monitoring and Ethical Committee on 10th February 2016)

Final data collection and data audit

Follow-up for the EVAR Trials has been extended until at least the end of 2014, hence facilitating a maximum follow up of 15 years post randomisation. The final follow-ups are being collected by local coordinators and Rajesh Patel (the trial manager & auditor) is travelling to each centre to collect any outstanding missing data. This involves checking the hospital notes for any living patients who have not been seen in 2009 as well as for any other patients who died without a follow-up during the year preceding their death. From these inspections he will be able to confirm whether all adverse events, complications and re-interventions have been reported. In addition, for all the patients from the EVAR-1 trial in England & Wales we have used Hospital Episode Statistics (HES) to check for hospital admissions (including at non-trial hospitals) and captured the data for potential aneurysm-related re-interventions (L code list attached), myocardial infarctions, strokes and amputations (Table 1): these re-interventions have then been verified by queries to the local centres. The source of information for late re-interventions (HES/centres/both) and whether the reintervention was aneurysm-related, open or endovascular have been recorded. Death reporting is from ONS and the Endpoint committee met on 7th December to assess and code the underlying cause of death. Any additional events/deaths found will be entered into the main trials database, with the work being completed by the second week in January 2016. Follow up for mortality is complete to 30th June 2015 and follow up for re-interventions to 31st March 2015, although details of the last 15 deaths are still being chased. The vital status of patients with neither trial hospital or HES follow-up was checked with their GP's. At least 10% of the new data entries have been checked for accuracy by a second data manager. The late follow up for complications in the EVAR group of EVAR-1 is reasonable (68%) but for the open repair group it is only34%.

Reinterventions

The coding used for re-interventions and mortality has changed from the 1999-2009 analysis. This includes the coding of re-interventions between 1999-2009 which previously were only given as text and had not been coded and analysed as re-interventions: in particular this includes secondary open abdominal procedures during the primary admission, repair of false femoral aneurysm, re-lining of the endograft and re-do procedures for the femoro-femoral crossover grafts used with aorto-uni-iliac graft configurations. All these re-interventions have now been coded in the complete database. An updated list of reintervention coding is attached (Table 3).

Complications

Complications are coded into 15 main categories based on data collected between1999-2009. After this time only `cluster' complications (Endoleaks Types I-III, migration, kinking and sac expansion) have been recorded on case record forms. These complications primarily relate to EVAR operations and as such complications analysis by randomised group is not feasible post 2009.

Timescales

Data collection and harmonisation will continue until 31st October 2015. There will then be a period of 2-3 months where the extended follow-up data will be checked and cleaned using semi-automated procedures (e.g. checking consistency of dates, range checks, outliers / irregularities). This process will be undertaken by the data manager at Imperial College (in post October 2015 to February 2016) and statisticians at Cambridge liaising with the coordinating centre at Imperial College.
Draft analyses will be conducted between January18thand February with draft tables and figures ready for discussion at the end of February. A final analysis will then be conducted with the intention to submit an EVAR 1 trial manuscript for publication by 31st March 2016. The HTA report does not need to be submitted until end July 2016. The possibility of a separate EVAR 2 paper will be discussed by the TMC.

Data analysis

The Costs analysis will be performed Mark Sculpher and David Epstein. All other analyses will be performed by Michael Sweeting and Jessica Barrett at the University of Cambridge.

Lost to follow-up and censoring criteria
Follow-up prior to 1st September 2009 has been described previously. Briefly, patients were flagged with the UK Office for National Statistics (ONS) to obtain information on whether they were alive or not. Direct contact of those listed as still alive was also made and those not contactable or lost to follow-up were censored on the date of their last known appointment.
Follow-up data beyond 2009 were recorded in a single case report form for each individual. This included information on the date last seen if discharged from follow-up or the date of death if the patient had died. These data will be combined with HES and ONS follow-up data to create a new follow-up time for each individual. Patients lost to follow-up at ONS will be censored on the date the ONS flag was cancelled or the date last seen alive by the coordinator or the date of final information from Hospital Episode Statistics, whichever occurred latest.

Descriptive analyses for both trials
(i) CONSORT diagrams indicating compliance with randomised group (including any conversions to open repair or abandoned procedures in theatre) and loss to follow-up for mortality, reinterventions and complications (since these dates will be different).

(ii) Comparison of baseline characteristics between randomised groups.
The data for the additional 235 patients randomised to 15th June 2005, will need to be summarised for the HTA report in July 2016.

PRIMARY OUTCOME – MORTALITY ANALYSES
The patients:
Results will be based upon 1252 patients recruited into EVAR Trial 1 and 404 patients recruited into EVAR Trial 2 between 1st September 1999 and 31st August 2004. The cut-off for follow-up will be 30th June 2015 with patients known to have emigrated or been lost to follow-up censored on the date last known to be alive.

Statistical analyses:
Comparison of **all-cause mortality** between intention-to-treat randomised groups will be performed using Cox regression modelling with hazard ratios presented as the EVAR group relative to the standard therapy group. Patients lost to follow-up at ONS will be censored on the date the ONS flag was cancelled, date of last hospital admission reported in HES or the date last seen alive by the coordinator whichever occurred latest. Kaplan-Meier curves by randomised group will be presented up to 15 years of follow-up. The KM estimates at the 15 year mark will also be quoted with 95% CIs.

Comparison of **AAA-related mortality** between intention-to-treat randomised groups will be performed using Cox regression modelling with hazard ratios presented as the EVAR group relative to the standard therapy group. AAA-related mortality is defined as any deaths within 30 days of any AAA surgery plus deaths with underlying cause given as ICD10 codes I713 to I719, and other deaths listed as AAA-related (codes 1 and 12) or primary AAA-rupture (code 2) after review by the Endpoint Committee. Patients dying from non AAA-related causes will be censored at death. Kaplan-Meier curves by randomised group will be presented up to 15 years of follow-up with KM estimates and 95% CIs at the 15 year point.

Adjustment for baseline factors will remain the same as those presented for 8 year follow-up analyses (NEJM 2010).
Primary adjustment: age, sex, aneurysm diameter, FEV_1, log(creatinine), and statin use.
Secondary adjustment: primary adjustments as well as BMI, smoking status, systolic BP, and serum cholesterol will also be undertaken.

Tests of interaction will be performed between randomised group and age, sex and aneurysm diameter. Age and aneurysm diameter will be included in the Cox model in continuous format but results will be presented above and below the median.

Time effects will be investigated by firstly assessing deviations from the proportional hazards assumption. This will be tested by regressing scaled Schoenfeld residuals against the log of time. Previous analyses have shown deviations from the proportional hazards assumption for the first 8-years of follow-up (NEJM 2010), so this analysis will also investigate whether proportional hazards

hold within the extended follow-up (9-15 years). The data will be analysed by presenting numbers of events/patients, crude rates per 100 person years and Cox regression hazard ratios for 4 time periods:
Randomisation to 6 months
6 months to 4 years
4 years to 8 years
Beyond 8 years

Centre effects – a subsidiary analysis will be performed to see whether the mortality outcomes vary significantly between centres. A random effects term for centre will be included in the Cox regression models using the shared frailty model option in Stata.

Missing data
For a small number of patients (<10%) the baseline covariates used for adjustment are missing. Two sensitivity analyses will be reported in the text: the first will use the missing indicator method for variables which have the most missing data; the second will use a multiple imputation chained equations approach. It is most unlikely that these analyses will change the principal results.

Causes of death will be tabulated by randomised group and split into these categories:
Coronary heart disease (3), stroke (4), other vascular (5), respiratory (8), lung cancer (6), other cancers (7), renal (9) other (10), AAA-related (sub-divided into primary AAA rupture, emergency operative death and elective operative death within 30 days of the procedure, secondary AAA rupture), unknown causes, see Table 3.

Numbers of deaths will also be presented within these time periods: randomisation to operation, operation to 30 days post-operation, more than 30 days post-operation.
Randomisation to 6 months
6 months to 4 years
4 years to 8 years
Beyond 8 years

Adverse events data – total numbers of MI, stroke, amputation, cancer and renal failure will be presented in each group and time to first major cardiovascular event, fatal and non-fatal (MI+stroke+amputation) will be compared between the groups.

EVAR Trial 1 per protocol analysis
Analysis will be timed from randomisation. Compliance in EVAR 1 is about 93% and per protocol patients will be defined as those who have had their first attempted elective surgery according to their randomised group even if the completed operation in theatre differed from their randomised group, e.g. conversions from EVAR to open repair in theatre. This excludes those without AAA repair, those who had emergency repair, those who had their AAA repair abandoned in theatre (AAA left unrepaired) and those who had their first attempted elective surgery against their randomised group.

EVAR Trial 2 per protocol analysis
Analysis will be timed from randomisation. Compliance in EVAR 2 is about 78% but a per-protocol analysis can be performed on all 404 patients if the following criteria are used for censoring at the time of protocol violation.

In the group randomised to EVAR, per protocol patients will be defined as those who had an elective EVAR attempted even if they subsequently converted to open repair during the primary procedure in theatre. Patients who died without AAA repair or had an emergency AAA repair will be included as per-protocol patients. Patients who had elective open repair in the EVAR group will be censored at AAA repair.

In the group randomised to no intervention, per protocol patients will be defined as those who remain without AAA repair or had emergency AAA repair as a result of rupture. Patients undergoing any type of elective AAA repair in the no intervention group will be censored at the time of elective AAA repair.

SECONDARY OUTCOMES - RE-INTERVENTIONS ANALYSES in EVAR 1

All patients randomised into EVAR-1 by 31st August 2004 will be included in these analyses. The types of reinterventions will be tabulated in order of severity according to the type of reintervention received using an updated format to account for all reinterventions (Table 3). The time to first re-intervention, first reintervention for a life-threatening problem (5* code) and first serious reintervention (2* and 3* codes) will be analysed within intention-to-treat randomised groups. The analyses will be timed from randomisation but differ from the mortality analyses in terms of the length of follow-up for the patients:

Censoring criteria for patients re-intervention analyses

The case record form and audit data will be complete by the end of March 2015.

- For all patients from Scotland and Northern Irelandand English patients unmatched in HES with a follow-up in 2014/5, the date of their latest follow-up will be used for censoring.
- For alive patients in Scotland and Northern Ireland and English patients unmatched in HES without a follow-up in 2014/15, the latest of their date of last follow-up or the date of audit of their notes will be used for censoring.
- For all English patients tracked via HES, censoring will be 31st March 2015, unless the date of death was earlier.
- For dead patients without a follow-up in 2014/5, the date of death will be used for censoring, providing it occurred within the year after their last follow-up or date their notes were audited, otherwise these latter dates will be used for censoring.
- For patients who died within the first year after randomisation or AAA repair, they will be censored on the date of death.
- For alive patients without AAA repair, they will be censored on the date of last follow-up or audit whichever occurred latest.
- For dead patients without AAA repair, they will be censored on the date of death.

Cox regression analysis will be used to present crude, primary and secondary adjusted hazard ratios for time to first re-intervention, first reintervention for a life-threatening problem (5* code) and first serious reintervention (2* and 3* codes) using the same adjustments as the mortality analyses but also for the following anatomical variables: top neck diameter, neck length and maximum common iliac diameter (largest of both legs). Re-interventions will include those that occurred during the primary admission as this is consistent with our 2005 and 2010 publications. The date of any re-intervention during the primary admission will be timed at the midpoint between the date of admission and the date of discharge or in-hospital death. Kaplan-Meier curves by randomised group will be presented out to 15years of follow-up with the KM estimates at the 15 year mark quoted with 95% CIs.

A description of the overall number of re-interventions will be presented, similar to Appendix Table 3 in NEJM 2010.

The crude incidence rate at which reinterventions occur will be reported by randomised group. This will be done for time to first reintervention and also for recurrent reinterventions. For the latter we will examine whether there is between patient heterogeneity in the rate of reinterventions by using negative binomial regression.

To inform the ongoing debate concerning the length of active surveillance, it also would be helpful to add an analysis of time to first re-intervention and first reintervention for a life-threatening condition (5*) in patients without any re-intervention between operation and 2-year follow up and with the analysis repeated for 5 –year follow up.

SECONDARY OUTCOMES – COMPLICATIONS

The poor late follow up of the open repair group is likely to limit the analyses which can be conducted in EVAR-1. We can report and tabulate the complications in the EVAR group and look at crude incidence rates over time. However, the number and type of complications reported in the case report forms after 2009 is more limited and hence complication analyses may have to be restricted. In addition, renal infarction has been added as a category since 2009. A full list of complications reported is attached (Table 4).

Rates of complications detected will be presented by randomised group up to 2009 both for the time to first complication and recurrent complications, using negative binomial regression as done with the reintervention analysis.

Post-2009, only cluster complications are reported. Hence, for descriptive purposes, the rate of cluster complications will be reported in the EVAR operated group only for the periods .1) Operation to 6 months, 2) 6 months to 2 years, 3) 2 years to 5 years, 4) 5 years to 10 years,5) Beyond 10 years.

SECONDARY OUTCOMES – SAC GROWTHAND RISK OF COMPLICATIONS AND RE-INTERVENTIONS

Late complications and reinterventions (i.e. those that occur after 2, 3 or 5-years post-operation) will be investigated further in the EVAR operated group only. A Cox proportional hazards model will be fitted to individuals still under follow-up at 2, 3 and 5-years post-operation and a number of potential predictors of time to next complication/reintervention will be investigated. A landmarking approach will be adopted whereby predictors will be derived based on past measurements of sac diameter and could include both current sac diameter and an estimate of the rate of sac growth. Rate of sac growth will be obtained from fitting mixed-effects models to the sac diameter data and obtaining an estimate of the derivative of the functional form at the chosen landmark time. Other covariates that could predict late complications/reinterventions such as age, sex, smoking, maximum baseline AAA diameter and other morphological characteristics, number of previous complications, number of previous reinterventions, graft shape and graft manufacturer will also be considered.

The C-index will be used to report the predicted performance of the models to judge the clinical utility as a decision-making tool for proposing further annual CT scans.

Four outcomes will be investigated:

1. Time to any next complication (using only data until 2009)
2. Time to next cluster complication (using extended follow-up until 2015)
3. Time to next reintervention (using extended follow-up until 2015)
4. Time to secondary AAA rupture (if numbers allow)

Cumulative incidence curves of each of the four outcomes post-landmark will be plotted, potentially subdivided by significant predictors (e.g. sac growth <5mm/year vs. sac growth >= 5mm/year). The cumulative incidence curves will account for mortality as a competing risk.

SECONDARY OUTCOMES –COST-EFFECTIVENESS

The EVAR trials have provided evidence upon which a number of detailed cost-effectiveness analyses have been undertaken, with the latest based on 10 years follow-up. The proposed data collection will facilitate a within-trial cost-effectiveness analysis of EVAR 1 and EVAR2. It is not anticipated that the proportion of patients alive at 15 years warrants extrapolation beyond the trial period. The “within-trial” analysis will estimate mean total costs and quality-adjusted life years (QALYs) of the randomised interventions based on individual patient data from EVAR 1 and EVAR 2 up to 15-years.

The analysis will be conducted from a health and social care perspective. The costs for EVAR 1 will include the initial aneurysm repair (with open surgery or EVAR), adverse events (MI, stroke, amputation, cancer and renal failure) and aneurysm-related reinterventions. Unit costs of these resources will be obtained from national databases e.g. reference cost schedules and published literature. The cost of the stent graft will be obtained from manufacturer’s list prices (currently £6558, Gore Medical, not including extensions and other consumables, e.g. guidewires) The price year will be 2014 (the latest available national cost databases).

The trials did not collect detailed information on primary care attendance, surveillance or outpatient visits during late follow up. Given the greater intensity of surveillance in the EVAR group (particularly

in EVAR 1), these may impact on the total costs. Simulation may be undertaken to examine the expected potential importance of these costs on the final results.

Health-related quality of life for each patient over time will be obtained from the trials. QALYs and costs will be discounted at the appropriate NICE rate.

The analysis will be undertaken on an intention-to-treat basis, including costs and outcomes of all randomized patients. Missing data will be handled using appropriate statistical methods, such as multiple imputation. Given the poor follow up in the open repair group, there is a potential for bias in the cost and QALY analysis. Therefore alternative missing data imputation methods will be tried as sensitivity analysis.

Confidence intervals for mean costs and QALYs, and the probability that the intervention is cost-effective, will be estimated by bootstrapping.

Table 1 Aneurysm-related re-intervention (L) & other codes searched in Hospital Episode Statistics

L16.1	Emergency bypass of aorta by anastomosis of axillary artery to femoral artery
L16.2	Bypass of aorta by anastomosis of axillary artery to femoral artery NEC
L16.3	Bypass of aorta by anastomosis of axillary artery to bilateral femoral arteries
L16.8	Other specified extra-anatomic bypass of aorta
L16.9	Unspecified extra-anatomic bypass of aorta
L18.1	Emergency replacement of aneurysmal segment of ascending aorta by anastomosis of aorta to aorta
L18.2	Emergency replacement of aneurysmal segment of thoracic aorta by anastomosis of aorta to aorta NEC
L18.3	Emergency replacement of aneurysmal segment of suprarenal abdominal aorta by anastomosis of aorta to aorta
L18.4	Emergency replacement of aneurysmal segment of infrarenal abdominal aorta by anastomosis of aorta to aorta
L18.5	Emergency replacement of aneurysmal segment of abdominal aorta by anastomosis of aorta to aorta NEC
L18.6	Emergency replacement of aneurysmal bifurcation of aorta by anastomosis of aorta to iliac artery
L18.8	Other specified emergency replacement of aneurysmal segment of aorta
L18.9	Unspecified emergency replacement of aneurysmal segment of aorta
L19.1	Replacement of aneurysmal segment of ascending aorta by anastomosis of aorta to aorta NEC
L19.2	Replacement of aneurysmal segment of thoracic aorta by anastomosis of aorta to aorta NEC
L19.3	Replacement of aneurysmal segment of suprarenal abdominal aorta by anastomosis of aorta to aorta NEC
L19.4	Replacement of aneurysmal segment of infrarenal abdominal aorta by anastomosis of aorta to aorta NEC
L19.5	Replacement of aneurysmal segment of abdominal aorta by anastomosis of aorta to aorta NEC
L19.6	Replacement of aneurysmal bifurcation of aorta by anastomosis of aorta to iliac artery NEC
L19.8	Other specified other replacement of aneurysmal segment of aorta
L19.9	Unspecified other replacement of aneurysmal segment of aorta
L20.1	Emergency bypass of segment of ascending aorta by anastomosis of aorta to aorta NEC
L20.2	Emergency bypass of segment of thoracic aorta by anastomosis of aorta to aorta NEC
L20.3	Emergency bypass of segment of suprarenal abdominal aorta by anastomosis of aorta to aorta NEC
L20.4	Emergency bypass of segment of infrarenal abdominal aorta by anastomosis of aorta to aorta NEC
L20.5	Emergency bypass of segment of abdominal aorta by anastomosis of aorta to aorta NEC
L20.6	Emergency bypass of bifurcation of aorta by anastomosis of aorta to iliac artery NEC
L20.8	Other specified other emergency bypass of segment of aorta
L20.9	Unspecified other emergency bypass of segment of aorta
L21.1	Bypass of segment of ascending aorta by anastomosis of aorta to aorta NEC
L21.2	Bypass of segment of thoracic aorta by anastomosis of aorta to aorta NEC
L21.3	Bypass of segment of suprarenal abdominal aorta by anastomosis of aorta to aorta NEC
L21.4	Bypass of segment of infrarenal abdominal aorta by anastomosis of aorta to aorta NEC
L21.5	Bypass of segment of abdominal aorta by anastomosis of aorta to aorta NEC
L21.6	Bypass of bifurcation of aorta by anastomosis of aorta to iliac artery NEC
L21.8	Other specified other bypass of segment of aorta
L21.9	Unspecified other bypass of segment of aorta
L22.1	Revision of prosthesis of thoracic aorta
L22.2	Revision of prosthesis of bifurcation of aorta
L22.3	Revision of prosthesis of abdominal aorta NEC
L22.4	Removal of prosthesis from aorta
L22.8	Other specified attention to prosthesis of aorta
L22.9	Unspecified attention to prosthesis of aorta
L23.1	Plastic repair of aorta and end to end anastomosis of aorta
L23.2	Plastic repair of aorta using subclavian flap
L23.3	Plastic repair of aorta using patch graft
L23.4	Release of vascular ring of aorta
L23.5	Revision of plastic repair of aorta

L23.6	Plastic repair of aorta and insertion of tube graft
L23.7	Repair of interrupted aortic arch
L23.8	Other specified plastic repair of aorta
L23.9	Unspecified plastic repair of aorta
L25.1	Endarterectomy of aorta and patch repair of aorta
L25.2	Endarterectomy of aorta NEC
L25.3	Open embolectomy of bifurcation of aorta
L25.4	Operations on aneurysm of aorta NEC
L25.5	Operations on aortic body
L25.8	Other specified other open operations on aorta
L25.9	Unspecified other open operations on aorta
L26.1	Percutaneous transluminal balloon angioplasty of aorta
L26.2	Percutaneous transluminal angioplasty of aorta NEC
L26.3	Percutaneous transluminal embolectomy of bifurcation of aorta
L26.4	Aortography
L26.5	Percutaneous transluminal insertion of stent into aorta
L26.6	Transluminal aortic stent graft with fenestration NEC
L26.7	Transluminal aortic branched stent graft NEC
L26.8	Other specified transluminal operations on aorta
L26.9	Unspecified transluminal operations on aorta
L27.1	Endovascular insertion of stent graft for infrarenal abdominal aortic aneurysm
L27.2	Endovascular insertion of stent graft for suprarenal aortic aneurysm
L27.3	Endovascular insertion of stent graft for thoracic aortic aneurysm
L27.4	Endovascular insertion of stent graft for aortic dissection in any position
L27.5	Endovascular insertion of stent graft for aortic aneurysm of bifurcation NEC
L27.6	Endovascular insertion of stent graft for aorto-uniiliac aneurysm
L27.8	Other specified transluminal insertion of stent graft for aneurysmal segment of aorta
L27.9	Unspecified transluminal insertion of stent graft for aneurysmal segment of aorta
L28.1	Endovascular insertion of stent for infrarenal abdominal aortic aneurysm
L28.2	Endovascular insertion of stent for suprarenal aortic aneurysm
L28.3	Endovascular insertion of stent for thoracic aortic aneurysm
L28.4	Endovascular insertion of stent for aortic dissection in any position
L28.5	Endovascular insertion of stent for aortic aneurysm of bifurcation NEC
L28.6	Endovascular insertion of stent for aorto-uniiliac aneurysm
L28.8	Other specified transluminal operations on aneurysmal segment of aorta
L28.9	Unspecified transluminal operations on aneurysmal segment of aorta
O20.1	Endovascular placement of one branched stent graft
O20.2	Endovascular placement of one fenestrated stent graft
O20.3	Endovascular placement of one stent graft NEC
O20.4	Endovascular placement of two stent grafts
O20.5	Endovascular placement of three or more stent grafts
O20.8	Other specified endovascular placement of stent graft
O20.9	Unspecified endovascular placement of stent graft
T25.1	Primary repair of incisional hernia using insert of natural material
T25.2	Primary repair of incisional hernia using insert of prosthetic material
T25.3	Primary repair of incisional hernia using sutures
T25.8	Other specified primary repair of incisional hernia
T25.9	Unspecified primary repair of incisional hernia

T26.1	Repair of recurrent incisional hernia using insert of natural material
T26.2	Repair of recurrent incisional hernia using insert of prosthetic material
T26.3	Repair of recurrent incisional hernia using sutures
T26.4	Removal of prosthetic material from previous repair of incisional hernia
T26.8	Other specified repair of recurrent incisional hernia
T26.9	Unspecified repair of recurrent incisional hernia
T27.1	Repair of ventral hernia using insert of natural material
T27.2	Repair of ventral hernia using insert of prosthetic material
T27.3	Repair of ventral hernia using sutures
T27.4	Removal of prosthetic material from previous repair of ventral hernia
T27.8	Other specified repair of other hernia of abdominal wall
T27.9	Unspecified repair of other hernia of abdominal wall
T28.8	Other specified other repair of anterior abdominal wall
T28.9	Unspecified other repair of anterior abdominal wall
T30.1	Reopening of abdomen and re-exploration of intra-abdominal operation site and surgical arrest of postoperative bleeding
T30.2	Reopening of abdomen and re-exploration of intra-abdominal operation site NEC
T30.3	Reopening of abdomen NEC
X09.3	Amputation of leg above knee
X09.4	Amputation of leg through knee
X09.5	Amputation of leg below knee
X09.8	Other specified amputation of leg

Table 2 Mortality coding by the Endpoint Committee

1. **Procedure related AAA**
    12. **Secondary AAA rupture (after repair)**
2. **Primary AAA Rupture (before repair)**
3. **Coronary Heart Disease**
4. **Stroke**
5. **Other vascular disease (incl PAD, thoracic aortic aneurysm, pulmonary embolism, dementia)**
6. **Cancer, Lung**
7. **Cancer, Other**
8. **Respiratory**
9. **Renal**
10. **Other**
    12. **Secondary AAA Rupture (see 1 above)**

Table 3 Re-intervention codes and their severity

Re-intervention Category	Category Code	Severity
Added stent	**1**	****
Staple or Ligation (EVAR)	**2**	***
Embolisation (of endoleak)	**3**	***
Sclerosis of endoleaks	**4**	***
Conversion to OR	**5**	*****
Other	**6**	
Known aneurysmal extension above or below original graft - endovascular	**7**	*****
Known aneurysmal extension above or below original graft – open repair	**7**	*****
Re-intervention for thrombosis of graft limb - endovascular	**8**	**
Re-intervention for thrombosis of graft limb – open procedure	**8**	**
Re-intervention for Graft infection - open	**9**	*****
Re-intervention for Graft infection - endovascular	**9**	*****
Incisional Hernia – open repair	**10**	**
False Femoral Aneurysm - open	**11**	**
Irrelevant	**12**	
Minor re- intervention	**13**	*
Fem-Fem graft	**14**	***
FEVAR	**15**	*****
Axillo - bi-fem	**16**	*****
Distal limb procedure/revascularisation - open	**17**	***
Distal limb procedure/revascularisation - endo	**17**	***
Re - operation of open repair - open	**18**	*****
Replacement stent graft	**19**	*****
Further open abdominal surgery in primary admission	**20**	
Amputation	**21**	***
Unknown	**99**	

Table 4 Complication coding for EVAR trials 1999-2009 (*1999-2015)

Complication Category	Category Code
Endoleak Type 1*	**1**
Endoleak Type 2*	**2**
Endoleak Type 3*	**3**
Migration*	**4**
Kinking*	**5**
Sac Expansion*	**6**
Other	**7**
Limb Thrombosis/Occlusion	**8**
Graft Infection	**9**
Incisional Hernia	**10**
False Femoral Aneurysm	**11**
Neck Expansion	**12**
Renal Failure	**13**
Anastomotic Aneurysm	**14**
Rupture	**15**
Stent Fracture	**16**
Renal Infarction**	**17**

**new category, not present before 2010