Sex-related Outcome Inequalities in Endovascular Aneurysm Repair

D. Lowry [a],[*], J. Singh [a], J. Mytton [b], A. Tiwari [a]

[a] Department of Vascular Surgery, University Hospitals Birmingham NHS Foundation Trust, Birmingham, UK
[b] Department of Informatics, University Hospitals Birmingham NHS Foundation Trust, Birmingham, UK

WHAT THIS PAPER ADDS
Women generally have poorer outcomes following vascular surgery, including open aneurysm repair. There is some evidence that this is also the case following endovascular aneurysm repairs. This paper adds to the current literature in that women have poorer readmission and mortality rates than men. These differences persist even after adjustment for age, deprivation, comorbidity, ethnicity, and Trust volume.

Objective/Background: Women are known to have a higher rate of postoperative complications and mortality following open abdominal aortic aneurysm (AAA) repair. It is less clear whether this remains true of endovascular aneurysm repair (EVAR). This study examines the association between sex and hospital length of stay (LoS), readmission rates, and mortality following elective EVAR in the population of England between April 2006 and March 2015.
Methods: Retrospective analysis of Hospital Episode Statistics (HES) was performed, including regression analysis of potential factors that may affect the primary outcomes (age, sex, deprivation, comorbidities and Trust volume).
Results: In total, 20,780 EVARs were performed in the time period, 11.2% ($n = 2,304$) on women. The women were older (78 years [interquartile range {IQR} 74—82 years] vs. 76 years [IQR 70—80 years]; $p < .001$) and had a longer LoS (5 days [IQR 3—8 days] vs. 4 days [IQR 3—6 days]; $p < .001$). Women also had a higher readmission rate and mortality rate at both 30 days and 1 year. Following multivariate logistic regression, being female remained significantly related to poor outcome on all outcomes: LoS (odds ratio [OR] 1.86, 95% confidence interval [CI] 1.69—2.05), 30-day readmission (OR 1.23, 95% CI 1.09—1.40), 1-year readmission (OR 1.16, 95% CI 1.06—1.28); 30-day mortality (OR 1.54, 95% CI 1.15—2.07), 1-year mortality (OR 1.24, 95% CI 1.06—1.45). Advancing age and increased comorbidity score were significantly related to longer LoS, higher readmission rates, and higher mortality. Deprivation score was associated with LoS and 1-year readmission rate but not with 30-day readmission and with increased mortality. Higher-volume Trusts (>50 EVARs per year) had higher readmission rates and 1-year mortality.
Conclusion: These population-based data show that, following EVAR, women have a longer LoS and higher readmission and mortality than men. This reflects the same disparity in outcomes that is found in open AAA repair. Further work to clarify the cause of this is needed.
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INTRODUCTION

Endovascular aneurysm repair (EVAR) is now the most common treatment for abdominal aortic aneurysm (AAA).[1,2] Historically it has been shown that women have a higher rate of postoperative complication and mortality following open AAA repair than men.[3] It is less clear whether this remains true of EVAR. Some studies have demonstrated that the disparity in short-term outcomes persists with

EVAR,[4—6] whereas others have demonstrated that there are no significant difference in outcomes when comparing men with women.[7—10] The majority of these conclusions are based on relatively small numbers and overall the evidence is weak.[11]

Investigators have considered the influence of sex on EVAR outcome within the population of the USA, based on the Medicare beneficiary database.[5,12] No similar studies have been performed on the population of England. Hospital Episode Statistics (HES) provide similar data and allow for a comparison to be made between the two countries. HES consist of administrative data collected about all National Health Service (NHS) hospital attendances that occur in England. Data collected include clinical information,

including diagnoses and operations, patient demographics, administrative information, and geographical information.[13] These data can be linked with other databases, including the Office of National Statistics (ONS) mortality database.

The primary aim of this study was to use these databases to identify the association between sex and length of stay (LoS), readmission rate, and mortality in patients undergoing elective EVAR in England. The secondary aims were to identify the association of comorbidity and deprivation with LoS, readmission rate, and mortality in patients undergoing elective EVAR in England.

METHODS

Retrospective analysis of HES and ONS mortality databases was performed. The data used in this project were shared by the Health and Social Care Information Centre with University Hospitals Birmingham NHS Foundation Trust under a data-sharing agreement for the purposes of services evaluation. Patient consent is not required to use these types of data. The project was discussed with University Hospitals Birmingham NHS Foundation Trust's Research and Development Department and agreed to fall outside of the remit of the NHS Research Ethics Committee, as only pseudonymised information was used. Data were extracted for all elective EVAR procedures performed in England between April 2006 and March 2015. The operation codes used for the extraction are listed in Table 1. Additional information gathered was sex, age, readmission within 30 days and 1 year, comorbidities, deprivation, and Trust volume. Operative details are not contained within HES data and so were not analysed.

Comorbidity was scored using the Charlson comorbidity index. The score is derived from the sum of weighted scores of 17 medical conditions coded as comorbidities within the HES database. Zero is the lowest score and there is no upper limit. Rather than treat the score as continuous data within the HES data, the score is treated as categorical with the following divisions: 0, 1—4, and 5+.[14] Information on the proportion of patients with peripheral vascular disease (PVD), renal disease, and diabetes mellitus was also gathered. For the purposes of the comorbidity index these comorbidities are coded for using combinations of *International Classification of Diseases* (ICD)-10 codes (Table 1).[14] PVD includes the code for aortic aneurysm (ICD-1 I71 and I79). To remove this as a confounder, this code was not included in the demographics calculations. PVD was also removed from the calculation of the comorbidity index. Instead, the multivariate logistic regression model includes PVD, excluding ICD-10 I71 and I79. The definition for renal disease includes both specific causes of renal disease (e.g., nephritic syndrome and hereditary nephropathy) and chronic kidney disease stages 1—5. The definition of diabetes mellitus includes type 1, type 2, and unspecified diabetes mellitus (Table 1).

The deprivation score is a measure of poverty in a geographical area. It is expressed as quintiles (1 = most deprived, 5 = least deprived) and derived from the Index of Multiple Deprivation (IMD). The IMD is based on the 32,482 geographical areas within the UK termed "Lower Super Output Areas" (LSOA). Each LSOA is scored on the following seven domains with the indicated weighting: income (22.5%), employment (22.5%), health deprivation and disability (13.5%), education, skills and training (13.5%), barriers to housing and services (9.3%), crime (9.3%), and living environment (9.3%). Based on these scores each LSOA is ranked with the first being the most deprived. A patient's postcode can be used to place them within an LSOA. If a patient lives within the lowest 20% of the ranked LSOA's then their deprivation score will be 1.[15]

The association of sex, age, admission year, deprivation score, comorbidity score, and Trust volume (low volume: < 30 cases per year; medium volume: 30—50 cases per year; high volume: > 50 per year) with EVAR outcomes was assessed using multivariate logistic regression models (Stata Release 12; Stata Corp., College Station, TX, USA). The primary outcomes measures were high LoS (>3), 30-day and 1-year readmission rates, and 30-day, 1-year, and 5-year mortality (based on the patients operated on between April 2006 and April 2010). A LoS of >3 days was considered to be high, and the patients were categorised accordingly. The choice of the definition for low-volume Trust was based on the current data set, which was split by tertiles. *p*-Values < .05 were considered to be statistically significant.

RESULTS

Between April 2006 and March 2015 38,826 elective aneurysm repairs were performed in England, 20,780 (53.5%) of which were EVAR procedures. After exclusion of records with missing data, 20,519 patients were analysed. Of the EVAR procedures, 2,304 (11.2%) were performed on women. The median age for men was 76 years (interquartile range [IQR] 70—80 years) versus 78 years (IQR 74—82 years) in women (*p* < .001). Patient characteristics are summarised in Table 2.

The number of EVAR procedures per annum tripled for both men and women in this time period (744 in 2006/07 vs. 2816 in 2014/15). There has also been a significant decrease in 30-day mortality and in the proportion of patients who stayed in hospital for >3 days (*p* = .003 and *p* < .001, respectively). There was no significant change in 30-day readmission rate (*p* = .21). Owing to small numbers of women in some years it was not possible to perform a year-by-year analysis comparing the sexes.

Women were more likely to score 0 for comorbidities than men (44.2% vs. 40.6%) and men were more likely to score >5 (34.0% vs. 30.9%; *p* < .001). A higher proportion of women lived in the most deprived areas of England than men; the converse was true of the least deprived areas (Table 2).

The LoS in days was significantly longer in women (median 5 days, IQR 3—8 days) compared with men (4 days, IQR 3—6 days; *p* < .001). Significantly more women had a LoS of >3 days compared with men (71.6% vs. 56.4%; *p* < .001).