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Improving 1-year Outcomes of Infrainguinal Limb Revascularisation: A Population-Based Cohort Study of 104 000 Patients in England

Running Title: *Heikkila et al.; Improving Outcomes after Revascularisation*

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Abstract

Background**—**The availability and diversity of lower limb revascularisation procedures have increased in England in the past decade. We investigated whether these developments in care have translated to improvements in patient pathways and outcomes.

Methods**—**Individual-patient records from Hospital Episode Statistics (HES) were used to identify 103 934 patients who underwent endovascular (angioplasty) or surgical (endarterectomy, profundaplasty or bypass) lower limb revascularisation for infrainguinal peripheral artery disease (PAD) in England between January 2006 and December 2015. Major lower limb amputations and deaths within 1 year following revascularisation were ascertained from HES and Office for National Statistics mortality records. Competing risks regression was used to estimate the cumulative incidence of major amputation and death, adjusted for patient age, sex, comorbidity score and indication for the intervention (intermittent claudication; severe limb ischaemia without tissue loss; severe limb ischaemia with ulceration; severe limb ischaemia with gangrene/osteomyelitis) and comorbid diabetes.

Results**—**The estimated 1-year risk of major amputation reduced from 5.7% (in 2006-07) to 3.9% (in 2014-15) following endovascular revascularisation, and from 11.2% (2006-07) to 6.6% (2014-5) following surgical procedures. The risk of death after both types of revascularisation also reduced. These trends were observed for all indications categories, with the largest reductions found in patients with severe limb ischaemia with ulceration or gangrene. Overall, morbidity increased over the study period, and a larger proportion of patients were treated for the severe end of the PAD spectrum using less invasive procedures.

Conclusions—Our findings show that from 2006 to 2015, the overall survival increased and the risk of major lower limb amputation decreased following revascularisation. These observations suggest that patient outcomes after lower limb revascularisation have improved during a period of centralisation and specialisation of vascular services in the United Kingdom.

Key Words: Revascularisation, endovascular, surgical, peripheral artery disease, PAD

Clinical Perspective

What is new

- During a 10-year period from 2006 to 2015, the estimated 1-year risks of major amputation and death reduced after both endovascular and surgical lower limb revascularisation in England.
- These trends were observed for all categories of peripheral artery disease severity, with the largest reductions seen among patients with the most severe underlying disease.
- Overall, morbidity increased over the study period, and a larger proportion of patients were treated for the severe end of the PAD spectrum using less invasive revascularisation procedures.

What are the clinical implications

- Our findings show that patient outcomes after lower limb revascularisation have improved between 2006 and 2015.
- These encouraging trends coincide with a period of centralisation and specialisation of vascular services in England, thought the findings cannot be interpreted as resulting directly from the reconfiguration of services.

Introduction

Mortality and amputation rates among patients undergoing endovascular or surgical revascularisation for lower limb peripheral artery disease (PAD) have been examined in randomised controlled trials and observational studies based on routinely collected hospitalisation data from the United States and Western European countries [1-7]. Over the past decades both types of studies have found high rates of both death and major lower limb amputation among revascularisation patients in the UK [1, 5, 6]. For example, in a study based on hospital admission records, the investigators reported a 1-year amputation rate of 9.2% in and a 1-year mortality rate of 16.1% after femoropoliteal bypass surgery performed in England in 2006[6]. This has been a concern, particularly when compared to corresponding rates from other countries, such as Germany, Finland and different parts of the United States [2-4, 7].

The availability of revascularisation procedures has changed during the past decade (2006-2015), and with recent developments in endovascular and surgical technology, particularly stents and drug eluting technologies, less invasive procedures have become more widely used in the United Kingdom and elsewhere [8, 9]. However, the impact of the increased availability and diversification of procedures on patient outcomes, such as major lower limb amputation and death, is unclear. For many patients both surgical and endovascular procedures are deemed suitable alternative revascularisation strategies and randomised controlled trials comparing the outcomes of these of procedures have aimed to produce information to guide clinical decision-making where equipoise exists[10, 11]. In many cases, however, patient fitness or anatomy dictate that one treatment modality is preferable to the other. Patient selection will thus influence the patient outcomes after revascularisation procedures, which needs to be taken into account in analyses of routinely collected data.

To investigate whether developments in care have translated to improvements in patient outcomes, we examined the 1-year risks of major lower limb amputation and death following endovascular and surgical lower limb revascularisation for infrainguinal PAD undertaken between 2006 and in 2015 in England. Our analyses were based on individual-patient records from a nationwide set of routinely collected hospital admissions data, Hospital Episode Statistics (HES).

Methods

Data sources

This study is exempt from United Kingdom National Research Ethics Committee approval as it involved secondary analysis of an existing dataset of anonymised data. HES data were made available by the NHS Digital (Copyright© 2015, reused with the permission of NHS Digital. All rights reserved). We do not have permission to share patient-level HES data and are therefore unable to make the data or study materials available to other researchers for replication purposes. HES data are available from the NHS Digital Data Access Advisory Group (enquiries@nhsdigital.nhs.uk) for studies which meet the criteria for access to confidential data.

Individual-level data on endovascular and surgical lower limb revascularisations performed between 1st January 2003 and 31st December 2015 were obtained from HES. This nationwide administrative dataset captures information on all hospital admissions in National Health Service (NHS) hospitals in England [12]. Information on lower limb amputations following revascularisation was obtained from HES and mortality was ascertained by linking the patients' HES records (using an encrypted individual identifiers) to Office for National Statistics (ONS) records of deaths registered in England up to the end of December 2015 [13].

Study population

Our study population was men and women, aged 35 years or older, who underwent their first lower limb revascularisation for infrainguinal PAD (index procedure) during the ten-year period from January 2006 to December 2015. Patients with a HES record of a revascularisation up to three years prior to the index procedure (back to 2003) were excluded. We also excluded patients undergoing iliac procedures and those having revascularisation due to cancer or trauma. Patient records with missing data on covariates (patient demographics, indications for revascularisation or comorbidities) were also excluded (<1% of all potentially eligible patients).

Procedures and patient outcomes

The revascularisation procedures were divided into two groups: endovascular (angioplasty as the only revascularisation, with or without stent) and surgical revascularisations (endarterectomy or profundaplasty as the only revascularisation, or leg bypass either as the only revascularisation or in combination with other revascularisation procedures). Office for Population Censuses and Surveys (OPCS) version 4 codes used to identify these procedures are provided in Online Supplement 1, Tables S1 and S2.

The primary outcomes in our analyses were any major lower limb amputation and death from any cause occurring within one year of revascularisation. The OPCS codes for identifying major lower limb amputations are provided in Online Supplement 1, Table S3.

Patient characteristics

HES data included information on patient age, sex, comorbidities and indications for revascularisation. Indications and comorbidities were ascertained from the International Classification of Diseases version 10 (ICD-10) diagnostic codes recorded at the relevant admission. Indications for revascularisation were identified from the diagnostic codes recorded at the index admission and defined as follows: IC: intermittent claudication; SLI1: severe limb ischaemia without a record of tissue loss; SLI2: severe limb ischaemia with ulceration; and SLI3: severe limb ischaemia with gangrene or osteomyelitis. Severe limb ischaemia was defined as PAD or diabetes with peripheral circulatory complications (Online Supplement, Table S4). Comorbidities were coded into the Royal College of Surgeons (RCS) Charlson Score, as previously reported [14]. Briefly, the score was defined as the number of selected comorbidities recorded at the index admission (revascularisation), with the exception of acute conditions (such as myocardial infarction), which were counted as co-morbidities if present in a HES record of a hospital admission within the 12 months prior to the index procedure. (Online Supplement, Table S5). PAD was used to define indication for intervention and thus not included in the RCS Charlson score. Comorbid diabetes was defined as a record of diabetes in the index admission or up to a year prior to it (Online Supplement, Table S6).

Statistical analyses

The risks of major amputation and death were examined using Fine-Gray competing risks regression. [15, 16] We examined unadjusted and multivariable-adjusted associations of each procedure with each outcome (amputation and death), with the other outcome as a competing risk. Analyses were stratified by diabetes status. Linear, logistic and competing risks regression models were used to examine trends across the study period. The time-to-event was defined as months from the first revascularisation procedure to major lower limb amputation, death of the patient or the end of follow-up (one year after revascularisation). In the competing risk models the proportionality of sub-distribution hazards was checked by including an interaction term with time in the model. The assumption was valid for all procedure-outcome pairs. Age (ten-year bands), sex, the RCS Charlson score (0, 1, 2, 3+) and indications for revascularisation (IC, SLI1, SLI2 and SLI3) were analysed as categorical variables and comorbid diabetes as a binary variable. The adjusted cumulative incidence rates are shown for the specified values of the main exposure, at average values of the covariates. All analyses were conducted using Stata MP 14 (Stata Corporation, College Station, Texas, US).

Results

The characteristics of the patients included in our analyses are summarised in Table 1. In total, 77 213 men and women underwent endovascular revascularisation and 26 721 underwent surgical revascularisation for infrainguinal PAD between January 2006 and December 2015. The median follow-up was 12 months (range: 5 days to 12 months). Most patients were men and the majority were aged 65 years or older. The age-distribution remained similar throughout the study period, whereas the proportion of men among revascularisation patients increased slightly from 62.6% to 64.8%. There was also an increase in the proportions of patients with RCS Charlson scores 2 and 3, as well as in the proportions of patients undergoing revascularisation for more severe limb ischaemia (SLI1, SLI2 and SLI3). The prevalence of diabetes among the study population increased by approximately 8% over the study period. Overall, endovascular procedures became more common and surgical revascularisation less common over the study period. The proportions of patients who underwent an amputation or died during the year following revascularisation decreased for both endovascular and surgical procedures. (Table 1).

Adjusted cumulative incidences of major lower limb amputation and death following endovascular and surgical revascularisation are shown in Figures 1 and 2, separately for each two-year interval. In the beginning of our study period, 2006-07, the 1-year cumulative incidence of amputation was 5.7% after endovascular and 11.2% after surgical revascularisation (Figure 1).

By 2014-2015, the risk of amputation following endovascular procedures had reduced to 3.9% ($p<0.0001$) and the same risk after surgery to 6.6% ($p<0.0001$). (Unadjusted estimates are provided in the Online Supplement, Figures S1 and S2, and Table S7.)

The adjusted 1-year cumulative incidence of death at the beginning of our study period, 2006-07, was 9.5% following endovascular procedures and 11.1% following surgery. Both decreased during the following bi-yearly intervals, with the cumulative incidence of death in 2014-15 falling to 6.0% after endovascular and 6.4% after surgical revascularisation ($p<0.0001$) (Figure 2).

Cumulative incidences of major amputation and death within one year of revascularisation, stratified by procedure and diabetes status, are shown in Figures 3 and 4. (The corresponding unadjusted estimates are provided in the Online Appendix, Tables S8 and S9.) The cumulative incidence of each outcome was higher among diabetic patients than among patients with no record of diabetes, in both procedure groups and throughout the study period (Figures 3 and 4).

Figure 5 shows the secular change in the risks of amputation and death, by procedure and diabetes status. In addition to the risk estimates, sub-distribution hazard ratios (SHRs) are presented: they indicate the change in the cumulative incidence functions for amputation and death during the bi-yearly intervals of follow-up compared to the baseline 2006-07. The 1-year cumulative incidence of major amputation following endovascular and surgical revascularisation reduced in diabetic and diabetes-free patients alike. The cumulative incidence of death also reduced (Figure 5).

The cumulative incidences of amputation and death, by indication for revascularisation, are summarised in Figures 6 and 7, and shown in detail in the Online Appendix, Tables S10 and

S11. Compared to 2006-07, the 1-year cumulative incidence of amputation following endovascular revascularisation was lower in 2014-15 in all indication categories (Figure 6). The evidence for a decreasing trend was the most notable in patients undergoing surgical revascularisation for SLI2 or SLI3. In the first group, the cumulative incidence of amputation reduced from 19.5% to 69.5%, from 25.3% to 16.1%. The 1-year cumulative incidence of amputation after endovascular revascularisation showed a similar pattern, and the evidence for a decreasing trend in risk was again the clearest in the SLI2 and SLI3 groups (Figure 6 and Table S10).

Cumulative incidence of death within a year following both endovascular and surgical revascularisation also decreased between the study baseline in 2006-07 and 2014-15, although the pattern was less clear than for amputation (Figure 7). Among patients undergoing endovascular revascularisation for IC or SLI1, the risk of death reduced by 2-3%, from approximately 6% to 3% in the IC group and 7% to 4% in the SLI1 group. Larger reductions were observed in the SLI2 and SLI3 groups, where the cumulative incidence of death decreased from 20.5% to 14.6% and from 25.5% to 15.9%, respectively (Figure 7 and Table S11). After surgical revascularisation, the 1-year cumulative incidence of death decreased from approximately 10% to 5% in the IC and SLI groups. Again, the reduction was more notable in the SLI3 group (Figure 7 and Table S11).

The proportions of patients undergoing endovascular and surgical revascularisation, by year and indication for the intervention, are shown in Figure 8. Overall, the proportion of endovascular revascularisations increased and the proportion of surgical procedures decreased slightly over the study period ($p<0.0001$, Table 1 and Figure 8). The increasing trend was the clearest among patients undergoing revascularisation for SLI3: in this group, the proportion of surgical revascularisations reduced from 33% in 2006-07 to 19% in 2014-2015 (p<0.0001).A similar trend was also observed in those treated for IC or SLI2. Among patients in the SLI1 group, the split of the procedures (endovascular and surgical) varied across the study period but there was little evidence for a trend (p=0.06). Endovascular revascularisation also became more common and surgical procedures less common among patients with a record of diabetes, whereas among those with no diabetes, the proportions of the two types of procedures remained static (Online Supplement, Figure S3).

Discussion

Summary of main findings

Our findings suggest that during our study period, 2006-2015, the 1-year risk of major amputation in England reduced from 5.7% to 3.9% following endovascular and from 11.2% to 6.6% following surgical lower limb revascularisation. The 1-year risk of death also reduced, from 9.5% to 6.0% following endovascular and from 11.1% to 6.4% following surgical procedures. The reduction in the risk of amputation was the largest among patients with most severe underlying disease (SLI3, severe limb ischaemia with gangrene).

We found some evidence that the relative frequency of the two types of revascularisation procedures changed between 2006-07 and 2014-2015. Overall, endovascular revascularisation became more common over the study period. The evidence for this trend was the clearest among patients who were treated for SLI3 (severe limb ischaemia with gangrene). These observations reflect an increase in the overall number of endovascular procedures being performed over the study period, with the number of surgical procedures staying static.

Our investigation focused on 1-year risks of amputation and death following infrainguinal revascularisation, and the reducing 1-year risk of major amputation following revascularisation for infrainguinal PAD is in agreement with previous research findings. The BASIL trial and a previous study based on HES data, both with outcomes measured in the mid-2000s, reported that approximately 12% of (mainly) femoropopliteal bypass patients underwent major amputation within a year of this operation. [1, 6] In our dataset 6.3% of patients undergoing endovascular and 11.9% of patients undergoing surgical revascularisation in 2006-07 had an amputation within a year of the index procedure. The slightly lower proportions of amputation outcomes in our analyses may be due to different inclusion and exclusion criteria: for instance, we excluded patients undergoing revascularisation due to cancer or trauma (ca. 2% of revascularisations in our dataset), which was not done in all previous studies. Our findings should not, however, be interpreted as indicative of the relative merits of endovascular and surgical revascularisation.

Several possible explanations for the observed reductions in the 1-year risk of amputation and death exist. One possibility is that the developments in techniques and technology (such as drug eluting stents) have led to more favourable patient outcomes. Also, during our study period, in particular the years from 2010 to 2015, vascular services in the UK were subject to a process of specialisation away from general surgery, and centralisation from multiple low volume centres to a smaller number of high volume specialist centres. [17] It is possible that this reorganisation of vascular surgical care has had an impact on the changes and improvements identified in the current study. In response to increasing evidence pointing to a positive relationship between hospital and surgeon volumes and the outcome of arterial surgery[18], in 2009 the Vascular Society of Great Britain and Ireland (VSGBI) published recommendations on reconfiguring the vascular services in the UK around a hub and spoke model. In this model of care all arterial surgery (including lower limb bypass and major amputations) is centralised into high-volume hub hospitals, with lower volume spoke hospitals providing local assessment, diagnosis and less complex interventions. A hub is a hospital that provides a vascular on-call rota of 1:6 or greater, and serves a population-base of at least 800 000. [17, 19]

Other possible explanations for the decreasing risks of amputation and death among PAD patients relate to changes in cardiovascular disease (CVD) epidemiology and risk factors in the years leading up to and during the study period, 2006-2015. For instance, the prevalence of smoking, an important risk factor for PAD, began to decrease in men and women in all age groups in the UK in the 1970s, and this trend has continued at least to the mid-2010s.[20, 21] Co-inciding with the reduction in smoking, prescription registers show that statin use increased in the UK in 1995-2013, in keeping with the National Institute of Health and Care Excellence (NICE) guidelines advising general practitioners (UK family physicians) to ensure statins are prescribed to all patients whose 10-year risk of CVD exceeds 20% (>10% since July 2014) [22, 23]. It is possible that the population-level reductions smoking exposure and cholesterol levels have led to the severity of PAD decreasing in patient cohorts presenting for revascularisation, which in turn could have improved outcomes of these procedures. However, our findings for 2006-2015 suggest that the overall proportion of patients having revascularisation for milder PAD (marked by IC) decreased and the proportions of those treated PAD with tissue loss increased. It seems thus unlikely that the observed improvements in outcomes reflect the decreasing severity of the underlying disease among patients undergoing revascularisation in the past few decades.

Coinciding with the increase in statin use and decrease in smoking, the overall burden of CVD in the UK has declined since the 1970s [24]. Mortality and case-fatality from major CVD outcomes (coronary heart disease and stroke) have declined considerably in all UK countries [24, 25]. The prevalence of CVD has, however, remained relatively static and slightly increased in men and women aged 65 years and older between 2004 and 2015, which Bhatnagar and colleagues hypothesise could be a result of the reduced mortality and case-fatality rates.[25] Taken together, these trends suggest that the burden of CVD may be shifting from hard and fatal outcomes (e.g. myocardial infarction or stroke) to milder forms of the disease, such as PAD. If this is the case, patients who a few decades ago would have died of a major coronary event or stroke are now have their CHD is managed and are accessing health services for PAD. In this scenario, the findings of the present investigation would be even more encouraging, if indeed the outcomes were improving despite older and more severely ill patients with more (cardiovascular and other) comorbidities undergoing lower limb revascularisation. Our findings lend some support to this hypothesis, for although patient age remained static throughout the study period, the number of comorbidities and the severity of the underlying PAD appeared to increase. However, these interpretations warrant caution because improvements in the completeness and accuracy of diagnostic coding in HES may have influenced out findings.

Finally, the observation that the risks of amputation, as well as death, reduced steadily in almost all patient groups could reflect an overall improvement in care, or it could relate to changes in clinical coding. A trend during our study period towards more complete and specific coding of secondary diagnoses (used to identify indications and comorbidities) could have led to overestimation of the risks of amputation and death during the earlier years in patients with the least severe underlying disease. However, this seems to be an unlikely explanation for the observed results, as the falling risks were observed for the total patient cohort and were the largest among the most severely ill patients. Comparison to studies in other countries and settings would help to assess whether our observations can be attributed to improvements in care, changes in CVD prevalence, incidence and risk factors, quality of the data, or some combination of all of these.

Strengths and limitations

An important strength of our analyses is that we used a large set of routinely collected patient-level data, which capture information on all revascularisation procedures conducted in NHS hospitals in England. It is thus unlikely that sample selection or loss to follow-up have significantly biased our findings. Furthermore, a dataset of just under 104 000 patients gave our analyses sufficient power to produce precise estimates of the risks of major lower limb amputation and death following endovascular and surgical revascularisation. A further strength of our analyses is that we used competing risks regression models to examine the risks of amputation and death separately, which is important for unpicking the associations of revascularisations with these outcomes in a population of older patients with multiple comorbidities. The amount of missing data in our analyses was negligible (<1%).

A limitation in our study is that the diagnostic validity of HES for identifying indications for interventions and comorbid conditions is not ideal. However, a recent systematic review suggests that the accuracy of diagnostic coding in this dataset has improved since the mid- to late 2000s [26, 27]. Indeed, the reduction in the number of patients with no comorbidities (from 17% in 2006-07 to 12% in 2014-2015, Table 1) could point to a larger number of comorbidities being accurately recorded in HES. It is possible that this contributed to some of the changes in outcomes and patient characteristics, such as the increasing prevalence of diabetes, observed over the study period. The coding of major interventions in HES is generally very accurate. Although it is possible that some revascularisation procedures have been incompletely recorded or omitted from HES, which might have introduced bias to our estimates, we would expect the size of such bias to be small in comparison to the observed changes in risks.

HES is a rich source of patient-level data on hospital admissions and procedures but it does not contain data on patient physiology or anatomy, and we were thus unable the gauge the potential confounding effects of patient fitness or vascular anatomy on the selection of patients for different types of revascularisation procedures. Finally, we conducted a large number of comparisons and it is therefore possible that some of the observed associations were chance findings.

Implications and future directions

Based on a large set of routinely collected observational data, the findings presented here should be interpreted as descriptive of the care and patient outcomes in England nationwide; further research, however, would be needed to produce risk models that would predict an individual patient's risk of amputation or death associated with undergoing lower limb revascularisation. Large, well-conducted prospective studies, based on disease or procedure registers with detailed information on physiological and anatomical covariates and linked to national hospitalisation and death records, would provide the best setting for future research into patient outcomes following lower limb revascularisation. They would provide generalisable information, with appropriate statistical power, to investigate the roles of the underlying disease and patient clinical characteristics on the patient care pathway and outcomes.

Conclusion

Over a 10-year period there has been a shift in the pattern of revascularisation procedures for infrainguinal PAD in England, with an increasing number of endovascular procedures being performed, especially among patients with the most severe forms of lower limb PAD. The overall survival increased, and rate of major lower limb amputation decreased over the same period for both endovascular and surgical procedures, despite higher morbidity and larger proportions of patients treated for the severe end of the spectrum of PAD. These trends suggest overall improvements in the outcomes for patients with severe PAD during a period of centralisation and specialisation of vascular surgical services in the UK.

Supporting information

Online Supplement

Sources of Funding

This study was undertaken as part of the work by the National Vascular Registry to evaluate the clinical outcomes achieved by English NHS vascular units. The National Vascular Registry is commissioned by the Healthcare Quality Improvement Partnership (HQIP) as part of the National Clinical Audit Programme (NCA). The funding bodies had no role in the study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Disclosures

None

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Table 1. Participant characteristics by year of revascularisation

N (%) participants	2006-07	2008-09	2010-11	2012-13	2014-2015	p for trend across the study period
Procedures						
Endovascular	13 701 (71.7)	14 826 (74.1)	16 117 (74.7)	16 922 (75.2)	15 647 (75.5)	<0.0001
Surgical	5 402 (28.3)	5 190 (25.9)	5 470 (25.3)	5 582 (24.8)	5 077 (24.5)	
Outcomes at 1 year						
Amputation	1 514 (7.9)	1 535 (7.7)	1 542 (7.1)	1 504 (6.7)	1 370 (6.6)	<0.0001
Death	2 362 (12.4)	2 330 (11.6)	2 486 (11.5)	2 426 (12.1)	2 143 (10.3)	<0.0001
Covariates						
Women	7 137 (37.4)	7 457 (37.3)	7 785 (36.1)	8 131 (36.1)	7 291 (35.2)	<0.0001
Age (years)						
<=49	688 (3.6)	718 (3.6)	857 (4.0)	810 (3.6)	763 (3.7)	0.4
50-59	2 252 (11.8)	2 392 (12.0)	2 618 (12.1)	2 870 (12.8)	2 676 (12.9)	
60-69	4 904 (25.7)	5 066 (25.3)	5 541 (25.7)	5 634 (25.0)	5 052 (24.4)	
70-79	6 426 (33.6)	6 557 (32.7)	6 812 (31.6)	7 052 (31.3)	6 469 (31.2)	
80+	4 833 (25.3)	5 283 (26.4)	5 759 (26.7)	6 38 (27.3)	3 764 (27.8)	
RCS Charlson score						
0	3 176 (16.6)	3 381 (16.9)	3 347 (15.5)	3 316 (14.7)	2 489 (12.0)	<0.0001
1	11 166 (58.5)	10 949 (54.7)	11 119 (51.5)	11 227 (49.9)	9 978 (48.2)	
2	1 549 (8.1)	1 825 (9.1)	2 160 (10.0)	2 289 (10.2)	4 109 (10.2)	
3+	3 212 (16.8)	3 861 (19.3)	4 961 (23.0)	5 672 (25.2)	6 148 (29.7)	
Indication*						
IC	5 760 (30.2)	5 212 (26.0)	4 509 (20.9)	3 721 (16.5)	3 104 (15.0)	<0.0001
SLI1	9 104 (47.7)	10 039 (50.3)	11 290 (52.3)	12 303 (54.7)	11 341 (54.7)	
SLI2	2 639 (13.8)	2 830 (14.1)	3 233 (15.0)	3 959 (17.6)	4 038 (19.5)	
SLI3	1 600 (8.4)	1 905 (9.5)	2 555 (11.8)	2 521 (11.2)	2 241 (10.8)	
Diabetic	4 977 (26.1)	5 426 (27.1)	6 255 (29.0)	7 130 (31.7)	7 210 (34.4)	<0.0001
All	**19 103 (100.0)**	**20 016 (100.0)**	**21 587 (100.0)**	**22 504 (100.0)**	**20 724 (100.0)**	

* IC: intermittent claudication; SLI1: severe limb ischaemia without tissue loss; SLI2: severe limb ischaemia with ulceration; SLI3: severe limb ischaemia with gangrene/osteomyelitis

10.1161/CIRCULATIONAHA.117.029834

Figure Legends

Figure 1. Multivariable-adjusted* cumulative incidence of amputation within 1 year following revascularisation †

* Adjusted for age, sex, RCS Charlson score and indication for revascularisation.

† The figures show the cumulative incidence for the endovascular and surgical revascularisation, at mean values of covariates.

Figure 2. Multivariable-adjusted* cumulative incidence of death within 1 year following revascularisation †

* Adjusted for age, sex, RCS Charlson score and indication for revascularisation.

†The figures show the cumulative incidence for the endovascular and surgical revascularisation, at mean values of covariates.

Figure 3. Multivariable-adjusted* cumulative incidence of amputation within 1 year following revascularisation, by type of procedure and comorbid diabetes

* Adjusted for age, sex, RCS Charlson score and indication for revascularisation.

† E+D: endovascular, with diabetes; E-D: endovascular, no diabetes; S+D: surgical, with diabetes; S-D: surgical, no diabetes. The figures show the cumulative incidence for the endovascular and surgical revascularisation, at mean values of covariates.

Figure 4. Multivariable-adjusted* cumulative incidence of death within 1 year following revascularisation, by type of procedure and comorbid diabetes

10.1161/CIRCULATIONAHA.117.029834

[*] Adjusted for age, sex, RCS Charlson score and indication for revascularisation.

† Legend: E+D: endovascular, with diabetes; E-D: endovascular, no diabetes; S+D: surgical, with diabetes; S-D: surgical, no diabetes. The figures show the cumulative incidence for the endovascular and surgical revascularisation, at mean values of covariates.

Figure 5. Secular change in the risk of amputation and death between 2006-07 and 2014-15, by procedure and diabetes status *

* Adjusted for age, sex, RCS Charlson score and indication for revascularisation.

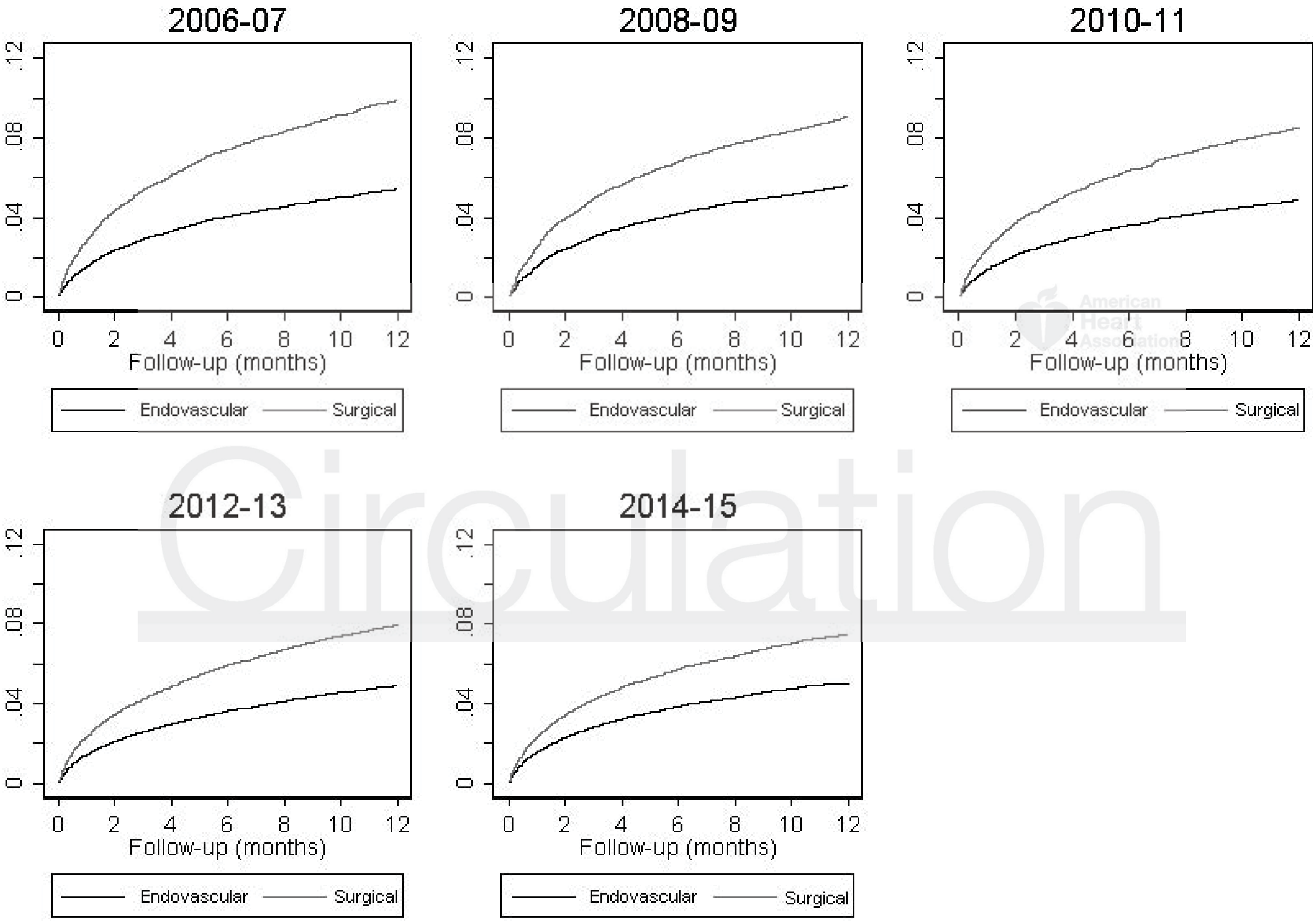
Figure 6. Secular change in the risk of amputation between 2006-07 and 2014-15, by procedure and indication *

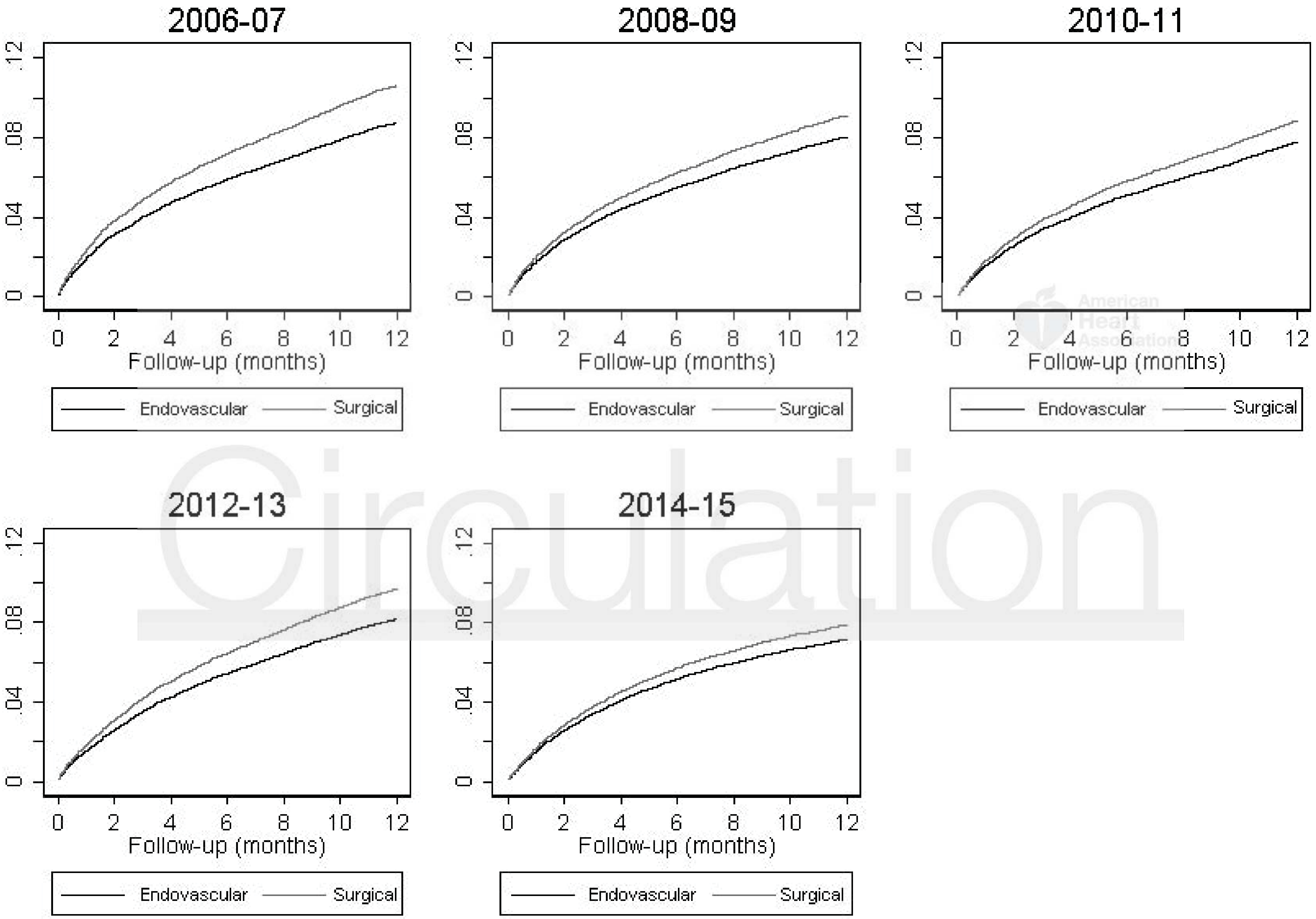
* adjusted for age, sex, RCS Charlson score and indication for revascularisation.

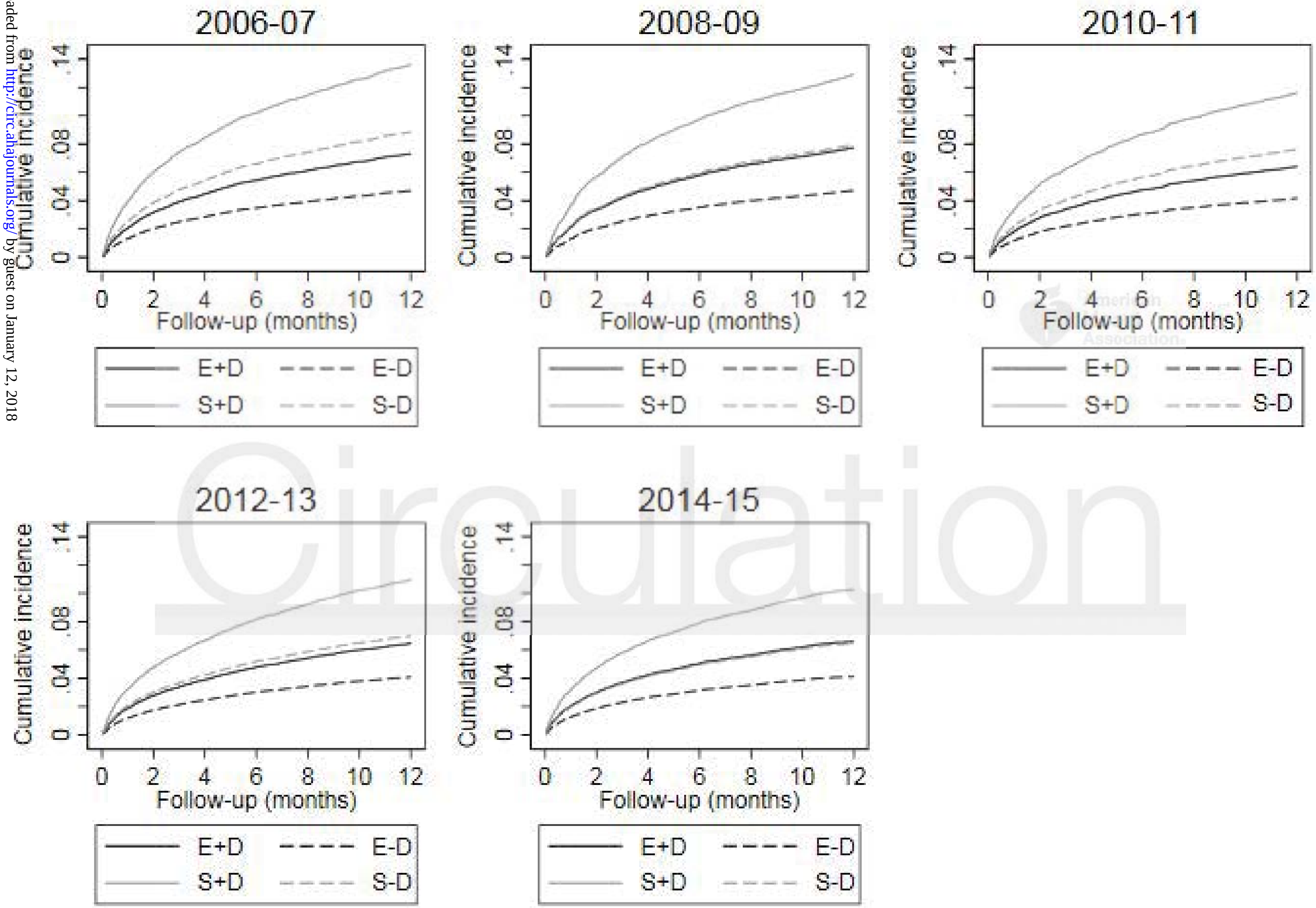
Figure 7. Secular change in the risk of death between 2006-07 and 2014-15, by procedure and indication *

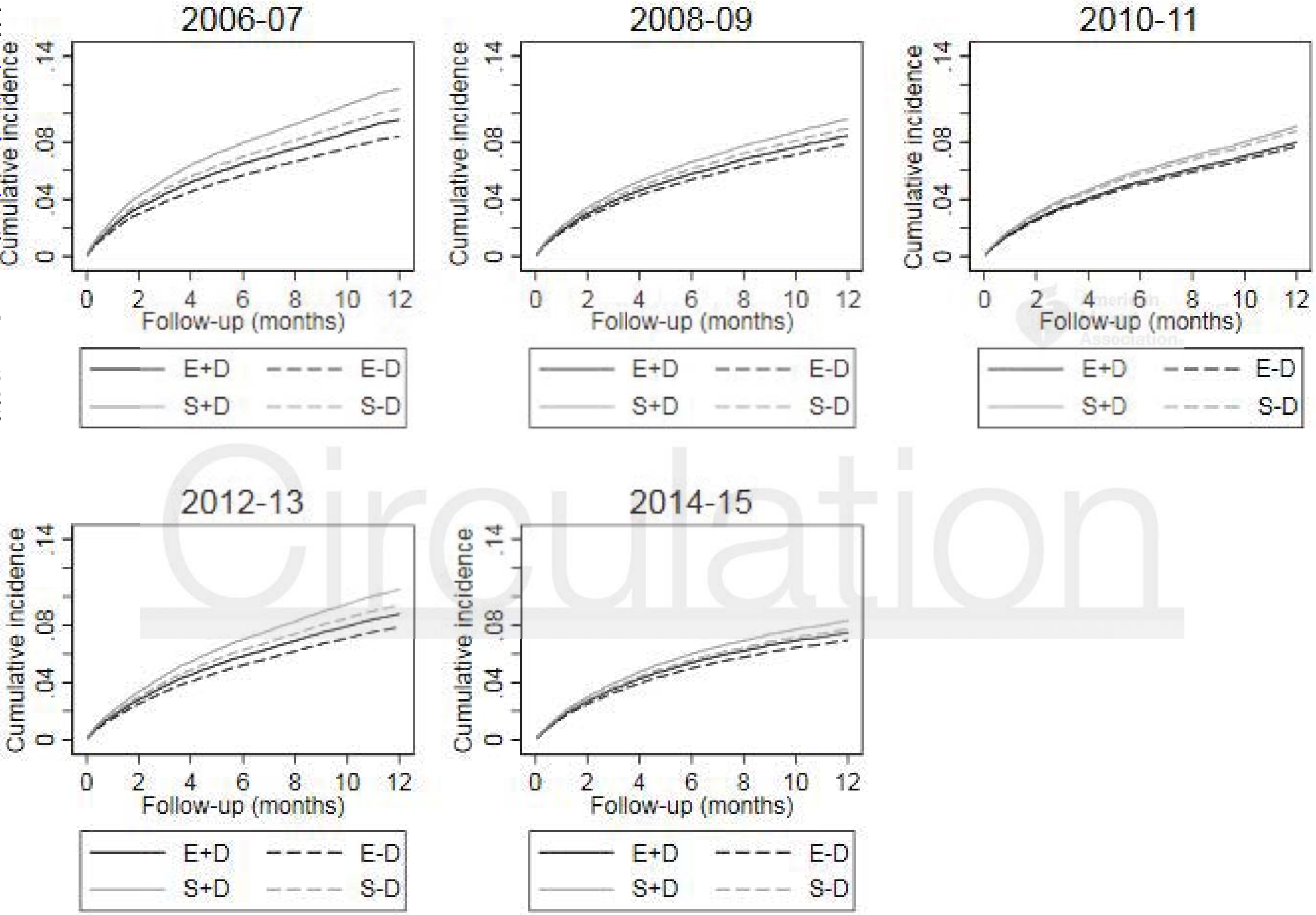
* Adjusted for age, sex, RCS Charlson score and indication for revascularisation.

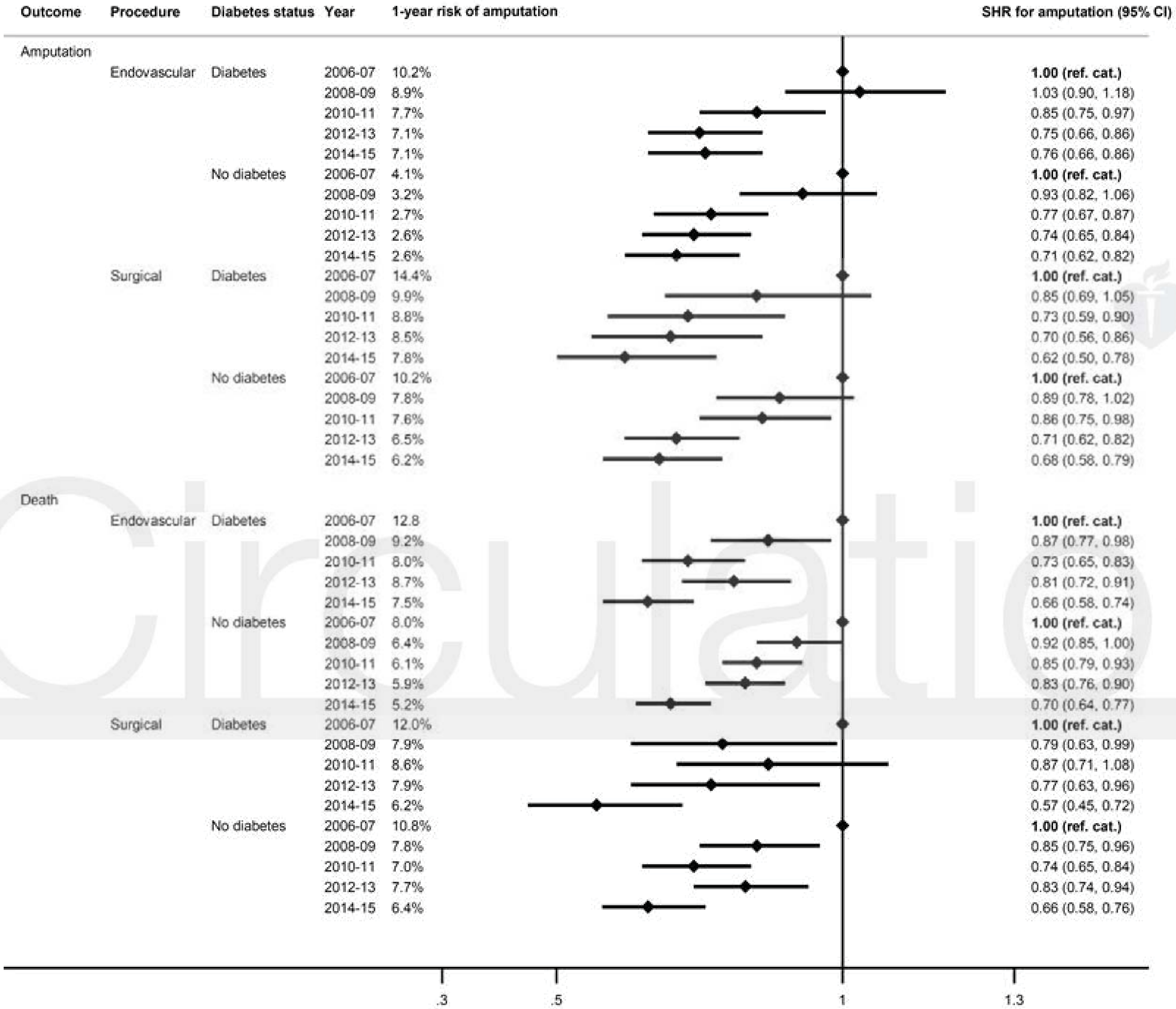
Figure 8. Proportions of patients undergoing endovascular and surgical revascularisation, by year and indication for revascularisation

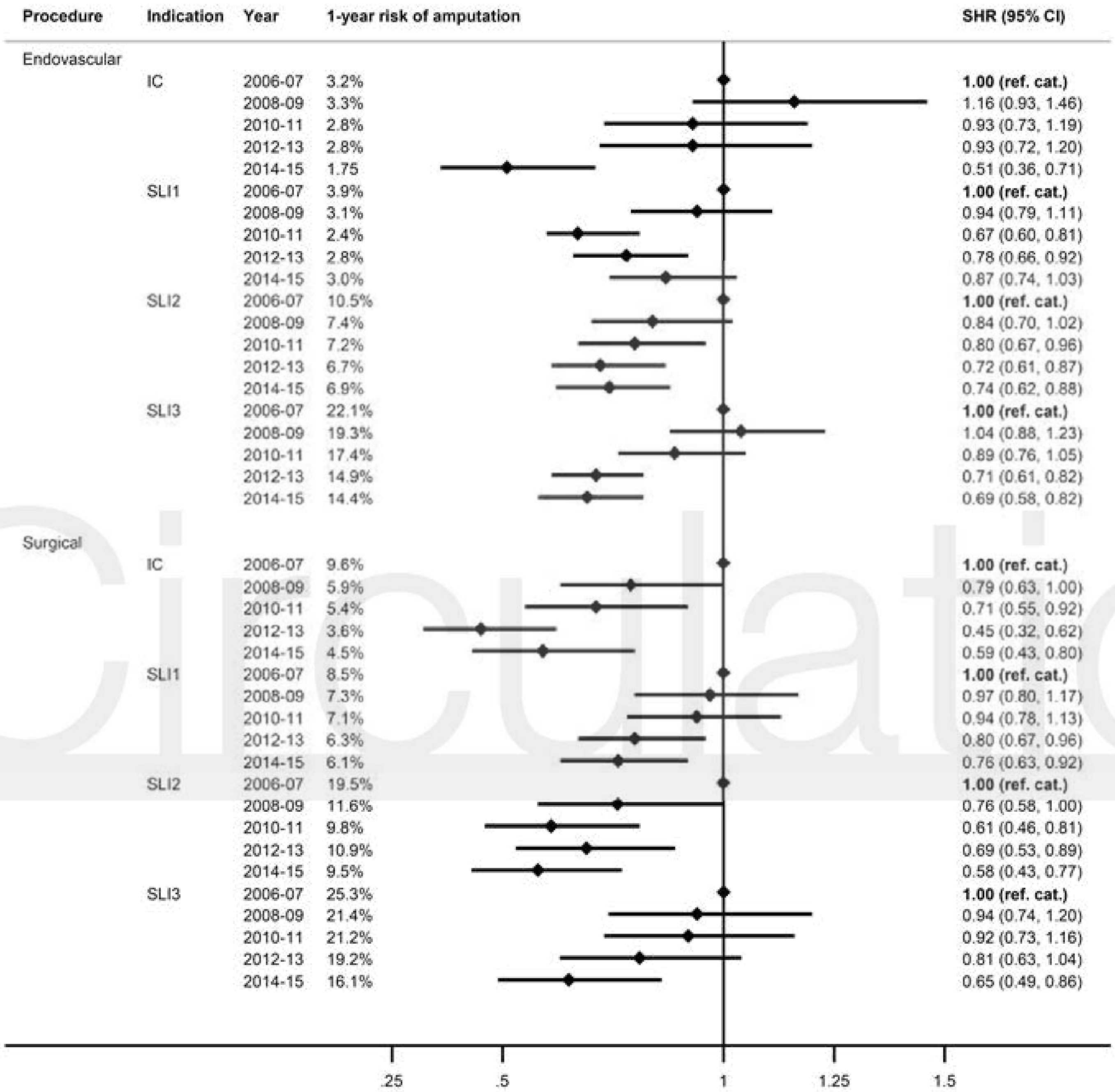

2006-07
2008-09
2010-11
2012-13
2014-15
0
.04
.08
.12
0 2 4 6 8 10 12
Follow-up (months)
Endovascular
Surgical

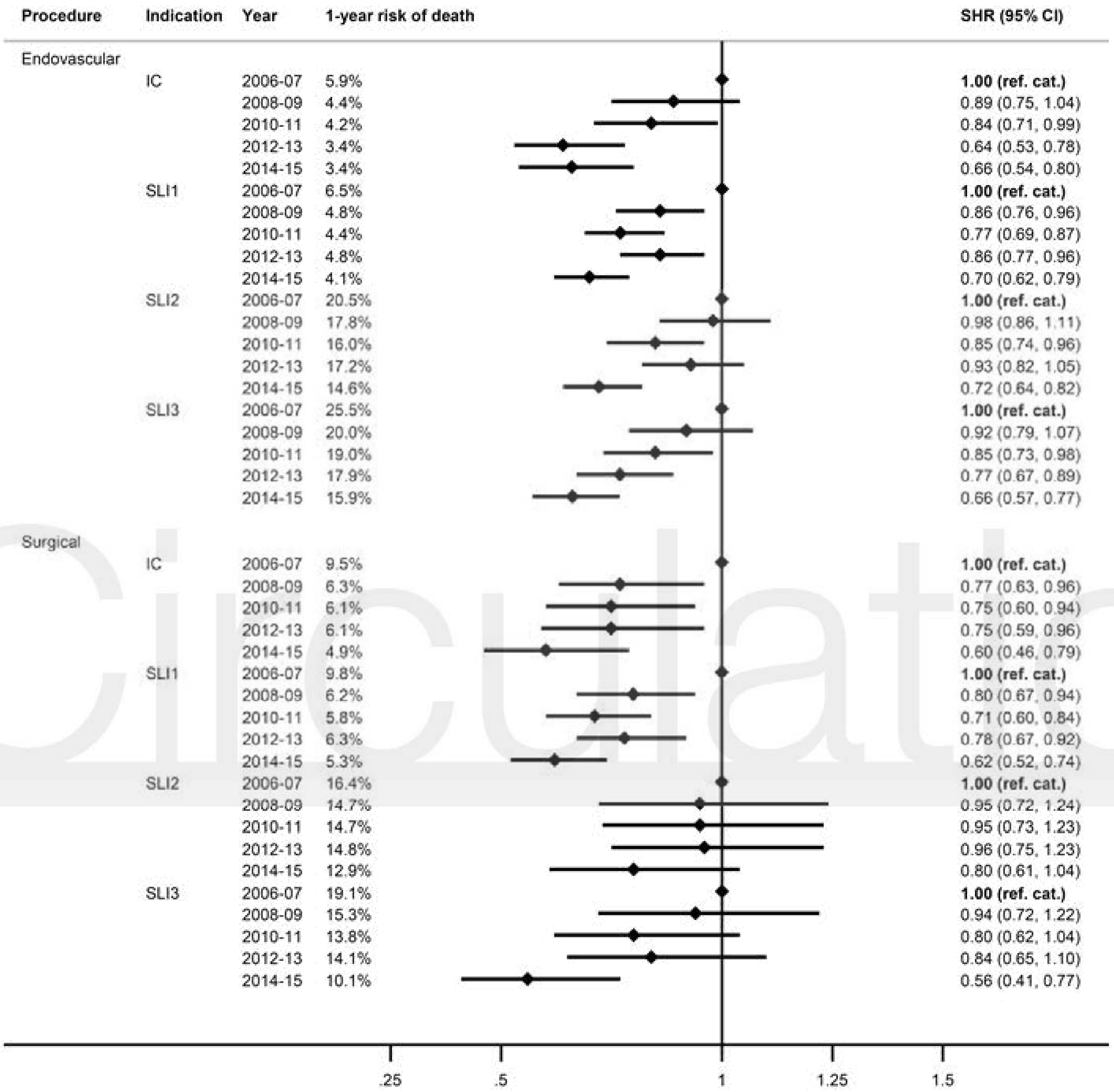

2006-07
2008-09
2010-11
2012-13
2014-15
0
.04
.08
.12
0 2 4 6 8 10 12
Follow-up (months)
Endovascular
Surgical

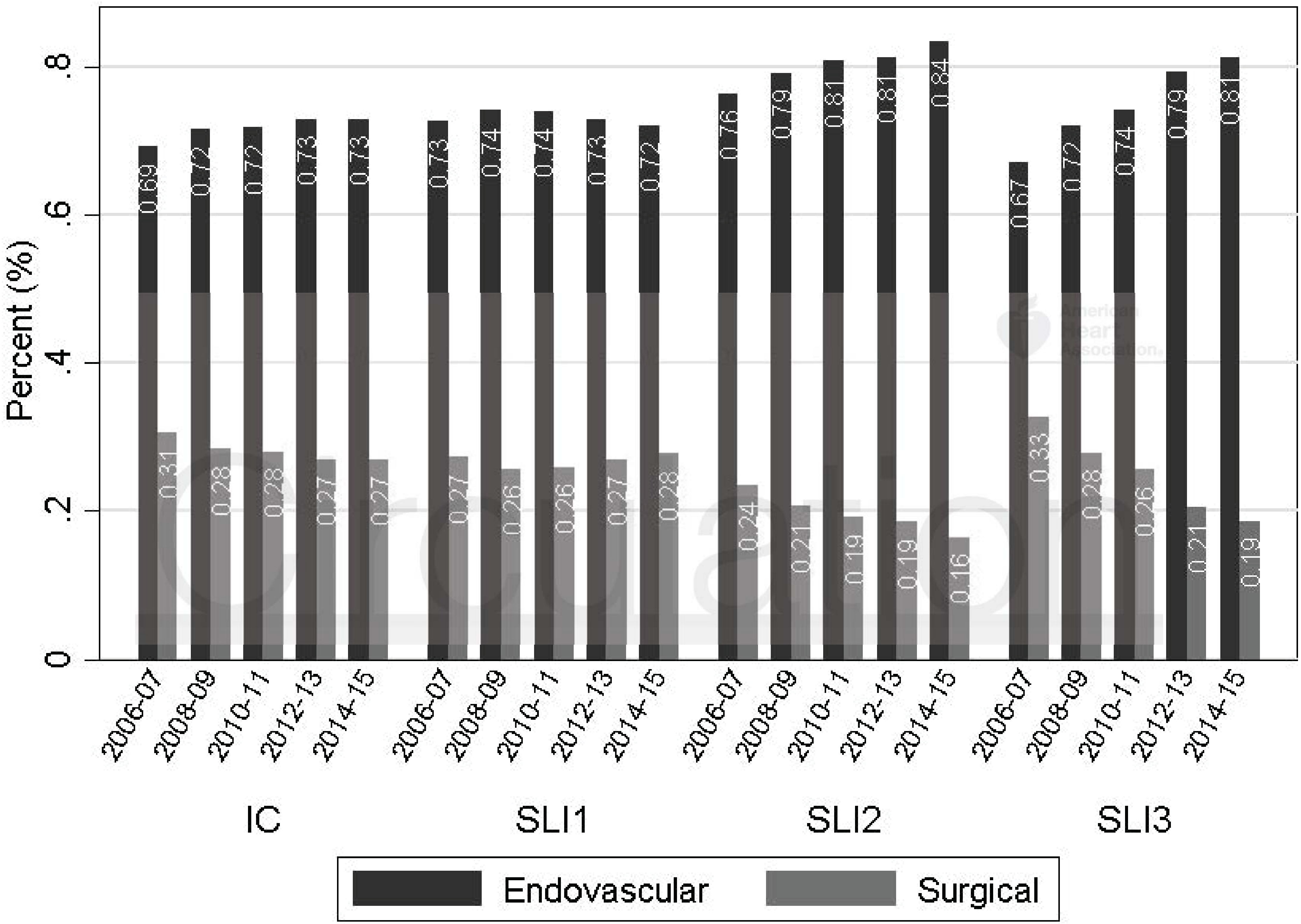

2006-07
2008-09
2010-11
2012-13
2014-15
Cumulative incidence
0
.04
.08
.14
Follow-up (months)
0 2 4 6 8 10 12
E+D
E-D
S+D
S-D


2006-07
2008-09
2010-11
2012-13
2014-15
Cumulative incidence
0
.04
.08
.14
Follow-up (months)
0 2 4 6 8 10 12
E+D
E-D
S+D
S-D


Outcome | Procedure | Diabetes status | Year | 1-year risk of amputation | SHR for amputation (95% CI)
Amputation
Endovascular | Diabetes | 2006-07 | 10.2% | 1.00 (ref. cat.)
2008-09 | 8.9% | 1.03 (0.90, 1.18)
2010-11 | 7.7% | 0.85 (0.75, 0.97)
2012-13 | 7.1% | 0.75 (0.66, 0.86)
2014-15 | 7.1% | 0.76 (0.66, 0.86)
No diabetes | 2006-07 | 4.1% | 1.00 (ref. cat.)
2008-09 | 3.2% | 0.93 (0.82, 1.06)
2010-11 | 2.7% | 0.77 (0.67, 0.87)
2012-13 | 2.6% | 0.74 (0.65, 0.84)
2014-15 | 2.6% | 0.71 (0.62, 0.82)
Surgical | Diabetes | 2006-07 | 14.4% | 1.00 (ref. cat.)
2008-09 | 9.9% | 0.85 (0.69, 1.05)
2010-11 | 8.8% | 0.73 (0.59, 0.90)
2012-13 | 8.5% | 0.70 (0.56, 0.86)
2014-15 | 7.8% | 0.62 (0.50, 0.78)
No diabetes | 2006-07 | 10.2% | 1.00 (ref. cat.)
2008-09 | 7.8% | 0.89 (0.78, 1.02)
2010-11 | 7.6% | 0.86 (0.75, 0.98)
2012-13 | 6.5% | 0.71 (0.62, 0.82)
2014-15 | 6.2% | 0.68 (0.58, 0.79)
Death
Endovascular | Diabetes | 2006-07 | 12.8 | 1.00 (ref. cat.)
2008-09 | 9.2% | 0.87 (0.77, 0.98)
2010-11 | 8.0% | 0.73 (0.65, 0.83)
2012-13 | 8.7% | 0.81 (0.72, 0.91)
2014-15 | 7.5% | 0.66 (0.58, 0.74)
No diabetes | 2006-07 | 8.0% | 1.00 (ref. cat.)
2008-09 | 6.4% | 0.92 (0.85, 1.00)
2010-11 | 6.1% | 0.85 (0.79, 0.93)
2012-13 | 5.9% | 0.83 (0.76, 0.90)
2014-15 | 5.2% | 0.70 (0.64, 0.77)
Surgical | Diabetes | 2006-07 | 12.0% | 1.00 (ref. cat.)
2008-09 | 7.9% | 0.79 (0.63, 0.99)
2010-11 | 8.6% | 0.87 (0.71, 1.08)
2012-13 | 7.9% | 0.77 (0.63, 0.96)
2014-15 | 6.2% | 0.57 (0.45, 0.72)
No diabetes | 2006-07 | 10.8% | 1.00 (ref. cat.)
2008-09 | 7.8% | 0.85 (0.75, 0.96)
2010-11 | 7.0% | 0.74 (0.65, 0.84)
2012-13 | 7.7% | 0.83 (0.74, 0.94)
2014-15 | 6.4% | 0.66 (0.58, 0.76)
.3
.5
1
1.3


Procedure
Indication
Year
1-year risk of amputation
SHR (95% CI)
Endovascular
IC
2006-07 3.2% 1.00 (ref. cat.)
2008-09 3.3% 1.16 (0.93, 1.46)
2010-11 2.8% 0.93 (0.73, 1.19)
2012-13 2.8% 0.93 (0.72, 1.20)
2014-15 1.75 0.51 (0.36, 0.71)
SLI1
2006-07 3.9% 1.00 (ref. cat.)
2008-09 3.1% 0.94 (0.79, 1.11)
2010-11 2.4% 0.67 (0.60, 0.81)
2012-13 2.8% 0.78 (0.66, 0.92)
2014-15 3.0% 0.87 (0.74, 1.03)
SLI2
2006-07 10.5% 1.00 (ref. cat.)
2008-09 7.4% 0.84 (0.70, 1.02)
2010-11 7.2% 0.80 (0.67, 0.96)
2012-13 6.7% 0.72 (0.61, 0.87)
2014-15 6.9% 0.74 (0.62, 0.88)
SLI3
2006-07 22.1% 1.00 (ref. cat.)
2008-09 19.3% 1.04 (0.88, 1.23)
2010-11 17.4% 0.89 (0.76, 1.05)
2012-13 14.9% 0.71 (0.61, 0.82)
2014-15 14.4% 0.69 (0.58, 0.82)
Surgical
IC
2006-07 9.6% 1.00 (ref. cat.)
2008-09 5.9% 0.79 (0.63, 1.00)
2010-11 5.4% 0.71 (0.55, 0.92)
2012-13 3.6% 0.45 (0.32, 0.62)
2014-15 4.5% 0.59 (0.43, 0.80)
SLI1
2006-07 8.5% 1.00 (ref. cat.)
2008-09 7.3% 0.97 (0.80, 1.17)
2010-11 7.1% 0.94 (0.78, 1.13)
2012-13 6.3% 0.80 (0.67, 0.96)
2014-15 6.1% 0.76 (0.63, 0.92)
SLI2
2006-07 19.5% 1.00 (ref. cat.)
2008-09 11.6% 0.76 (0.58, 1.00)
2010-11 9.8% 0.61 (0.46, 0.81)
2012-13 10.9% 0.69 (0.53, 0.89)
2014-15 9.5% 0.58 (0.43, 0.77)
SLI3
2006-07 25.3% 1.00 (ref. cat.)
2008-09 21.4% 0.94 (0.74, 1.20)
2010-11 21.2% 0.92 (0.73, 1.16)
2012-13 19.2% 0.81 (0.63, 1.04)
2014-15 16.1% 0.65 (0.49, 0.86)
.25
.5
1
1.25
1.5


Procedure
Indication
Year
1-year risk of death
SHR (95% CI)
Endovascular
IC 2006-07 5.9% 1.00 (ref. cat.)
2008-09 4.4% 0.89 (0.75, 1.04)
2010-11 4.2% 0.84 (0.71, 0.99)
2012-13 3.4% 0.64 (0.53, 0.78)
2014-15 3.4% 0.66 (0.54, 0.80)
SLI1 2006-07 6.5% 1.00 (ref. cat.)
2008-09 4.8% 0.86 (0.76, 0.96)
2010-11 4.4% 0.77 (0.69, 0.87)
2012-13 4.8% 0.86 (0.77, 0.96)
2014-15 4.1% 0.70 (0.62, 0.79)
SLI2 2006-07 20.5% 1.00 (ref. cat.)
2008-09 17.8% 0.98 (0.86, 1.11)
2010-11 16.0% 0.85 (0.74, 0.96)
2012-13 17.2% 0.93 (0.82, 1.05)
2014-15 14.6% 0.72 (0.64, 0.82)
SLI3 2006-07 25.5% 1.00 (ref. cat.)
2008-09 20.0% 0.92 (0.79, 1.07)
2010-11 19.0% 0.85 (0.73, 0.98)
2012-13 17.9% 0.77 (0.67, 0.89)
2014-15 15.9% 0.66 (0.57, 0.77)
Surgical
IC 2006-07 9.5% 1.00 (ref. cat.)
2008-09 6.3% 0.77 (0.63, 0.96)
2010-11 6.1% 0.75 (0.60, 0.94)
2012-13 6.1% 0.75 (0.59, 0.96)
2014-15 4.9% 0.60 (0.46, 0.79)
SLI1 2006-07 9.8% 1.00 (ref. cat.)
2008-09 6.2% 0.80 (0.67, 0.94)
2010-11 5.8% 0.71 (0.60, 0.84)
2012-13 6.3% 0.78 (0.67, 0.92)
2014-15 5.3% 0.62 (0.52, 0.74)
SLI2 2006-07 16.4% 1.00 (ref. cat.)
2008-09 14.7% 0.95 (0.72, 1.24)
2010-11 14.7% 0.95 (0.73, 1.23)
2012-13 14.8% 0.96 (0.75, 1.23)
2014-15 12.9% 0.80 (0.61, 1.04)
SLI3 2006-07 19.1% 1.00 (ref. cat.)
2008-09 15.3% 0.94 (0.72, 1.22)
2010-11 13.8% 0.80 (0.62, 1.04)
2012-13 14.1% 0.84 (0.65, 1.10)
2014-15 10.1% 0.56 (0.41, 0.77)
.25
.5
1
1.25
1.5


Percent (%)
0
.2
.4
.6
.8
2006-07
2008-09
2010-11
2012-13
2014-15
IC
SLI1
SLI2
SLI3
Endovascular
Surgical

Circulation

American Heart Association

Improving 1-year Outcomes of Infrainguinal Limb Revascularisation: A Population-Based Cohort Study of 104 000 Patients in England

Katriina Heikkila, David C. Mitchell, Ian M. Loftus, Amundeep S. Johal, Sam Waton and David A. Cromwell

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Supplemental Material

Article: Improving 1-year Outcomes of Infrainguinal Limb Revascularisation: A Population-based Cohort Study of 104 000 Patients in England

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Supplemental Tables

Table S1. Office of Population Censuses and Surveys Classification of Surgical Operations and Procedures (OPCS) version 4 codes to define endovascular lower limb revascularisation

Code	Description
L63.1	Percutaneous transluminal angioplasty of femoral artery
L63.5	Percutaneous transluminal insertion of stent into femoral artery
L66.2	Percutaneous transluminal stent reconstruction of artery
L66.5	Percutaneous transluminal balloon angioplasty of artery
L66.7	Percutaneous transluminal placement of peripheral stent in artery
L71.1	Percutaneous transluminal angioplasty of artery

Table S2. OPCS version 4 codes to define surgical lower limb revascularisation

Code	Description
Endarterectomy or profundaplasty	
L60.1	Endarterectomy of femoral artery and patch repair of femoral artery
L60.2	Endarterectomy of femoral artery NEC
L60.3	Profundaplasty of femoral artery and patch repair of deep femoral artery
L60.4	Profundaplasty of femoral artery NEC
Bypass	
L58.1	Emergency bypass of femoral artery by anastomosis of femoral artery to femoral artery NEC
L58.2	Emergency bypass of femoral artery by anastomosis of femoral artery to popliteal artery using prosthesis NEC
L58.3	Emergency bypass of femoral artery by anastomosis of femoral artery to popliteal artery using vein graft NEC
L58.4	Emergency bypass of femoral artery by anastomosis of femoral artery to tibial artery using prosthesis NEC
L58.5	Emergency bypass of femoral artery by anastomosis of femoral artery to tibial artery using vein graft NEC
L58.6	Emergency bypass of femoral artery by anastomosis of femoral artery to peroneal artery using prosthesis NEC
L58.7	Emergency bypass of femoral artery by anastomosis of femoral artery to peroneal artery using vein graft NEC
L59.1	Bypass of femoral artery by anastomosis of femoral artery to femoral artery NEC
L59.2	Bypass of femoral artery by anastomosis of femoral artery to popliteal artery using prosthesis NEC
L59.3	Bypass of femoral artery by anastomosis of femoral artery to popliteal artery using vein graft NEC
L59.4	Bypass of femoral artery by anastomosis of femoral artery to tibial artery using prosthesis NEC
L59.5	Bypass of femoral artery by anastomosis of femoral artery to tibial artery using vein graft NEC
L59.6	Bypass of femoral artery by anastomosis of femoral artery to peroneal artery using prosthesis NEC
L59.7	Bypass of femoral artery by anastomosis of femoral artery to peroneal artery using vein graft NEC

NEC: not elsewhere classified

Table S3. OPCS 4.6 codes to define major lower limb amputations

Code	**Description**
X09.1	Hindquarter amputation
X09.2	Disarticulation of hip
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
X09.9	Unspecified amputation of leg

Table S4. ICD-10 codes to define indications for revascularisation

Disease/condition	**ICD-10 codes**
Intermittent claudication	I739
Severe limb ischaemia AND/OR Diabetes with peripheral circulatory complications	I702, I724, I730-8, I743-5, I771, I779 E105, E115, E145
Ulceration	L97X, L030, L984
Gangrene	R02X
Osteomyelitis	M866, M869

Table S5. ICD-10 codes to define co-morbidities included in the RCS Charlson score (from diagnosis codes in the record of the index admission and previous admissions)

Co-morbidity	**ICD-10 codes**
Myocardial infarction	I21*, I22*, I23*, I252
Congestive cardiac failure	I11, I13, I255, I42, I43, I50, I517
Cerebrovascular disease	G45, G46, I60–I69
Dementia	A810, F00–F03, F051, G30, G31
Chronic pulmonary disease	I26, I27, J40–J45, J46*, J47, J60–J67, J684, J701, J703
Rheumatological disease	M05, M06, M09, M120, M315, M32–M36
Liver disease	B18, I85, I864, I982, K70, K71, K721, K729, K76, R162, Z944
Hemiplegia or paraplegia	G114, G81–G83
Renal disease	I12, I13, N01, N03, N05, N07, N08, N171*, N172*, N18, N19*, N25, Z49, Z940, Z992
Any malignancy	C00–C26, C30–C34, C37–C41, C43, C45–C58, C60–C76, C80–C85, C88, C90–C97
Metastatic solid tumour	C77–C79
AIDS/HIV infection	B20–B24

AIDS: acquired immune deficiency syndrome; HIV: human immunodeficiency virus
*Acute conditions that were defined as co-morbidities if present in a record of a previous hospital admission within 12 months prior to amputation.

Table S6. Codes to define diabetes

ICD-10 code	
E10	Insulin-dependent diabetes mellitus
E11	Non-insulin-dependent diabetes mellitus
E12	Malnutrition-related diabetes mellitus
E13	Other specified diabetes mellitus
E14	Unspecified diabetes mellitus

Table S7. Associations of year with amputation and death within 1 year of revascularisation, stratified by procedure type

Amputation		**Unadjusted estimates**			**Adjusted[1] estimates**		
Procedure Year	**N (%) amputations**	**Cumulative incidence (%)**	**SHR (95% CI)**	**p trend**	**Cumulative incidence (%)**	**SHR (95% CI)**	**p trend**
Endovascular							
2006-07	870 (6.4)	6.3	1 (ref. cat)		5.7	1 (ref. cat)	
2008-09	977 (6.6)	6.4	1.04 (0.95, 1.14)		4.8	0.98 (0.89,1.07)	
2010-11	974 (6.0)	6.0	0 95 (0.87, 1.04)		4.1	0.81 (0.74, 0.89)	
2012-13	1 012 (6.0)	5.9	0.94 (0.86, 1.03)		3.9	0.76 (0.69, 0.83)	
2014-15	958 (6.1)	6.1	0.97 (0.88, 1.06)	0.1	3.9	0.76 (0.69, 0.83)	<0.0001
Surgical							
2006-07	644 (11.9)	11.9	1 (ref. cat)		11.2	1 (ref. cat)	
2008-09	558 (10.8)	9.1	0.90 (0.80, 1.00)		8.2	0.88 (0.79, 0.99)	
2010-11	568 (10.4)	8.9	0.86 (0.77, 0.97)		7.8	0.82 (0.73, 0.92)	
2012-13	492 (8.8)	7.8	0.73 (0.65, 0.82)		7.0	0.71 (0.63, 0.80)	
2014-15	412 (8.1)	7.3	0.67 (0.59, 0.76)	<0.0001	6.6	0.66 (0.59, 0.75)	<0.0001

Death		**Unadjusted estimates**			**Adjusted[1] estimates**		
Procedure Year	**N (%) deaths**	**Cumulative incidence (%)**	**SHR (95% CI)**	**p trend**	**Cumulative incidence (%)**	**SHR (95% CI)**	**p trend**
Endovascular							
2006-07	1 630 (11.9)	11.9	1 (ref. cat)		9.5	1 (ref. cat)	
2008-09	1 718 (11.6)	11.3	0.97 (0.91, 1.04)		7.4	0.90 (0.84, 0.97)	
2010-11	1 849 (11.5)	11.2	0.96 (0.90, 1.03)		6.8	0.81 (0.76, 0.87)	
2012-13	2 048 (12.1)	11.6	1.02 (0.95, 1.08)		6.9	0.83 (0.78, 0.89)	
2014-15	1 643 (10.5)	10.5	0.88 (0.83, 0.95)	0.013	6.0	0.69 (0.64, 0.74)	<0.0001
Surgical							
2006-07	732 (13.6)	13.6	1 (ref. cat)		11.1	1 (ref. cat)	
2008-09	612 (11.8)	10.5	0.87 (0.78, 0.96)		7.8	0.83 (0.75, 0.93)	
2010-11	637 (11.7)	10.4	0.85 (0.76, 0.94)		7.4	0.77 (0.69, 0.86)	
2012-13	678 (12.2)	10.8	0.89 (0.81, 0.99)		7.7	0.81 (0.73, 0.91)	
2014-15	500 (9.9)	9.1	0.71 (0.64, 0.80)	<0.0001	6.4	0.64 (0.57, 0.71)	<0.0001

[1] Adjusted for age, sex, RCS Charlson score and indication for revascularisation.

Table S8. Secular change in 1-year risk of major lower limb amputation, by procedure and diabetes status

			Unadjusted estimates			Adjusted[1] estimates		
Procedure Diabetes status	**Year**	**N (%) amputations**	**Cumulative incidence (%)**	**SHR (95% CI)**	**p trend**	**Cumulative incidence (%)**	**SHR (95% CI)**	**p trend**
Endovascular								
Diabetes	2006-07	396 (10.7)	10.6	1 (ref. cat)		10.2	1 (ref. cat)	
	2008-09	481 (11.4)	10.9	1.08 (0.95, 1.24)		8.9	1.03 (0.90, 1.18)	
	2010-11	507 (10.3)	10.0	0.96 (0.85, 1.10)		7.7	0.85 (0.75, 0.97)	
	2012-13	556 (9.8)	9.6	0.91 (0.80, 1.04)		7.1	0.75 (0.66, 0.86)	
	2014-15	565 (9.8)	9.7	0.93 (0.81, 1.05)	0.019	7.1	0.76 (0.66, 0.86)	<0.0001
No diabetes	2006-07	474 (4.8)	4.7	1 (ref. cat)		4.1	1 (ref. cat)	
	2008-09	496 (4.7)	4.3	0.98 (0.87, 1.12)		3.2	0.93 (0.82, 1.06)	
	2010-11	467 (4.2)	3.8	0.88 (0.77, 1.00)		2.7	0.77 (0.67, 0.87)	
	2012-13	456 (4.1)	3.8	0.85 (0.75, 0.97)		2.6	0.74 (0.65, 0.84)	
	2014-15	393 (4.0)	3.7	0.83 (0.73, 0.96)	0.001	2.6	0.71 (0.62, 0.82)	<0.0001
Surgical								
Diabetes	2006-07	196 (15.5)	15.5	1 (ref. cat)		14.4	1 (ref. cat)	
	2008-09	164 (13.4)	10.8	0.86 (0.70, 1.05)		9.9	0.85 (0.69, 1.05)	
	2010-11	157 (11.9)	9.7	0.75 (0.60, 0.92)		8.8	0.73 (0.59, 0.90)	
	2012-13	159 (11.1)	9.3	0.70 (0.57, 0.86)		8.5	0.70 (0.56, 0.86)	
	2014-15	134 (9.8)	8.4	0.61 (0.49, 0.77)	<0.0001	7.8	0.62 (0.50, 0.78)	<0.0001
No diabetes	2006-07	448 (10.8)	10.8	1 (ref. cat)		10.2	1 (ref. cat)	
	2008-09	394 (9.9)	8.6	0.91 (0.80, 1.04)		7.8	0.89 (0.78, 1.02)	
	2010-11	411 (9.9)	8.6	0.91 (0.80, 1.04)		7.6	0.86 (0.75, 0.98)	
	2012-13	333 (8.0)	7.2	0.73 (0.63, 0.84)		6.5	0.71 (0.62, 0.82)	
	2014-15	278 (7.5)	6.8	0.68 (0.59, 0.79)	<0.0001	6.2	0.68 (0.58, 0.79)	<0.0001

[1] Adjusted for age, sex, RCS Charlson score and indication for revascularisation

Table S9. Secular change in 1-year risk of death following revascularisation, by procedure and diabetes status

			Unadjusted estimates			Adjusted[1] estimates		
Procedure Diabetes status	**Year**	**N (%) deaths**	**Cumulative incidence (%)**	**SHR (95% CI)**	**p trend**	**Cumulative incidence (%)**	**SHR (95% CI)**	**p trend**
Endovascular								
Diabetes	2006-07	527 (14.2)	14.2	1 (ref. cat)		12.8	1 (ref. cat)	
	2008-09	556 (13.2)	12.3	0.93 (0.82, 1.05)		9.2	0.87 (0.77, 0.98)	
	2010-11	606 (12.3)	11.6	0.86 (0.76, 0.96)		8.0	0.73 (0.65, 0.83)	
	2012-13	809 (14.2)	13.0	1.00 (0.89, 1.11)		8.7	0.81 (0.72, 0.91)	
	2014-15	681 (11.8)	11.5	0.84 (0.75, 0.94)	0.035	7.5	0.66 (0.58, 0.74)	<0.0001
No diabetes	2006-07	1 103 (11.0)	11.0	1 (ref. cat)		8.0	1 (ref. cat)	
	2008-09	1 162 (10.9)	10.7	1.00 (0.91, 1.07)		6.4	0.92 (0.85, 1.00)	
	2010-11	1 243 (11.1)	10.8	1.00 (0.93, 1.09)		6.1	0.85 (0.79, 0.93)	
	2012-13	1 239 (11.0)	10.8	1.00 (0.92, 1.08)		5.9	0.83 (0.76, 0.90)	
	2014-15	962 (9.7)	9.8	0.88 (0.80, 0.96)	0.017	5.2	0.70 (0.64, 0.77)	<0.0001
Surgical								
Diabetes	2006-07	173 (13.7)	13.6	1 (ref. cat)		12.0	1 (ref. cat)	
	2008-09	139 (11.4)	10.3	0.83 (0.66, 1.04)		7.9	0.79 (0.63, 0.99)	
	2010-11	178 (13.5)	11.8	0.99 (0.80, 1.21)		8.6	0.87 (0.71, 1.08)	
	2012-13	175 (12.3)	10.9	0.89 (0.72, 1.10)		7.9	0.77 (0.63, 0.96)	
	2014-15	129 (9.4)	8.9	0.68 (0.54, 0.85)	0.006	6.2	0.57 (0.45, 0.72)	<0.0001
No diabetes	2006-07	559 (13.5)	13.5	1 (ref. cat)		10.8	1 (ref. cat)	
	2008-09	473 (11.9)	10.6	0.88 (0.78, 0.99)		7.8	0.85 (0.75, 0.96)	
	2010-11	459 (11.1)	10.0	0.81 (0.71, 0.91)		7.0	0.74 (0.65, 0.84)	
	2012-13	503 (12.1)	10.7	0.89 (0.79, 1.00)		7.7	0.83 (0.74, 0.94)	
	2014-15	371 (10.0)	9.2	0.73 (0.64, 0.83)	<0.0001	6.4	0.66 (0.58, 0.76)	<0.0001

SHR: sub-distribution hazard ratio; CI: confidence interval

[1] IC: intermittent claudication; SLI1: severe limb ischaemia without tissue loss; SLI2: severe limb ischaemia with ulceration; SLI3: severe limb ischaemia with gangrene/osteomyelitis. [2] Adjusted for age, sex, RCS Charlson score and indication for revascularisation.

Table S10. Secular change in 1-year risk of major lower limb amputation following revascularisation, by procedure and indication

			Unadjusted estimates			Adjusted[2] estimates		
Procedure Indication[1]	**Year**	**N (%) amputations**	**Cumulative incidence (%)**	**SHR (95% CI)**	**p trend**	**Cumulative incidence (%)**	**SHR (95% CI)**	**p trend**
Endovascular								
IC	2006-07	142 (3.6)	3.6	1 (ref. cat)		3.2	1 (ref. cat)	
	2008-09	159 (4.3)	3.9	1.20 (0.96, 1.50)		3.3	1.16 (0.93, 1.46)	
	2010-11	115 (3.6)	3.4	1.00 (0.78, 1.28)		2.8	0.93 (0.73, 1.19)	
	2012-13	95 (3.5)	3.4	0.98 (0.76, 1.28)		2.8	0.93 (0.72, 1.20)	
	2014-15	46 (2.0)	2.1	0.57 (0.41, 0.79)	0.001	1.7	0.51 (0.36, 0.71)	<0.0001
SLI1	2006-07	266 (4.0)	4.0	1 (ref. cat)		3.9	1 (ref. cat)	
	2008-09	290 (3.9)	3.5	0.96 (0.82, 1.14)		3.1	0.94 (0.79, 1.11)	
	2010-11	242 (2.9)	2.7	0.72 (0.60, 0.85)		2.4	0.67 (0.60, 0.81)	
	2012-13	304 (3.4)	3.1	0.83 (0.71, 0.99)		2.8	0.78 (0.66, 0.92)	
	2014-15	316 (3.9)	3.5	0.96 (0.82, 1.14)	0.4	3.0	0.87 (0.74, 1.03)	0.034
SLI2	2006-07	222 (11.0)	11.0	1 (ref. cat)		10.5	1 (ref. cat)	
	2008-09	212 (9.5)	8.0	0.85 (0.71, 1.03)		7.4	0.84 (0.70, 1.02)	
	2010-11	235 (9.0)	7.7	0.81 (0.67, 0.97)		7.2	0.80 (0.67, 0.96)	
	2012-13	266 (8.3)	7.3	0.74 (0.62, 0.88)		6.7	0.72 (0.61, 0.87)	
	2014-15	292 (8.7)	7.7	0.79 (0.66, 0.94)	0.004	6.9	0.74 (0.62, 0.88)	<0.0001
SLI3	2006-07	240 (22.3)	22.3	1 (ref. cat)		22.1	1 (ref. cat)	
	2008-09	316 (23.0)	19.9	1.03 (0.87, 1.22)		19.3	1.04 (0.88, 1.23)	
	2010-11	382 (20.1)	17.9	0.89 (0.76, 1.05)		17.4	0.89 (0.76, 1.05)	
	2012-13	347 (17.3)	15.9	0.75 (0.64, 0.89)		14.9	0.71 (0.61, 0.82)	
	2014-15	304 (16.7)	15.4	0.73 (0.61, 0.86)	<0.0001	14.4	0.69 (0.58, 0.82)	<0.0001

SHR: sub-distribution hazard ratio; CI: confidence interval

1 IC: intermittent claudication; SLI1: severe limb ischaemia without tissue loss; SLI2: severe limb ischaemia with ulceration; SLI3: severe limb ischaemia with gangrene/osteomyelitis. 2 Adjusted for age, sex, RCS Charlson score and indication for revascularisation.

Table S10, continued. Secular change in 1-year risk of amputation following revascularisation, by procedure and indication

Procedure Indication[1]	Year	N (%) amputations	Unadjusted estimates Cumulative incidence (%)	SHR (95% CI)	p trend	Adjusted[2] estimates Cumulative incidence (%)	SHR (95% CI)	p trend
Surgical								
IC	2006-07	175 (9.9)	9.9	1 (ref. cat)		9.6	1 (ref. cat)	
	2008-09	119 (8.0)	6.2	0.80 (0.64, 1.01)		5.9	0.79 (0.63, 1.00)	
	2010-11	91 (7.2)	5.4	0.72 (0.56, 0.92)		5.4	0.71 (0.55, 0.92)	
	2012-13	45 (4.5)	3.7	0.44 90.32, 0.61)		3.6	0.45 (0.32, 0.62)	
	2014-15	50 (6.0)	4.7	0.59 (0.43, 0.80)	<0.0001	4.5	0.59 (0.43, 0.80)	<0.0001
SLI1	2006-07	214 (8.6)	8.6	1 (ref. cat)		8.5	1 (ref. cat)	
	2008-09	220 (8.5)	7.6	0.98 (0.82, 1.19)		7.3	0.97 (0.80, 1.17)	
	2010-11	241 (8.2)	7.4	0.95 (0.79, 1.15)		7.1	0.94 (0.78, 1.13)	
	2012-13	235 (7.1)	6.6	0.81 (0.68, 0.98)		6.3	0.80 (0.67, 0.96)	
	2014-15	209 (6.6)	6.3	0.77 (0.63, 0.93)	0.001	6.1	0.76 (0.63, 0.92)	<0.0001
SLI2	2006-07	120 (19.3)	19.4	1 (ref. cat)		19.5	1 (ref. cat)	
	2008-09	92 (15.7)	12.1	0.79 (0.60, 1.04)		11.6	0.76 (0.58, 1.00)	
	2010-11	79 (12.8)	10.2	0.63 (0.47, 0.83)		9.8	0.61 (0.46, 0.81)	
	2012-13	103 (14.0)	11.1	0.70 (0.53, 0.90)		10.9	0.69 (0.53, 0.89)	
	2014-15	79 (11.9)	9.8	0.59 (0.44, 0.78)	<0.0001	9.5	0.58 (0.43, 0.77)	<0.0001
SLI3	2006-07	135 (25.7)	25.6	1 (ref. cat)		25.3	1 (ref. cat)	
	2008-09	127 (23.9)	21.4	0.93 (0.73, 1.19)		21.4	0.94 (0.74, 1.20)	
	2010-11	157 (24.0)	21.5	0.93 (0.74, 1.16)		21.2	0.92 (0.73, 1.16)	
	2012-13	109 (21.0)	19.2	0.80 (0.62, 1.02)		19.2	0.81 (0.63, 1.04)	
	2014-15	74 (17.7)	16.5	0.66 (0.50, 0.88)	0.002	16.1	0.65 (0.49, 0.86)	0.002

SHR: sub-distribution hazard ratio; CI: confidence interval

[1] IC: intermittent claudication; SLI1: severe limb ischaemia without tissue loss; SLI2: severe limb ischaemia with ulceration; SLI3: severe limb ischaemia with gangrene/osteomyelitis. [2] Adjusted for age, sex, RCS Charlson score and indication for revascularisation.

Table S11. Secular change in 1-year risk of death following revascularisation, by procedure and indication

			Unadjusted estimates			Adjusted[2] estimates		
Procedure Indication[1]	**Year**	**N (%) deaths**	**Cumulative incidence (%)**	**SHR (95% CI)**	**p trend**	**Cumulative incidence (%)**	**SHR (95% CI)**	**p trend**
Endovascular								
IC	2006-07	327 (8.2)	8.2	1 (ref. cat)		5.9	1 (ref. cat)	
	2008-09	285 (7.6)	6.9	0.93 (0.79, 1.09)		4.4	0.89 (0.75, 1.04)	
	2010-11	243 (7.5)	6.7	0.91 (0.77, 1.08)		4.2	0.84 (0.71, 0.99)	
	2012-13	161 (5.9)	5.5	0.72 (0.59, 0.86)		3.4	0.64 (0.53, 0.78)	
	2014-15	143 (6.3)	5.8	0.77 (0.63, 0.93)	<0.0001	3.4	0.66 (0.54, 0.80)	<0.0001
SLI1	2006-07	566 (8.6)	8.5	1 (ref. cat)		6.5	1 (ref. cat)	
	2008-09	571 (7.6)	6.9	0.89 (0.79, 1.00)		4.8	0.86 (0.76, 0.96)	
	2010-11	580 (6.9)	6.4	0.80 (0.72, 0.90)		4.4	0.77 (0.69, 0.87)	
	2012-13	724 (8.1)	7.3	0.94 (0.84, 1.05)		4.8	0.86 (0.77, 0.96)	
	2014-15	571 (7.0)	6.5	0.82 (0.73, 0.92)	0.015	4.1	0.70 (0.62, 0.79)	<0.0001
SLI2	2006-07	435 (21.6)	21.7	1 (ref. cat)		20.5	1 (ref. cat)	
	2008-09	498 (22.2)	20.4	1.02 (0.90, 1.16)		17.8	0.98 (0.86, 1.11)	
	2010-11	525 (20.1)	18.9	0.92 (0.81, 1.04)		16.0	0.85 (0.74, 0.96)	
	2012-13	705 (21.9)	20.2	1.01 (0.89, 1.13)		17.2	0.93 (0.82, 1.05)	
	2014-15	560 (16.6)	16.7	0.76 (0.69, 0.86)	<0.0001	14.6	0.72 (0.64, 0.82)	<0.0001
SLI3	2006-07	302 (28.1)	28.4	1 (ref. cat)		25.5	1 (ref. cat)	
	2008-09	364 (26.5)	23.0	0.93 (0.80, 1.08)		20.0	0.92 (0.79, 1.07)	
	2010-11	501 (26.4)	22.8	0.91 (0.79, 1.05)		19.0	0.85 (0.73, 0.98)	
	2012-13	458 (22.9)	20.4	0.77 (0.67, 0.89)		17.9	0.77 (0.67, 0.89)	
	2014-15	369 (20.3)	18.8	0.69 (0.59, 0.80)	<0.0001	15.9	0.66 (0.57, 0.77)	<0.0001

SHR: sub-distribution hazard ratio; CI: confidence interval

[1] IC: intermittent claudication; SLI1: severe limb ischaemia without tissue loss; SLI2: severe limb ischaemia with ulceration; SLI3: severe limb ischaemia with gangrene/osteomyelitis. [2] Adjusted for age, sex and RCS Charlson score.

Table S11, continued. Secular change in 1-year risk of death following revascularisation, by procedure and indication

			Unadjusted estimates			Adjusted[2] estimates		
Procedure Indication[1]	**Year**	**N (%) deaths**	**Cumulative incidence (%)**	**SHR (95% CI)**	**p trend**	**Cumulative incidence (%)**	**SHR (95% CI)**	**p trend**
Surgical								
IC	2006-07	213 (12.0)	12.0	1 (ref. cat)		9.5	1 (ref. cat)	
	2008-09	144 (9.7)	8.6	0.80 (0.65, 0.99)		6.3	0.77 (0.63, 0.96)	
	2010-11	127 (10.0)	8.7	0.82 (0.66, 1.02)		6.1	0.75 (0.60, 0.94)	
	2012-13	94 (9.4)	8.3	0.77 (0.61, 0.99)		6.1	0.75 (0.59, 0.96)	
	2014-15	72 (8.6)	7.6	0.70 (0.53, 0.91)	0.006	4.9	0.60 (0.46, 0.79)	<0.0001
SLI1	2006-07	289 (11.6)	11.6	1 (ref. cat)		9.8	1 (ref. cat)	
	2008-09	251 (9.7)	8.3	0.83 (0.70, 0.98)		6.2	0.80 (0.67, 0.94)	
	2010-11	272 (9.3)	8.1	0.79 (0.67, 0.93)		5.8	0.71 (0.60, 0.84)	
	2012-13	332 (10.0)	8.6	0.85 (0.73, 1.00)		6.3	0.78 (0.67, 0.92)	
	2014-15	626 (8.3)	7.4	0.71 90.60, 0.83)	0.001	5.3	0.62 (0.52, 0.74)	<0.0001
SLI2	2006-07	116 (18.7)	18.8	1 (ref. cat)		16.4	1 (ref. cat)	
	2008-09	104 (17.8)	17.2	0.95 (0.73, 1.24)		14.7	0.95 (0.72, 1.24)	
	2010-11	112 (18.1)	17.3	0.95 (0.73, 1.23)		14.7	0.95 (0.73, 1.23)	
	2012-13	138 (18.8)	17.8	1.00 (0.78, 1.27)		14.8	0.96 (0.75, 1.23)	
	2014-15	108 (16.2)	16.0	0.86 (0.66, 1.11)	0.04	12.9	0.80 (0.61, 1.04)	0.1
SLI3	2006-07	114 (21.7)	21.6	1 (ref. cat)		19.1	1 (ref. cat)	
	2008-09	113 (21.3)	19.3	0.98 (0.76, 1.27)		15.3	0.94 (0.72, 1.22)	
	2010-11	126 (19.2)	18.0	0.88 90.68, 1.14)		13.8	0.80 (0.62, 1.04)	
	2012-13	114 (22.0)	19.8	1.01 (0.78, 1.31)		14.1	0.84 (0.65, 1.10)	
	2014-15	58 (13.8)	13.5	0.61 (0.45, 0.84)	0.016	10.1	0.56 (0.41, 0.77)	0.001

SHR: sub-distribution hazard ratio; CI: confidence interval

[1] IC: intermittent claudication; SLI1: severe limb ischaemia without tissue loss; SLI2: severe limb ischaemia with ulceration; SLI3: severe limb ischaemia with gangrene/osteomyelitis. [2] Adjusted for age, sex and RCS Charlson score

Supplemental Figures

Figure S1. Unadjusted cumulative incidence of amputation within 1 year following revascularisation

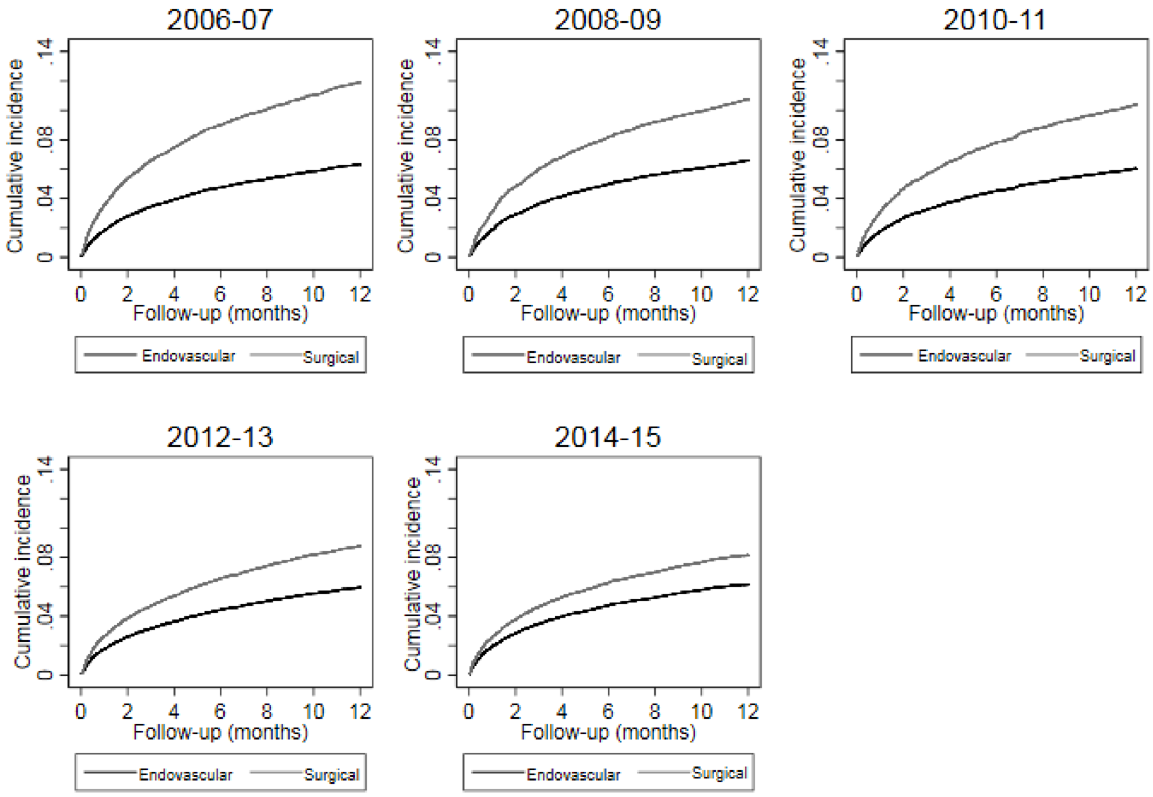

Figure S2. Unadjusted cumulative incidence of death within 1 year following revascularisation

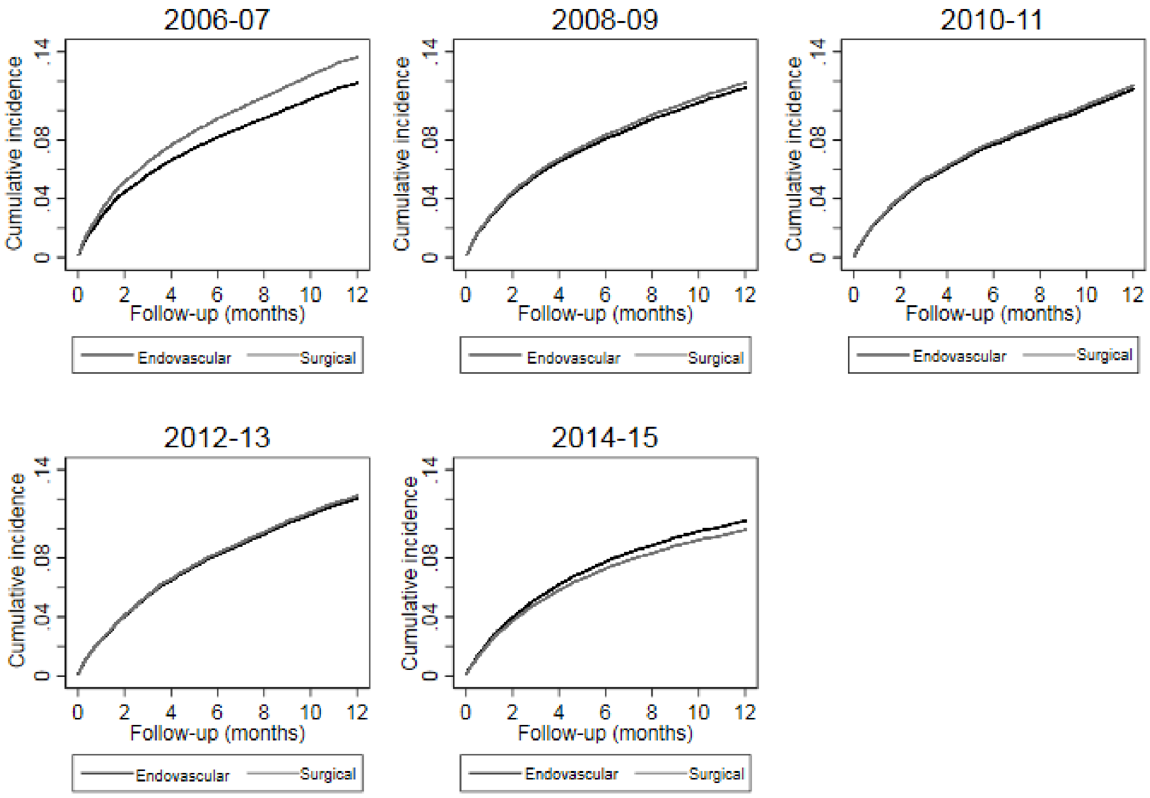

Figure S3. Proportions of patients undergoing endovascular and surgical revascularisation, by year and diabetes status