

## Hospital and Institutionalisation Care Costs after Limb and Visceral Ischaemia Benchmarked Against Stroke: Long-Term Results of a Population Based Cohort Study

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### WHAT THIS PAPER ADDS

This is the first prospective, population based study of acute/critical limb or visceral ischaemia (ACLVI) events in a population of 92,728 in Oxfordshire, UK. The study shows that the long-term costs after such events are substantial, and that costs vary considerably across type of event. When compared with stroke, hospital care costs are significantly higher after an acute visceral and peripheral arterial event, and similar after inclusion of institutionalisation costs. The present data will be useful to other researchers to perform comparisons in attempts to better understand the likely economic consequences of ACLVI events in their own setting.

**Objective/background:** There are few published data on the acute care or long-term costs after acute/critical limb or visceral ischaemia (ACLVI) events. Using data from patients with acute events in a population based incidence study (Oxford Vascular Study), the present study aimed to determine the long-term costs after an ACLVI event.

**Methods:** All patients with first ever incident ACLVI from 2002 to 2012 were included. Analysis was based on follow up until January 2017, with all patients having full 5 year follow up. Multivariate regressions were used to assess baseline and subsequent predictors of total 5 year hospital care costs. Overall costs after an ACLVI event were benchmarked against those after stroke in the same population, during the same period.

**Results:** Among 351 patients with an ACLVI event, mean 5 year total care costs were €35,211 (SD 50,500), of which €6443 (18%) were due to long-term institutionalisation. Costs differed by type of event (acute visceral ischaemia €16,476; acute limb ischaemia €24,437; critical limb ischaemia €46,281;  $p < 0.001$ ). Results of the multivariate analyses showed that patients with diabetes and those undergoing above knee amputations incurred additional costs of €11,804 ( $p = 0.014$ ) and €25,692 ( $p < 0.001$ ), respectively. Five year hospital care costs after an ACLVI event were significantly higher than after stroke (€28,768 vs. €22,623;  $p = 0.004$ ), but similar after including long-term costs of institutionalisation (€35,211 vs. €35,391;  $p = 0.957$ ).

**Conclusion:** Long-term care costs after an ACLVI event are considerable, especially after critical limb ischaemia. Hospital care costs were significantly higher than for stroke over the long term, and were similar after inclusion of costs of institutionalisation.

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### INTRODUCTION

Cardiovascular disease is the leading cause of death and disability, costing the US and European Union healthcare

systems \$196 billion and €111 billion, respectively.<sup>1,2</sup> Therefore, there has been much research interest to prevent, diagnose, and treat vascular disease.

However, although peripheral arterial disease (PAD) has a poor prognosis,<sup>3</sup> it has been neglected in terms of research,<sup>4</sup> and there are therefore a paucity of data evaluating the economic impact of PAD on healthcare systems. Although a number of studies have been published assessing the care costs of PAD, these have tended to be based on hospital coding data of diagnosis or interventions;<sup>5–7</sup> concentrated only on patients with diabetes

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or specific interventions,<sup>8,9</sup> more stable PAD;<sup>10</sup> or randomised controlled trials with stringent inclusion criteria;<sup>11</sup> and have tended to omit long-term institutionalisation care costs. This lack of economic evidence on PAD outcome therefore limits comparisons of outcome and cost between this and other conditions, which in turn reduces the ability to make decisions about the relative funding requirements for service provision and research.

Using data from patients with an acute/critical limb or visceral ischaemia (ACLVI) event in a population based incidence study (Oxford Vascular Study [OXVASC]) ascertained between 2002 and 2012, the present study aimed to reliably determine the absolute long-term costs and their baseline and subsequent predictors. In addition, given that the costs of other vascular disease, in this case stroke, have been estimated in the same population and using the same methodology,<sup>12,13</sup> there is a unique opportunity to benchmark the long-term costs of these acute events against stroke.

## MATERIALS AND METHODS

### *The Oxford Vascular Study*

The Oxford Vascular Study (OXVASC) population comprises all individuals (2002–2012 average = 92,728) registered in nine general practices across Oxfordshire, UK. The study methods have been described elsewhere,<sup>3,14</sup> and are also reported in the online supplementary appendix. Briefly, patient registration began on April 2002, and is ongoing. Patients in whom an ACLVI event was suspected were ascertained. An ACLVI event in this study is defined as any arterial event that affected a limb or an organ other than the heart or the brain/eye and led to hospital assessment or admission or caused death in the community. Acute limb ischaemia (ALI), critical limb ischaemia (CLI), and acute visceral ischaemia (AVI) are included within this definition. Ascertainment was undertaken using multiple overlapping methods of pursuit and considered for inclusion, including prospective daily searches for acute events in hospital and supplemented by searches of discharge and primary care diagnostic coding data. OXVASC was approved by the local research ethics committee.

All diagnoses were reviewed by a vascular surgeon. Cardiovascular examination included assessment of the peripheral pulses, Buerger's test,<sup>15</sup> and absolute ankle pressure and ankle brachial pressure index recordings. For patients with incompressible ankle signals, pressures were estimated by pole test. For patients in whom clinical vascular assessment was not possible by the study clinician before urgent revascularisation or death, the assessments made by the admitting clinician were used. If a patient died before assessment or was identified only by cold pursuit, eyewitness accounts were obtained, and relevant records reviewed. If death occurred outside the hospital or before investigation, autopsy results were reviewed. Clinical details

were sought from primary care physicians or other clinicians on all deaths resulting from a possible vascular cause.

All patients with a first ever incident ACLVI event from April 1, 2002 to March 31, 2012 from the study registered practices were included and followed-up. ALI was defined as an arterial event of sudden onset and <2 weeks in duration resulting in symptomatic limb ischaemia. AVI was defined as acute arterial events of sudden onset and <2 weeks in duration resulting in symptomatic visceral ischaemia (including bowel, liver, spleen, and renal end organ compromise). CLI was defined as an event with symptoms present for >2 weeks with ischaemic rest pain or tissue loss of sufficient severity to warrant urgent hospital admission and thought to be secondary to large or small vessel arterial disease. History of stable PAD was defined as symptomatic PAD without prior ACLVI history or emergency intervention. These patients typically have intermittent claudication (calf cramping) with any pain at rest or ulceration.

All surviving patients were followed up by the following methods: 1) 6 month face to face follow up; 2) primary care records; 3) ongoing study ascertainment of hospital contacts of study participants and the wider study population; 4) routine review of administrative hospital and centralised care records; 5) mortality records; and 6) review of Coroner's office death reports for deaths outside hospital or during surgical procedures. If a vascular event was suspected, the patient was reassessed by a study physician. All patients had mortality follow up.

### *Resource use and unit costs*

The following healthcare costs were included: accident and emergency visits, emergency transport by ambulance, inpatient care stays, day cases, and outpatient care visits. In terms of social care, costs associated with stays in a nursing or residential care home were included. Hospital care resource use was obtained from computerised patient hospital records from the date of first ever incident ACLVI event until death or 5 years after the event, whichever was first.

Patients' centralised Hospital Episodes Statistics (HES) records, as well as those from the Oxford University Hospitals NHS Foundation Trust (which is made up of 4 hospitals) and nine Oxfordshire community hospitals, were reviewed. Information on any accident and emergency visit, emergency transport, outpatient care visit, day case, or hospitalisation was obtained. For each hospital admission, information was recorded on the date of admission and discharge, including the dates of transfers between different specialty wards. Hospitalisations during which patients were admitted and discharged on the same day were classified as day cases. Hospital admissions resulting from the incident ACLVI event were defined as the first admission occurring within 7 days of the event. Subsequent admissions resulting from an ACLVI event were defined as: 1) admissions within 7 days of any subsequent ACLVI event; 2) admissions within 7 days of any subsequent intervention

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