Outcomes of Lower Limb Angioplasty Vary by Area Deprivation in England

Authors: Petra Schoenweger[a], Fiona Miller[b], David A Cromwell[a,c], Sam Waton[c], Amundeep S Johal[c], Jonathan R Boyle[d], Katriina Heikkila[a,e]

[a] Department of Health Services Research and Policy, London School of Hygiene and Tropical Medicine, London, UK

[b] King's College Hospital NHS Foundation Trust, London, UK

[c] Clinical Effectiveness Unit, the Royal College of Surgeons of England, London, UK

[d] Cambridge Vascular Unit, Cambridge University Hospitals, NHS Trust, Cambridge, UK

[e] Division of Insurance Medicine, Department of Clinical Neuroscience, Karolinska Institutet, Stockholm, Sweden

Corresponding author:
Katriina Heikkilä
Division of Insurance Medicine
Department of Clinical Neuroscience
Karolinska Institutet, Berzelius väg 3
17177 Stockholm, Sweden
Email: katriina.heikkila@ki.se

Word count: 860
Category: Research letter
Short title: Outcomes of angioplasty vary by area deprivation

In high-income countries, the incidence of peripheral artery disease (PAD) is higher among persons living in areas with a higher level of socioeconomic deprivation[1]. The prevalence of PAD varies across different ethnic groups; however, literature indicates that the environment and the exposure to risk factors seem to be more important than the genetics[2].

Although there is evidence of an association between lower socioeconomic status and worse health status in patients[2], it is not clear whether the socioeconomic pattern translates to patient outcomes following interventions for PAD. Lower limb endovascular procedures to treat PAD are safe and effective interventions for acute and chronic limb ischaemia[3]. The aim of this study was to investigate the association of neighbourhood deprivation with outcomes following lower limb endovascular revascularisation (angioplasty with/without stent) for PAD.

We used data from the National Vascular Registry (NVR) - a nationwide clinical audit of vascular interventions - and included patients aged 40+ years who had lower limb endovascular treatment for PAD in England between 01/2015 and 12/2018.

Neighbourhood socioeconomic deprivation was measured using the Index of Multiple Deprivation (IMD), a ranked score based on multiple indicators of socioeconomic deprivation at neighbourhood-level (https://www.gov.uk/government/statistics/english-indices-of-deprivation-2015). Each patient was allocated an IMD quintile, ranging from the 1st (least deprived) to the 5th (most deprived), based on their residential postcode at the time of intervention.

The outcomes we analysed were unplanned further surgery (angioplasty with/without stent, minor/ major amputation, clot aspiration, thrombolysis), unplanned admission to any higher level of care (ward, high-dependency unit, ICU), in-hospital death and post-operative complications within the index admission. Covariates were age, sex, comorbidities, medication, smoking, indication for intervention (acute limb ischaemia, chronic limb ischaemia, neuropathy, uncontrolled infection) and Fontaine score. Associations of IMD quintiles and covariates with outcomes were analysed using logistic regression. Odds ratios were calculated with the 5th relative to the 1st quintile. All analyses were conducted using Stata IC 15 (Stata Corporation, College Station, Texas, US).

The analysis was based on a cohort of 14,727 (67.7%) patients with complete data on patient and procedure characteristics (Table 1). The average age was 71.2 years (SD 11.0), and 68%

were men. Patients living in more deprived areas were on average younger, more often male ($p=.008$), and more often smokers ($p<.001$). Comorbid diabetes ($p<.001$) and chronic lung diseases ($p<.001$) were also more common in patients in more deprived areas. Indications for intervention and Fontaine score varied across the IMD quintiles (Table 1).

Compared to patients from the least deprived areas, those from the most deprived areas had an increased risk of major amputations (OR =2.4, 95% CI: 1.29, 4.14), postoperative cardiac problems (OR=2.1; 95% CI: 1.08, 4.07), postoperative limb ischaemia (OR=1.9, 95% CI: 1.03, 3.21), and unplanned admission to higher levels of care (OR=1.7, 95% CI: 1.05, 2.67), even after adjustment for age, sex, comorbidities, smoking, medication, indication for intervention and Fontaine score. The odds for in-hospital death were similar in patients between the 1st and the 5th quintile (OR: 1.2, 95% CI: 0.81, 1.83).

Our findings suggest that socioeconomic deprivation is linked to an approximately two-fold increase in the risks of adverse outcomes after lower limb angioplasty. The overall adverse outcome rates following lower limb angioplasty were low, ranging between 1.6% for in-hospital death and 7.8% for unplanned further surgery.

The relationship between greater deprivation and an increased risk of major amputation requires careful interpretation. The results were not only significantly higher in the most deprived quintile, but also between every quintile compared to the least deprived one. Although the associations among all outcomes were modest in size, the results are not without clinical importance.

A key strength of this study is the large dataset with almost 15,000 angioplasties. Limitations are the low case-ascertainment rate for angioplasties in the NVR (with an average of 34% of the procedures reported) and the exclusion of records without an IMD value (23.1%), both possibly introducing selection bias. Missing IMD values are either because patients had not consented holding their postcode, or the postcode was not collected. It is possible that patients who consented may have different socioeconomic characteristics from those who did not consent. Further, though we adjusted our estimates for the Fontaine score, the lack of more detailed data on the severiry of ischaemia or tissue loss may have introduced residual error. It is also possible that the observed association between neighbourhood deprivation and outcomes of angioplasty has been influenced by residual confounding from unmeasured factors, e.g. hospital volume or facilities, or individual-level socioeconomic position, care seeking behaviour (patients from socioeconomically deprived areas could have presented for treatment at a later stage with more advanced disease), adherence to medication and access to healthcare.

The study results indicate that major lower limb amputations following endovascular treatment for PAD are 2.4 times more common among patients living in socioeconomically deprived neighbourhoods, compared to those living in less deprived neighbourhoods. Associations of a similar size between other postoperative complications (limb ischaemia, cardiac problems) and neighbourhood deprivation were also observed. The findings suggest that further investigation in early risk factor management and best medical treatment for PAD in patients living in less affluent neighbourhoods is required to assess potential benefits in terms of PAD incidence and endovascular procedure outcomes.

Conflict of interest: none.

References

1 Pujades-Rodriguez M, Timmis A, Stogiannis D, Rapsomaniki E, Denaxas S, Shah A, et al. Socioeconomic Deprivation and the Incidence of 12 Cardiovascular Diseases in 1.9 Million Women and Men: Implications for Risk Prediction and Prevention. *PLoS One* 2014;**9**:e104671.

2 Conte MS, Bradbury AW, Kolh P, White J V., Dick F, Fitridge R, et al. Global Vascular Guidelines on the Management of Chronic Limb-Threatening Ischemia. *Eur J Vasc Endovasc Surg* 2019;**58**:S1-S109.e33.

3 Aboyans V, Ricco J-B, Bartelink M-LEL, Björck M, Brodmann M, Cohnert T, et al. 2017 ESC Guidelines on the Diagnosis and Treatment of Peripheral Arterial Diseases, in collaboration with the European Society for Vascular Surgery (ESVS). *Eur J Vasc Endovasc Surg* 2018;**55**:305-368.

Table 1. Associations of patient characteristics with quintiles of IMD[1]

Characteristics	No. of cases (%)	1st Q	%	5th Q	%	P value [2]
Key indication for intervention[3]						
Acute limb ischemia	1,142 (7.8)	146	5.9	221	6.6	<.001
Chronic limb ischaemia	9,256 (62.9)	1,641	66.3	2,102	62.6	<.001
Neuropathy	271 (1.8)	34	1.4	100	3	<.001
Uncontrolled infection	455 (3.1)	46	1.9	127	3.8	.001
Fontaine score						.033
No symptoms	595 (4.0)	95	3.8	115	3.4	
Intermittent claudication	6,214 (42.2)	1,085	43.8	1,384	41.2	
Nocturnal pain	3,080 (20.9)	501	20.2	675	20.1	
Necrosis/ gangrene	4,838 (32.9)	794	32.1	1,185	35.3	
In-hospital complications						
Cardiac problems	125 (0.9)	13	0.5	32	0.9	.045
Limb ischaemia	163 (1.1)	17	0.7	50	1.5	.067
Puncture site haematoma	235 (1.6)	60	2.4	39	1.2	.004
In-hospital death						
	240 (1.6)	43	1.7	56	1.7	.420
Admission to higher level of care						
	224 (1.5)	27	1.1	59	1.8	.220
Unplanned further surgery						
Major amputation	187 (1.3)	15	0.6	58	1.7	.001

[1]IMD quintiles: 1st Q: least deprived, 5th Q: most deprived;

[2] Wald- tests

[3] Other Indications for intervention: Uncontrolled infection, Aneurysm (both not associated with IMD)