Tailored risk assessment and forecasting in intermittent claudication using machine learning

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Background
Guidelines recommend cardiovascular risk reduction and supervised exercise therapy as the initial treatment for patients with intermittent claudication (IC). However, implementation challenges and poor patient compliance lead to significant variation in management and therefore outcomes. We propose a precise machine learning derived decision support system that aims to provide personalised outcome predictions across different initial management strategies.

Methods
Feature selection was performed using the least absolute shrinkage and selection operator method. The model was developed using a bootstrapped sample of 10,000 patients based on 255 patients from our vascular centre. The model considered 27 baseline characteristics, compliance to best medical therapy/smoking cessation and initial treatment strategy. The model was validated using a separate dataset of 254 patients. This model was then used to build a prototype interactive decision support system which was evaluated using calibration curves, decision curve analyses and area under the receiver operator characteristic (AUROC) curves.

Results
The AUROC curves demonstrated excellent discrimination for the risk of progression to chronic limb threatening ischaemia at 2(0.892) and 5 years (0.866) and the likelihood of major adverse cardiovascular events (0.836), major adverse limb events(0.891) and revascularisation (0.896) within 5 years, regardless of the initial treatment strategy. Calibration curves demonstrated good consistency and decision curve analyses confirmed clinical utility. The decision support tool maintained an accuracy of >80% and an effect size of >0.5.

Conclusion
Our decision support system successfully predicts outcomes in patients with IC offering potential for improved risk stratification and patient outcomes.

Long term outcomes of hybrid revascularisation for complex peripheral arterial disease

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Background
This aim of this cohort study was to determine the peri-operative and long-term outcomes in patients undergoing hybrid revascularisation.

Methods
A cohort study of patients from 2012 to 2019 who underwent hybrid revascularisation, with follow-up ending in 2023 was performed. The primary outcomes were freedom from target lesion revascularisation (TLR), major ipsilateral limb amputation (MLA) and mortality. Secondary outcomes were length of stay (LOS) and peri-operative morbidity including major adverse cardiovascular events (MACE).

Results
418 patients underwent hybrid revascularisation for Rutherford III(43.7%), IV(19.9%) and V-VI(36.4%) ischaemia and median follow-up was 84.1[IQR 81.1-89.8]months. All underwent femoral endarterectomy and endovascular treatment of their supra-inguinal (66.7%), infra-inguinal (26.3%) or multi-level (6.9%) vessels. The 5-year for freedom from TLR, MLA and mortality were 78.2%[74%-82.6%, 95%CI], 91.5%[88.7%-94.4%, 95%CI] and 63%[58%-68%, 95%CI], respectively. Peri-operative complication rates, including MACE (12.8% vs 3.8%, p=0.001), were observed at a significantly higher rate among CLTI compared to claudication patients. Compared to supra-inguinal lesion-treatment, freedom from TLR was worse in infra-inguinal lesion-treatment [HR 2.06(1.31-3.23,p=0.002)] and in multi-level lesion-treatment [HR 1.94(0.91-4.10,p=0.084)]. Cox regression analysis identified key variables predictive of worse TLR, MLA and mortality rates. Being female was associated with significantly better survival rates when presenting with claudication but significantly worse survival when presenting with CLTI.

Conclusion
This study represents the largest series of hybrid revascularisation with long term follow-up. The technique is an effective strategy that has with acceptable peri-operative morbidity, target lesion revascularisation, major amputation and survival.

Mechanical thrombectomy to treat acute deep venous thrombosis - the Lysis free era

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Background
Endovenous techniques are available in the management of patients with acute lower limb deep venous thrombosis (DVT). These include Catheter Directed Thrombolysis (CDT), pharmacomechanical thrombectomy, aspiration thrombectomy and mechanical thrombectomy (MT). CDT involves intensive nursing requirement; longer hospital stay and increased bleeding complications. We present a case series of patients treated with MT using the Inari Medical ClotTriever device over almost 3-year period from our tertiary vascular centre.

Methods
A retrospective analysis was performed of a prospectively collated database of patients who underwent intervention for acute lower limb DVT using the ClotTriever device between April 2021 to January 2023 in our institution.

Results
A total of 65 patients have been treated with mechanical thrombectomy. The median age is 53(16-80); 36 were male. The IVC was involved in 14(22%) cases. The average time from initial date of symptoms to intervention was 13.5(3 -70) days. The median follow-up interval was 12(1-28) months. The average iliac venous stent rate was 71%. Primary patency was achieved in 85% of patients; 88% primary assisted patency; 94% secondary patency. No thrombolysis infusion was used in the primary treatment of these patients. There have been no device related complications.

Conclusion
In our centre, mechanical thrombectomy has been used successfully without the need for thrombolytic infusion in the management of acute lower limb deep venous thrombosis since April 2021. Mechanical thrombectomy has the advantage of requiring shorter length of stay in hospital, decreased nursing requirements, no need for repeated angiography and reduced bleeding complications.

Utility of hand grip strength in predicting mortality risk in chronic limb-threatening ischaemia

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Background
Sarcopenia is defined as low skeletal muscle strength, quantity and quality. Most studies of sarcopenia in chronic limb-threatening ischaemia (CLTI) only assess muscle quantity or quality on imaging. The aim of this study was to investigate the association of sarcopenia by hand grip strength with two-year mortality in people with CLTI.

Methods
Single-centre prospective cohort study (NCT04027244). Patients undergoing a procedure for CLTI between May 2019 and May 2021 were eligible (minimum age: ≥65 initially; ≥50 from November 2019). Seated hand grip strength was measured using the Jamar+ digital hand dynamometer. Sarcopenia was defined as maximum grip strength (five repetitions bilaterally) <16kg in women and <27kg in men. Association of sarcopenia with two-year mortality was analysed using Cox regression and reported as hazard ratios (HR) with 95% confidence intervals (CI). The multivariable model included age, sex, frailty and Charlson comorbidity index (CCI).

Results
Ninety-seven participants were included. Twenty-five (26%) classified as having sarcopenia. Those with sarcopenia were a mean eight years older (p<.001). Sarcopenia was also associated with worse wound, ischaemia, foot infection clinical stage (p=.004), frailty (p=.001), and greater CCI score (p=.011).
At two-years, 25 people (26%) had died: 17 of whom had sarcopenia (68%) compared to only eight without (11%). Sarcopenia was independently associated with worse two-year mortality (HR 6.4; 95% CI 2.4, 17.2; p<.001).

Conclusion
Hand grip strength is highly predictive of worse two-year survival in people with CLTI. Grip strength may be a useful adjunct to risk stratification and aid shared decision making in CLTI.

Outcomes of open surgical, hybrid and endovascular management of lower limb acute limb ischaemia

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Background
Acute limb ischemia (ALI) is a medical emergency with significant morbidity and mortality. Rapid diagnosis is required because it is a time-sensitive condition. The aim of this study was to compare differences in outcomes of the different modalities used in the management of ALI.

Methods
A single-centre retrospective cohort study was conducted on all patients who presented with lower limb ALI between 2014 and 2020. Demographic, clinical, and procedural characteristics were recorded, and differences between women vs men were assessed using independent *t* test and χ^2 test. The primary outcomes were major amputation and survival. Cox proportional hazards regression analyses were performed to identify independent predictors of poorer outcomes.

Results
A total of 322 ALI cases were actively managed with varying approaches: medical-only (86, 26.7%), open-only (125, 38.8%), hybrid (35, 10.9%) and endovascular-only (76, 23.6%). A further 30 cases were palliated. Male to female ratio was 1:1. There were no significant differences in amputation rates between treatment modalities when adjusted to ALI Rutherford classification at presentation. Independent predictors of poorer survival were age, Rutherford classification, chronic obstructive pulmonary disease and malignancy, but not treatment modality. Temporal analysis revealed a non-significant trend in improved amputation rates and a significant trend in improved survival rates.

Conclusion
Acute limb ischaemia remains a challenging condition to manage. Rutherford classification at presentation appears to be a strong predictor of outcomes irrespective of the management approach. Temporal improvements in outcomes may signify better decision-making in case selection and management approach.

Temporal changes and determinants of Quality of Life in patients with Chronic Limb Threatening Ischaemia

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Background
This study aimed to describe change in quality of life (QoL) over two-years, and its determinants, in people with chronic limb-threatening ischaemia (CLTI).

Methods
Single centre prospective cohort study (NCT04027244). English-speaking CLTI patients presenting between May 2019 and March 2022 were eligible. QoL was assessed at baseline, one- and two-years using the Vascular Quality of Life Questionnaire (VascuQoL) (disease-specific) and EQ-5D-5L (generic health-related). Associations with overall survival were assessed using Cox-regression and reported as hazard ratios (HR) with 95% confidence intervals (CI). Minimal Clinical Important Difference (MCID) of QoL scores were determined using distribution-based approaches, analysed using ordered logistic regression, and reported as odds ratios (OR) with 95% CI.

Results
432 patients were included. 151 patients (35%) died at two-years. Worse baseline EQ-5D-5L score (per 0.1 score increase: HR 0.88; 95% CI 0.79, 0.98) as well as increasing age, frailty, and conservative/palliative management were independently associated with worse survival.
Most patients (70%) reported a MCID improvement in the VascuQoL at two-years, but this was not seen in the EQ-5D-5L (16% had MCID improvement). Hybrid revascularisation (OR 3.28; 95% CI 1.04, 10.39) was independently associated with MCID improvement in VascuQoL. By EQ-5D-5L, frailty (OR 2.57; 95% CI 1.04, 6.38) and WIfI stage 3 (OR 3.33; 95% CI 1.09, 10.36) were independently associated with MCID improvement.

Conclusion
People with CLTI generally show improvement in disease-specific QoL over two-years but this is not replicated in generic health-related QoL. In those suitable, hybrid or open surgical revascularisation may offer better QoL benefits.

Covered Endovascular Reconstruction of Aortic Bifurcation (CERAB) learning curves at a tertiary referral centre

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Background
Covered Endovascular Reconstruction of the Aortic Bifurcation (CERAB) is superior to kissing iliac stenting. However, the learning curve for CERAB is unknown.

Methods
All CERAB procedures performed at a single UK tertiary vascular centre were identified. Demographic, radiation, and outcome data were collected retrospectively. TASCII classification was determined from pre-operative CT. Primary outcomes included major peri-operative complication, 30-day mortality and readmission, 60-day primary- and primary-assisted patency and operative radiation dose, dose Area Product (DAP). Learning curves were analysed by raw value and cumulative sum of deviance from mean (CUSUM).

Results
28 patients underwent CERAB between Sep 2020 and Oct 2023, 21 male, median age 62. TASCII categories were B (4), C (12) and D (12). Median length of stay was 4 days, and 4 patients were re-admitted within 30 days. Peri-operative mortality occurred in two cases, due to non-ischaemic diverticulitis and mesenteric ischaemia. 2 patients had arterial stenosis due to dissection flap or closure device failure. 93% maintained primary patency and 100% preserved primary assisted patency at 60 days. Over the series mean DAP down-trended with no significant difference in DAP between TASCII categories. CUSUM radiation learning curve showed a peak at case fifteen, after which dose trended down. There was no learning curve for peri-operative survival, 60-day primary patency, or major peri-operative complications.

Conclusion
Starting a CERAB program appears clinically safe, with no learning curve demonstrated for primary patency, major complication, or death. However, radiation dose did demonstrate a learning curve which may be related to procedural familiarity.