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Cost-effectiveness analysis of diagnostic methods in the management of patients with symptomatic, lower limb peripheral arterial disease.

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Background

Lower limb peripheral arterial disease (PAD) is characterised by symptoms including intermittent claudication (pain on walking), ischaemic rest pain, ulceration and gangrene. Relevant risk factors are: age (with one in five people over the age of 65 having evidence of PAD on clinical examination, but only one in four of these presenting symptoms), smoking, hypertension, hyperlipidaemia, diabetes, obesity, physical inactivity and family history. Management is determined by the severity of the disease, with most of the patients with intermittent claudication (Fontaine stage II) being managed conservatively, while patients with limb-threatening ischaemia (Fontaine stages III and IV) generally undergo some kind of invasive intervention (mainly angioplasty, percutaneous transluminal angiography –PTA- and amputation, according to the disease severity level).

Imaging techniques that are used for the assessment of the lower limb vasculature prior to any invasive intervention can be broadly grouped as: contrast angiography (CA), magnetic resonance angiography (MRA), computed tomography angiography (CTA) and duplex ultrasound (DUS).

Objective

To assess the cost-effectiveness, from the UK NHS perspective, of magnetic resonance angiography (MRA), duplex ultrasound (DUS) and computed tomography (CT) compared with contrast angiography (CA) in assessing the extent and location of stenosis and subsequently formulating a treatment plan for patients with peripheral arterial disease (PAD), by using decision analytic techniques.

Methods

Model structure

A probabilistic decision tree was developed in order to estimate the cost-effectiveness (i.e. costs per QALY) of performing preoperative vascular tests (2D TOF MRA, contrast-enhanced MRA, CTA or DUS), compared to CA (i.e. the reference standard in clinical practice) for the assessment of PAD on the whole leg, and the arteries above and below the knee.

Outcomes were reported per patient, per leg. The boundary of 50-100% stenosis for the whole leg was considered in the baseline analysis to identify patients with limb-threatening ischemia that should be treated either with PTA, bypass or amputation, while those diagnosed with less than 50% stenosis were to be treated with medical management. There were six health states considered in the model: fully ambulant, limited ambulance but independent, limited ambulance and dependent, confined to a wheelchair, confined to bed, and dead. Further analyses were performed for above the knee and below the knee comparisons (see Figure 1-4).

Figure 1: Preoperative diagnostic tests compared

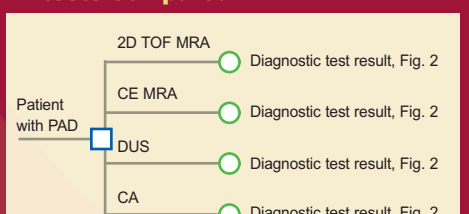


Figure 2: Diagnostic results after initial testing

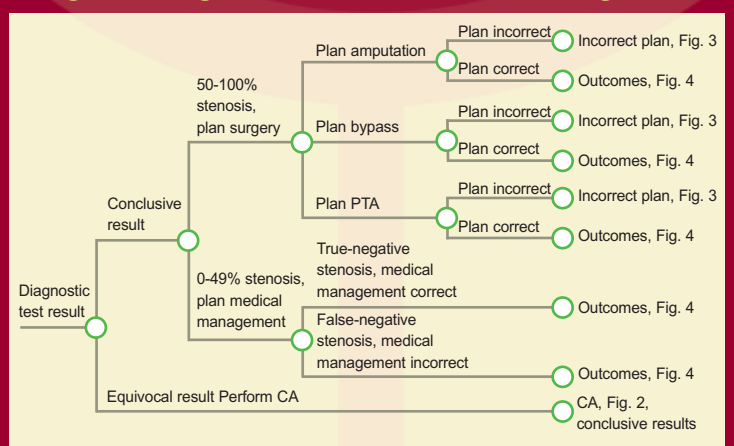


Figure 3: Incorrect treatment plans

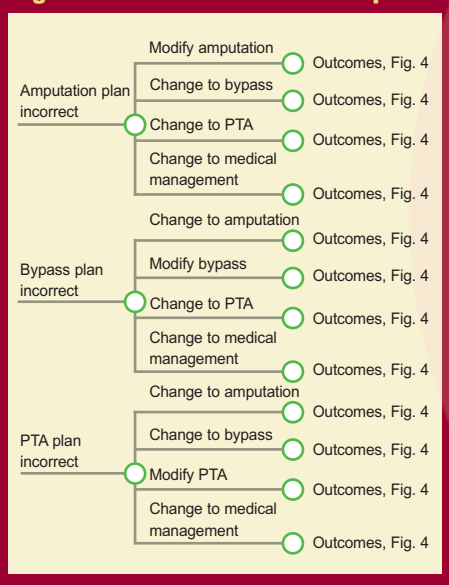
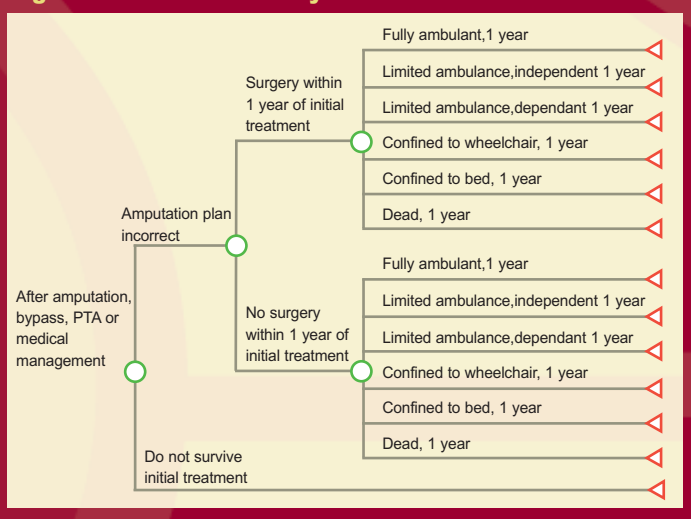


Figure 4: Outcomes at 1 year



CTA was finally excluded from the economic analysis since data regarding management of patients after test results were unavailable for this test. Evidence about long term survival was limited; therefore, the time horizon considered at analysis was one year.

Cost estimators

The costs included in the economic analysis were the direct medical costs incurred in: the preoperative diagnostic tests; secondary CA for those inconclusive tests or for patients with contraindications; major complications associated with CA; initial vascular interventions and secondary procedures during the same admission; further required vascular interventions within 1 year; modifying inaccurately formulated initial treatment plans; costs derived from intervention-related mortality; cost of medical management; and follow-up costs. Some assumptions based on expert opinion were additionally formulated due to the unavailability of data.

The Pay and Prices Index for Hospital and Community Health Services (HCHS) was used to adjust costs for inflation (UK pounds sterling 2004). When required, conversion to UK costs was performed using Purchasing Power Parities (PPP) indices. Discounting was not relevant and, as such, was not conducted.

Analysis of uncertainty

To conduct the probabilistic sensitivity analysis, appropriate parameter distributions were chosen according to the characteristics of the variables for those parameters where suitable data were available: beta distributions were used for the probability parameters where only two categories of events were possible, Dirichlet distributions were used in order to account for polychotomous input parameters and gamma distributions were used for the cost

Effectiveness estimators

A systematic review was conducted to identify the diagnostic accuracy of DUS, MRA and CTA for the assessment of PAD. To fully populate the model additional data were required; these were obtained from other relevant studies not included in the systematic review and, when estimates were not available, expert opinion was consulted in order to formulate the required assumptions. Health utility values were assigned to each of the six possible health states (see Figure 4) according to those previously published.

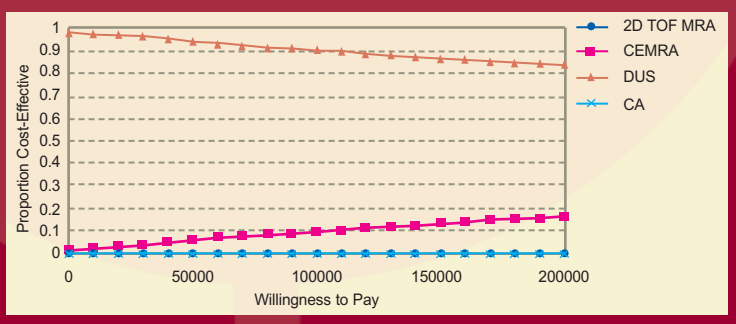
parameters. Second-order Monte Carlo simulations were performed (1000 in total) to obtain estimates of the average health effects and costs for each simulation. A dominance analysis was conducted when suitable, and cost-effectiveness acceptability curves (CEACs) where employed to summarise uncertainty.

Results

Whole leg assessment

The results for the assessment of the whole leg showed that across all the diagnostic tests a similar number of QALYs were gained during the first year after initial assessment (range: 0.61 QALYs with 2D TOF MRA to 0.64 QALYs with DUS and CA). DUS was the dominant strategy, with a cost per QALY equal to £13,646 presenting the higher probability of being cost-effective, with a probability of at least 96.5% for a threshold value of £30,000 or higher.

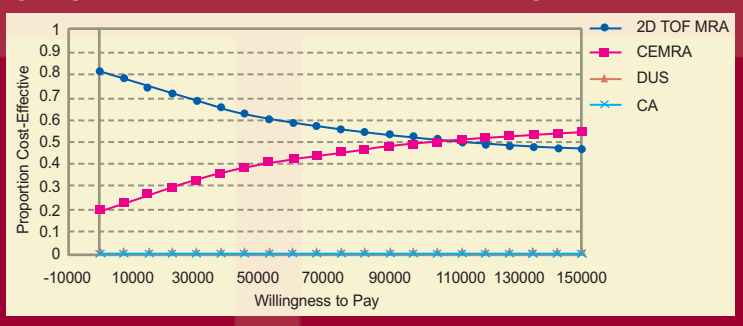
Figure 5: CEACs of the alternative diagnostic preoperative tests for whole leg comparisons



Assessment of the arteries above the knee

2D TOF MRA appeared to be the most cost-effective strategy for the assessment of arteries above the knee, with a cost per QALY of £13,442, since CE MRA obtained only a slightly higher number of QALYs (0.643 versus 0.642) at an excessive incremental cost per additionally QALY gained (£122,687). Both DUS and CA were dominated.

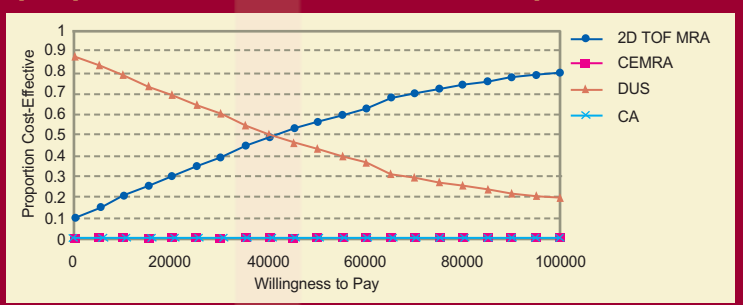
Figure 6: CEACs of the alternative diagnostic preoperative tests for above the knee comparisons



Assessment of the arteries below the knee

The assessment of the arteries below the knee presented high levels of uncertainty. For a willingness to pay per additional QALY around £40,000, both DUS and 2D TOF MRA showed similar likelihoods of being cost-effective, although for threshold values lower than £40,000, DUS presented a higher probability of being the most cost-effective choice (see Figure 7).

Figure 7: CEACs of the alternative diagnostic preoperative tests for below the knee comparisons



Conclusions

The cost-effectiveness of the diagnostic tests was dependent on the area of the leg being assessed, with DUS being dominant for comparisons of the whole leg and cost-effective for below the knee comparisons at commonly accepted cost per QALY threshold values, and MRA being cost-effective for above the knee assessments.

Further research is required, in the form of long-term observational studies, to obtain data on the long-term prognosis and management of patients that would facilitate more accurate economic modelling.

References

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