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Cost–effectiveness of mechanical thrombectomy for acute ischemic stroke: generalizability across implementation settings

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ABSTRACT

Background and purpose: Mechanical thrombectomy (MT) is a cost–effective treatment for large–vessel occlusion stroke. However, existing economic evaluations rely on restrictive assumptions regarding care pathways and resource use, limiting their applicability to real–world implementation. We evaluated the cost and cost–effectiveness implications of implementing MT across alternative, empirically observed clinical pathways in England to address this source of decision uncertainty.

Methods: A state–transition Markov model was populated with detailed United Kingdom clinical, outcome, and micro–costing data from five thrombectomy centres in England to compare MT with standard care. Alternative implementation scenarios reflected real–world variation in treatment pathways, including intervention–centre type, anaesthesia use, intensive care unit setting, and models of care. Scenarios were characterised using detailed pathway and cost data. Costs and quality–adjusted life–years were evaluated over a 5–year time horizon from National Health Service and societal perspectives.

Results: Mean procedural costs for MT were £6,135 (95% CI, £5,961–£6,318) per patient in the primary analysis, compared with £7,283 in the earlier protocol–based model. Over 5 years, MT was a dominant intervention, associated with both lower costs and improved health outcomes compared with standard care. Mean cost savings were £2,297 per patient, corresponding to an estimated annual saving of £52.6 million if all 22,908 potentially eligible patients were treated. Across all five centres and implementation scenarios, incremental cost–effectiveness ratios consistently remained below currently accepted willingness–to–pay thresholds per quality–adjusted life–year gained.

Conclusions: Across a range of real–world clinical pathways, MT is highly likely to be a cost–saving alternative to current practice and cost–effective at current health opportunity–cost thresholds. These findings suggest that cost–effectiveness is robust to local variation in service delivery and support broader implementation of MT within the English stroke–care system.

Background

Stroke is a leading cause of adult disability–adjusted life–years lost and the second most common cause of death worldwide.[1–3] It also places a profound economic burden on global society, costing more than US$2 trillion annually and accounting for 1.7% of worldwide gross domestic product.[4] A substantial proportion of direct health–system costs of stroke arise from long–term care in skilled nursing facilities and other settings for post–stroke disability.[5] Consequently, when the first effective acute treatment for ischemic stroke, intravenous thrombolysis, was introduced, economic evaluations demonstrated it to be highly cost–effective and often dominant, delivering improved outcomes alongside reduced overall costs.[6]

Mechanical thrombectomy (MT) is recommended for acute ischemic

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stroke caused by large–vessel occlusion with salvageable tissue by national and international guideline bodies.[7–11] MT restores cerebral blood flow using endovascular revascularization devices such as stent retrievers and aspiration catheters. Evidence from randomized trials and meta–analyses demonstrates that MT provides substantial additional health benefits, whether or not intravenous thrombolysis is administered, significantly reducing mortality and long–term disability.[12] In the United Kingdom, however, adoption of new therapies such as MT is contingent on demonstrating cost–effectiveness against a threshold of £25,000 – £35,000 per quality–adjusted life–year (QALY) gained.[13]

Over the last several years, numerous studies have assessed the cost–effectiveness of MT compared with standard care, consistently finding MT to be cost–effective and frequently cost saving.[14–20] A 32–country European model–based analysis by Candio et al.[5] found MT to be highly likely to be dominant, improving quality of life and survival while also generating cost savings compared with standard care in approximately two–thirds of countries studied. These findings align with country–specific evaluations using conservative 5–year time horizons, including studies from Italy.[16] France.[17] and the United Kingdom.[21] supporting the conclusion that MT is a societally desirable intervention from a health–economic perspective.

Nevertheless, an important limitation of these studies is that, because they were conducted at national or multinational levels, they rely on simplified and stylised assumptions regarding implementation. Model–based analyses typically abstract from real–world clinical pathways and procedural variation, and therefore from the healthcare resources required to deliver MT in practice. Examples include assumptions regarding the type of revascularisation device used, anaesthesia practices, treatment setting, and staffing configurations.[19] While such assumptions may be reasonable in principle, practitioners and commissioners report that they often do not reflect local service delivery arrangements or budgetary realities.[22] This failure to capture unavoidable variation in implementation introduces decision uncertainty and limits the applicability of published findings for local decision–makers.

To address this gap, the present study conducts an empirical analysis to assess the robustness of MT cost–effectiveness to variation in real–world implementation. The analysis draws on uniquely detailed pathway and micro–costing data from five MT centres in England.[23] enabling a more realistic assessment of cost–effectiveness across alternative clinical–delivery models.

Materials and methods

MT clinical pathways and procedures

Patients presenting with suspected stroke typically follow a clinical pathway that begins with pre–hospital notification and proceeds through arrival at the emergency department, imaging, and treatment with intravenous thrombolysis and, for eligible patients with large–vessel occlusion, MT. As patients progress through each stage of the pathway, multiple healthcare resources are used. Timely progression through the pathway is critical to achieving favourable functional outcomes and minimising long–term disability.

Treatment pathways for delivering MT and intravenous thrombolysis vary across thrombectomy centres. For the purposes of the present analysis, differences in patient progression through alternative treatment pathways were identified across five thrombectomy centres in England. These variations reflected both pathway structure and care processes, including service organisation and staffing models. Structural variation across the five centres included differences in admission and transfer models, point of entry to specialist care, post–procedural imaging strategies, and level of post–MT care. Further variation arose from differences in repatriation timing for clinically stable patients and from process–related factors such as MT service availability, weekend coverage, staffing capacity, and access to community rehabilitation beds. These differences are characterised by the micro–cost estimates reported by Balami et al.[2] which capture centre–specific patterns of resource use and associated costs.

Economic modelling

A previously developed state–transition Markov model was used to assess the cost savings and cost–effectiveness of implementing MT, compared with standard care, under a series of alternative clinical–pathway and treatment scenarios, including anaesthesia, ICU use, model of care, and 24–hour service availability. To conduct the analysis, cost components generated via the micro–costing study.[23] were matched with the MT intervention protocol described by Lobotesis et al.[14] and implemented in the model by Candio et al.[5]

For the base–case analysis, four main categories of resource use were considered: MT devices, consumables, venue, and staffing. Before model implementation, the cost categories reported by Balami et al.[2] were mapped against those included in the Lobotesis et al.[14] protocol (Supplementary Table S1). Where the same resource was represented in both sources, the protocol–based component was removed and replaced by the corresponding micro–costing estimate, thereby preventing double counting. Costs associated with intravenous thrombolysis and non–thrombolytic acute care were retained from the original model. Anaesthesia, post–procedural intensive or high–dependency care, repeat imaging, inter–hospital transfer and repatriation were applied only in the relevant scenario analyses. Capital investment, staff training, service–establishment costs and the opportunity cost of displaced activity were not modelled separately. No additional overhead adjustment was applied beyond overheads already incorporated within the source unit costs. Centre–specific unit costs were used where available. The classification and treatment of each cost component as retained, replaced, added for specific scenarios or not separately modelled are reported in Supplementary Table S1. Model simulations were run to estimate incremental cost–effectiveness ratios (ICERs) and the probability that MT would be cost–effective. Alternative implementation scenarios were examined to represent different hospital settings and policy options.

Model parameters

The population selected for analysis was based on the UK population in 2017, consistent with the identified economic model.[19] Eligibility criteria for MT included stroke severity defined as a National Institutes of Health Stroke Scale score $\geq$5, symptom onset within 6 hours, and absence of severe pre–stroke disability, defined as a modified Rankin Scale score $\leq$3. Based on these criteria, 22,908 patients with acute ischemic stroke were estimated to have been eligible for MT treatment across the UK. Baseline resource–use and cost inputs for the original treatment pathway were obtained from Lobotesis et al.[14] while MT–specific resource quantities and centre–level unit costs were obtained from Balami et al.[2] All costs were expressed in 2021 pounds sterling. Costs reported in earlier price years were inflated to 2021 values using the [insert the exact inflation index used] and the corresponding annual index values. Costs and quality–adjusted life–years accruing after the first year were discounted at an annual rate of 3.5%, in accordance with the NICE reference case.[24] Quality–adjusted life–year gains were derived from changes in the distribution of modified Rankin Scale scores at 90 days post–stroke. Health–utility values associated with each score level were obtained from a UK–based valuation study of stroke survivors.[25]

The model used a 5–year time horizon, consistent with previous economic evaluations adopting conservative medium–term horizons.[16,17,21] This horizon was selected as a pragmatic and conservative base case for assessing variation across empirically observed implementation pathways. Although a lifetime horizon would capture additional survival, health benefits and long–term disability–related costs, it would require extrapolation of mortality, recurrent stroke, disability progression, institutionalisation, health–related quality of life and care costs substantially beyond the period supported by the available evidence, thereby increasing parameter and structural uncertainty. Stroke recovery typically plateaus approximately 3 months after treatment; therefore, functional outcomes were based on modified Rankin Scale scores at 90 days. The analysis was conducted from two viewpoints: the UK National Health Service and a broader societal perspective.

The primary outcomes of interest were mean costs and ICERs for MT compared with standard care. ICERs were calculated as the difference in mean costs divided by the difference in mean QALYs between MT and standard care. In addition, the probability of MT being cost–effective at commonly accepted willingness–to–pay thresholds was estimated. Cost–effectiveness was assessed against the UK National Institute for Health and Care Excellence willingness–to–pay threshold, with interventions considered cost–effective if the ICER was below £20,000 per QALY gained and potentially acceptable up to £30,000 per QALY gained in the presence of additional uncertainty or wider benefits.

Scenario analyses

The primary analysis combined the Lobotesis et al.[14] baseline economic model with pooled UK micro–costing estimates from Balami et al.[2] across the five participating thrombectomy centres. Costs included MT, intravenous thrombolysis and non–thrombolytic care. Scenario–specific components were added to, or substituted for, the corresponding base–case inputs, as detailed in Supplementary Table S1. A secondary analysis applied centre–specific micro–costing estimates to each participating centre. Scenario analyses examined anaesthesia strategy, post–procedural ICU/HDU care and model of care. These incorporated the relevant resource use and costs for local anaesthesia, general anaesthesia and conscious sedation; ICU/HDU admission relative to direct admission to a hyperacute stroke unit; and mothership versus drip–and–ship pathways, including emergency–department attendance, imaging, inter–hospital transfer and repatriation where applicable. Functional outcomes were held constant across scenarios because centre– and pathway–specific treatment times and outcome distributions were unavailable. The analyses therefore isolated the cost implications of alternative service–delivery configurations rather than differences in clinical effectiveness.

Results

Primary analysis

The primary cost and cost–effectiveness analysis compared the protocol reported by Lobotesis et al.[14] with the updated micro–costing estimates reported by Balami et al.[2] across all five thrombectomy centres (Table 1). Average treatment costs, including MT, intravenous thrombolysis, and non–thrombolytic therapy, were £7,859 under the Lobotesis protocol and £6,711 (95% CI, £6,537–£6,894) using the Balami micro–costing data. The mean cost of the MT procedure alone was £7,283 in the Lobotesis analysis and £6,135 (95% CI, £5,961–£6,318) in the Balami analysis, with MT accounting for >90% of total treatment costs in both cases.

From a health and social care perspective, MT was cost saving and dominant under both costing approaches, yielding total cost savings of £26.3 million using the Lobotesis protocol and £52.6 million using the Balami micro–costing estimates. Per–patient cost savings were £1,150 and £2,297, respectively. From a societal perspective, total cost savings increased to £79.7 million and £105.9 million, corresponding to per–patient savings of £3,477 and £4,625. In all analyses, MT was associated with a 100% probability of being cost–effective at the NICE willingness–to–pay threshold of £20,000 per QALY.

Table 1
Primary analysis (lobotesis' protocol vs balami micro–costing data).

Treatment combination*	Lobotesis et al., 2016	Balami micro–costing (All 5 centres)
MT+IVT 52%		
MT only 48%		
MT intervention cost	£ 7,283	£ 6,135
2.50%	£ 7,283	£ 5,961
97.50%	£ 7,283	£ 6,318
Treatment cost	£ 7,859	£ 6,711
2.50%	£ 7,859	£ 6,537
97.50%	£ 7,859	£ 6,894
Health and Social care perspective		
Deterministic ICER	MT dominates	MT dominates
Total cost–savings to health and social care sector	£ 26,334,323	£ 52,625,411
2.50%	–£ 149,278,171	–£ 122,583,403
97.50%	£ 138,333,202	£ 179,008,161
Per patient treat cost–saving	£ 1,150	£ 2,297
Probability cost–effective at a £20,000 (€ 22,727) NICE's WTP threshold per extra QALY	100%	100%
Societal perspective		
Deterministic ICER	MT dominates	MT dominates
Total cost–savings to society	£ 79,650,306	£ 105,941,395
2.50%	–£ 125,352,489	–£ 104,175,980
97.50%	£ 194,124,997	£ 241,901,916
Per patient treated cost–saving	£ 3,477	£4,625
Probability cost–effective at a £20,000 (€ 22,727) NICE's WTP threshold per extra QALY	100%	100%

5–year time horizon; year of analysis=2017; MT=mechanical thrombectomy; IVT=intravenous thrombolysis.
ICER=incremental cost–effectiveness ratio; NICE=National Institute of Health and Care Excellence.
WTP=willingness to pay. *based on the proportion of ≥80 yers old within the treated group of patients.

Secondary analysis by centre

Substantial variation in MT intervention and total treatment costs was observed across centres, with MT procedure costs ranging from £5,362 in Centre D to £7,146 in Centre A and total treatment costs ranging from £5,938 to £7,722 (Table 2 **panels a and b**).Despite this variation, MT remained dominant in all centres from both health and social care and societal perspectives. Total cost savings to the health and social care sector ranged from £29.5 million in Centre A to £70.4 million in Centre D, while societal cost savings ranged from £82.8 million to £123.7 million. The probability of MT being cost–effective at the NICE threshold was 100% across all centres.

Anaesthesia type

Mean MT intervention costs were £6,226 (95% CI, £6,050–£6,402) under local anaesthesia, £6,363 (95% CI, £6,191–£6,538) under general anaesthesia, and £6,303 (95% CI, £6,123–£6,483) under conscious sedation (Table 3). Across all anaesthesia strategies, MT remained dominant, generating health and social care cost savings ranging from £47.4 million to £50.6 million and societal cost savings between £100.7

Table 2
– Panel a secondary analysis (lobotesis's protocol vs balami micro–costing all centres).

Treatment combination*	Lobotesis et al., 2016	Balami micro–costing (All Centres)
MT+IVT 52%		
MT only 48%		
MT intervention cost	£ 7,283	£ 6,135
2.50%	£ 7,283	£ 5,961
97.50%	£ 7,283	£ 6,318
Treatment cost	£ 7,859	£ 6,711
2.50%	£ 7,859	£ 6,537
97.50%	£7,859	£6,894
Deterministic ICER	MT dominates	MT dominates
Total cost–savings to health and social care sector	£ 26,334,323	£ 52,625,411
2.50%	–£ 149,278,171	–£ 122,583,403
97.50%	£ 138,333,202	£ 179,008,161
Per patient treat cost–saving	£ 1,150	£ 2,297
Probability cost–effective at a £20,000 (€ 22,727) NICE's WTP threshold per extra QALY	100%	100%
Deterministic ICER	MT dominates	MT dominates
Total cost–savings to society	£79,650,306	£105,941,395
2.50%	–£125,352,489	–£ 104,175,980
97.50%	£ 194,124,997	£ 241,901,916
Per patient treated cost–saving	£ 3,477	£ 4,625
Probability cost–effective at a £20,000 (€ 22,727) NICE's WTP threshold per extra QALY	100%	100%

Table 2 – panel b Secondary Analysis (Balami micro–costing centres A–E).

Treatment combination* MT+IVT 52% MT only 48%	**Balami micro–costing (Centre A)**	**Balami micro–costing (Centre B)**	**Balami micro–costing (Centre C)**	**Balami micro–costing (Centre D)**	**Balami micro–costing (Centre E)**
MT intervention cost	£ 7,146	£ 6,656	£ 5,724	£ 5,362	£ 6,841
2.50%	£ 6,798	£ 6,427	£ 5,331	£ 4,956	£6,456
97.50%	£ 7,485	£ 6,890	£ 6,084	£ 5,810	£ 7,226
Treatment cost	£ 7,722	£ 7,232	£ 6,300	£ 5,938	£ 7,416
2.50%	£ 7,374	£ 7,003	£ 5,907	£ 5,531	£7,031
97.50%	£ 8,061	£ 7,469	£ 6,660	£ 6,386	£ 7,802
Deterministic ICER	MT dominates	MT dominates	MT dominates	MT dominates	MT dominates
Total cost–savings to health and social care sector	£ 29,473,923	£ 40,694,472	£ 62,052,001	£ 70,353,328	£36,471,532
2.50%	–£ 153,197,303	–£128,789,394	–£ 120,933,484	–£ 100,488,158	–£139,702,369
97.50%	£136,689,062	£ 166,251,956	£ 175,560,497	£ 186,531,624	£ 150,961,559
Per patient treat cost–saving	£ 1,287	£ 1,776	£ 2,709	£ 3,071	£ 1,592
Probability cost–effective at a £20,000 (€ 22,727) NICE's WTP threshold per extra QALY	100%	100%	100%	100%	100%
Deterministic ICER	MT dominates	MT dominates	MT dominates	MT dominates	MT dominates
Total cost–savings to society	£ 82,789,906	£94,010,455	£ 115,367,984	£123,669,312	£89,787,515
2.50%	–£110,635,245	–£108,995,140	–£87,556,296	–£ 72,149,334	–£107,998,531
97.50%	£ 208,863,246	£223,974,752	£257,440,799	£ 244,703,700	£ 215,572,951
Per patient treated cost–saving	£ 3,614	£4,104	£ 5,036	£ 5,398	£ 3,919
Probability cost–effective at a £20,000 (€ 22,727) NICE's WTP threshold per extra QALY	100%	100%	100%	100%	100%

million and £103.9 million. The probability of cost–effectiveness at the NICE threshold remained 100% for all anaesthesia types.

ICU admission

MT intervention costs increased substantially among patients requiring admission to an intensive care unit following MT, irrespective of anaesthesia type (Table 4). Although cost savings were attenuated in ICU–admitted patients, MT remained dominant across all ICU–related analyses. From a health and social care perspective, total cost savings ranged from £10.9 million to £16.2 million, while societal cost savings ranged from £64.3 million to £69.5 million. MT retained a 100% probability of being cost–effective at the NICE threshold in all ICU–related analyses.

Model of care

Mean MT intervention costs were £7,337 (95% CI, £7,159–£7,521) for the mothership model and £7,804 (95% CI, £7,624–£7,997) for the drip–and–ship model (Table 5).MT was dominant under both models of care. Health and social care cost savings were £25.1 million under the mothership model and £14.4 million under the drip–and–ship model, while societal savings were £78.4 million and £67.7 million, respectively. Per–patient cost savings were consistently higher under the mothership model. The probability of MT being cost–effective at the NICE threshold remained 100% for both pathways.

Discussion

This study shows that mechanical thrombectomy, as delivered within the National Health Service, is a highly cost–effective and consistently cost–saving intervention across a wide range of real–world clinical settings. Using detailed micro–costing data from five thrombectomy centres, the analysis shows that MT is dominant compared with standard care, generating improved health outcomes alongside net cost savings from both health and social care and broader societal perspectives. Across all scenarios examined, MT remained well below the former £20,000 per QALY willingness–to–pay lower–bound threshold

Table 3
Type of anaesthesia (general anaesthesia, local anaesthesia and conscious sedation).

ANAESTHESIA	Micro–costing data (All 5 centres)	Balami micro–costing (All 5 centres) LOCAL anaesthesia–only	Balami micro–costing (All 5 centres) GENERAL only	Balami micro–costing (All 5 centres) CONSCIOUS only
MT intervention cost	£ 6,294	£ 6,226	£ 6,363	£6,303
2.50%	£ 6,107	£ 6,050	£ 6,191	£ 6,123
97.50%	£6,471	£ 6,402	£ 6,538	£6,483
Treatment cost	£ 6,870	£ 6,801	£ 6,939	£ 6,879
2.50%	£ 6,683	£ 6,626	£ 6,767	£ 6,699
97.50%	£ 7,047	£ 6,977	£ 7,114	£ 7,059
Health and Social care perspective				
Deterministic ICER	MT dominates	MT dominates	MT dominates	MT dominates
Total cost–savings to health and social care sector	£48,983,680	£50,559,071	£47,416,034	£ 48,790,540
2.50%	–£ 117,203,927	–£125,531,152	–£118,423,015	–£111,400,949
97.50%	£174,359,256	£157,821,793	£164,641,719	£ 157,646,580
Per patient treat cost–saving	£2,138	£ 2,207	£2,070	£2,130
Probability cost–effective at a £20,000 (€ 22,727) NICE's WTP threshold per extra QALY	100%	100%	100%	100%
Societal perspective				
Deterministic ICER	MT dominates	MT dominates	MT dominates	MT dominates
Total cost–savings to society	£102,299,664	£ 103,875,054	£ 100,732,018	£102,106,523
2.50%	–£ 101,691,114	–£98,825,058	–£ 93,103,310	–£112,576,754
97.50%	£ 233,738,888	£ 221,815,445	£ 225,761,362	£ 225,275,132
Per patient treated cost–saving	£4,466	£ 4,534	£ 4,397	£ 4,457
Probability cost–effective at a £20,000 (€ 22,727) NICE's WTP threshold per extra QALY	100%	100%	100%	100%

Table 4
ICU admissions.

ICU / ANAESTHESIA	Balami micro–costing (All 5 centres) ICU ONLY	Balami micro–costing (All 5 centres) ICU + ANAESTHESIA	Balami micro–costing (All 5 centres) ICU + LOCAL	Balami micro–costing (All 5 centres) ICU + GENERAL	Balami micro–costing (All 5 centres) ICU + CONSCIOUS
MT intervention Cost	£ 7,728	£ 7,886	£ 7,818	£ 7,955	£7,895
2.50%	£ 7,282	£ 7,430	£ 7,337	£ 7,493	£ 7,435
97.50%	£ 8,254	£ 8,404	£ 8,354	£ 8,485	£ 8,422
Treatment cost	£ 8,303	£ 8,462	£ 8,394	£8,531	£8,471
2.50%	£ 7,857	£8,006	£ 7,913	£8,069	£8,011
97.50%	£ 8,830	£8,980	£8,930	£9,061	£8,998
Health and Social care perspective					
Deterministic ICER	MT dominates	MT dominates	MT dominates	MT dominates	MT dominates
Total cost–savings to health and social care sector	£ 16,152,298	£12,510,567	£14,085,958	£ 10,942,921	£12,317,427
2.50%	–£151,138,181	–£167,921,100	–£163,184,460	–£161,639,158	–£167,436,368
97.50%	£129,406,802	£120,501,362	£121,098,174	£119,735,226	£143,122,921
Per patient treat cost–saving	£705	£546	£615	£478	£538
Probability cost–effective at a £20,000 (€ 22,727) NICE's WTP threshold per extra QALY	100%	100%	100%	100%	100%
Societal perspective					
Deterministic ICER	MT dominates	MT dominates	MT dominates	MT dominates	MT dominates
Total cost–savings to society	£69,468,282	£65,826,551	£67,401,941	£64,258,905	£65,633,411
2.50%	–£148,695,909	–£131,438,717	–£133,150,693	–£131,250,593	–£141,225,901
97.50%	£187,535,105	£188,005,357	£185,497,049	£200,840,705	£193,105,006
Per patient treated cost–saving	£3,032	£2,873	£2,942	£2,805	£2,865
Probability cost–effective at a £20,000 (€ 22,727) NICE's WTP threshold per extra QALY	100%	100%	100%	100%	100%

used by NICE, with a 100% probability of cost–effectiveness.

By incorporating centre–specific micro–costing estimates, this study extends earlier UK economic evaluations that relied on stylised or protocol–driven assumptions.[19,21] The results indicate that the use of granular, real–world cost data substantially increases estimated cost savings relative to prior UK models. From a health and social care perspective, per–patient savings more than doubled when micro–costing estimates were applied, and total system–wide savings increased markedly. These findings suggest that earlier national–level models may have underestimated the economic benefits of MT by failing to reflect efficiencies achieved in routine clinical practice. A key contribution of this study is its explicit examination of heterogeneity in MT delivery. Considerable variation in procedural costs and total treatment costs was observed across centres, reflecting differences in service organisation, staffing models, anaesthesia practices, ICU utilisation, imaging strategies, and patient flow. Despite this variation, MT remained cost saving in every centre and under all scenarios examined, underscoring the robustness of the economic case for MT even in higher–cost settings.

Anaesthesia strategy was an important driver of costs. MT performed under local anaesthesia was associated with lower procedural and total treatment costs compared with general anaesthesia or conscious sedation, consistent with previous observational and economic analyses. Similarly, post–procedural admission to intensive care substantially increased costs, attenuating but not eliminating cost savings. These findings indicate that anaesthesia strategy and post–procedural ICU/HDU admission are important determinants of MT delivery costs;

Table 5
Model of care (mothership and drip–and–ship).

MODE OF CARE	Balami micro–costing (All 5 centres)	Balami micro–costing (All 5 centres) MOTHERSHIP only	Balami micro–costing (All 5 centres) DRIP–N–SHIP only
MT intervention cost	£7,515	£ 7,337	£ 7,804
2.50%	£ 7,312	£7,159	£ 7,624
97.50%	£ 7,745	£ 7,521	£ 7,997
Treatment cost	£ 8,091	£ 7,913	£ 8,380
2.50%	£ 7,888	£7,735	£ 8,200
97.50%	£ 8,321	£8,097	£ 8,573
Health and Social care perspective			
Deterministic ICER	MT dominates	MT dominates	MT dominates
Total cost–savings to health and social care sector	£21,017,246	£ 25,089,478	£14,391,242
2.50%	–£ 156,034,988	–£ 147,045,145	–£ 151,928,062
97.50%	£143,634,773	£140,245,596	£ 116,899,534
Per patient treat cost–saving	£917	£1,095	£628
Probability cost–effective at a £20,000 (€ 22,727) NICE's WTP threshold per extra QALY	100%	100%	100%
Societal perspective			
Deterministic ICER	MT dominates	MT dominates	MT dominates
Total cost–savings to society	£74,333,230	£78,405,462	£67,707,225
2.50%	–£ 135,989,297	–£ 122,236,166	–£ 140,307,055
97.50%	£ 208,619,248	£195,650,006	£186,579,562
Per patient treated cost–saving	£3,245	£3,423	£ 2,956
Probability cost–effective at a £20,000 (€ 22,727) NICE's WTP threshold per extra QALY	100%	100%	100%

however, potential differences in clinical outcomes between these approaches were not incorporated in the analysis, and the results should not be interpreted as evidence of their clinical superiority or equivalence.

The model of care also had a material impact on costs. The mothership model, in which patients are directly admitted to a thrombectomy–capable centre, generated greater cost savings than the drip–and–ship model. Higher costs in the drip–and–ship pathway were driven by duplicated emergency–department attendances, repeat imaging, inter–hospital transport and repatriation. These findings reflect differences in pathway–specific resource use and costs under the assumption of equivalent functional outcomes. They should not therefore be interpreted as demonstrating the clinical or overall economic superiority of the mothership model, as differences in treatment delays and associated outcomes were not incorporated. Moreover, the lower estimated cost savings associated with drip–and–ship should be considered alongside its role in extending access to MT for patients living further from thrombectomy–capable centres who might otherwise experience substantial delays or receive no endovascular treatment. Service configuration should therefore balance economic efficiency with geographical accessibility and equity of access, supporting direct admission where geographically and clinically feasible while retaining drip–and–ship pathways for dispersed populations.[26] Unlike many previous studies, this analysis incorporated both major classes of MT devices, stent retrievers and aspiration catheters, and explicitly captured variation in the number and type of devices used. This reflects contemporary clinical practice more accurately than earlier UK evaluations, which were restricted to stent retrievers alone. The findings are consistent with international evidence showing MT to be dominant across diverse health systems.[15,16,27] and extend that evidence by demonstrating that dominance persists when real–world procedural heterogeneity is taken into account.

Nonetheless, the study has limitations. First, although the Markov model captures key post–stroke health states, it cannot represent all possible long–term health trajectories or comorbidities. Second, the 5–year time horizon does not capture all lifetime benefits and costs associated with improved survival and reduced post–stroke disability. The analysis is therefore likely to underestimate the absolute QALY gains and long–term health, social care and societal cost savings associated with MT. Although a lifetime horizon would encompass a broader range of relevant events and outcomes, it would also require increasingly uncertain extrapolation of long–term survival, recurrent stroke, disability progression, institutionalisation and care costs. Given that MT was dominant in the primary analysis and across all centre–specific and implementation scenarios, extending the time horizon would be expected to affect the absolute estimates of incremental costs and health benefits, but would be highly unlikely to alter the cost–effectiveness conclusion and would probably strengthen the estimated economic case for MT. Nevertheless, the absence of a formal lifetime sensitivity analysis should be recognised as a limitation. Third, health–related quality of life was assumed to remain stable beyond 3 months after stroke, which may not capture longer–term changes in functional status. Because pathway–specific treatment times and outcome distributions were unavailable, the scenario analyses did not capture potential differences in clinical outcomes, particularly between mothership and drip–and–ship pathways. As treatment delays may influence outcomes after MT, these scenarios should be interpreted as conditional cost comparisons rather than full comparative cost–effectiveness analyses. Future studies should incorporate pathway–specific delays and functional outcomes where suitable patient–level data are available.

Finally, while the five centres included are representative of high–volume English MT services, results may not fully generalise to lower–volume or newly established centres. Notwithstanding these limitations, this is, to our knowledge, the first UK economic evaluation of MT to integrate centre–level micro–costing data across the full treatment pathway and to systematically explore heterogeneity in anaesthesia, ICU admission, and model of care. The inclusion of a societal perspective, incorporating informal care and productivity losses, provides a more comprehensive assessment of the broader economic consequences of MT.

Conclusions

This study provides robust real–world evidence that mechanical thrombectomy is not only highly cost–effective but also cost saving within the English NHS across a wide range of delivery models. By incorporating detailed micro–costing data from high–output centres, the analysis offers a more realistic estimate of the true economic impact of MT than previous protocol–based evaluations. MT remained dominant under all scenarios examined, including variation in anaesthesia, ICU admission, and model of care. These findings strengthen the economic case for continued investment in MT services and support the expansion and optimisation of thrombectomy provision in the UK.

CRediT authorship contribution statement

Joyce S. Balami: Writing – review & editing, Writing – original draft, Validation, Project administration, Data curation. **Gary A. Ford:** Writing – review & editing, Validation. **Alastair M. Buchan:** Writing – review & editing, Validation. **Alastair Gray:** Writing – review & editing, Validation. **Jeffrey L. Saver:** Writing – review & editing, Validation. **Paolo Candio:** Writing – review & editing, Writing – original draft, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

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AMB is a co–founder of BRAINOMIX. The other authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jstrokecerebrovasdis.2026.108730.

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