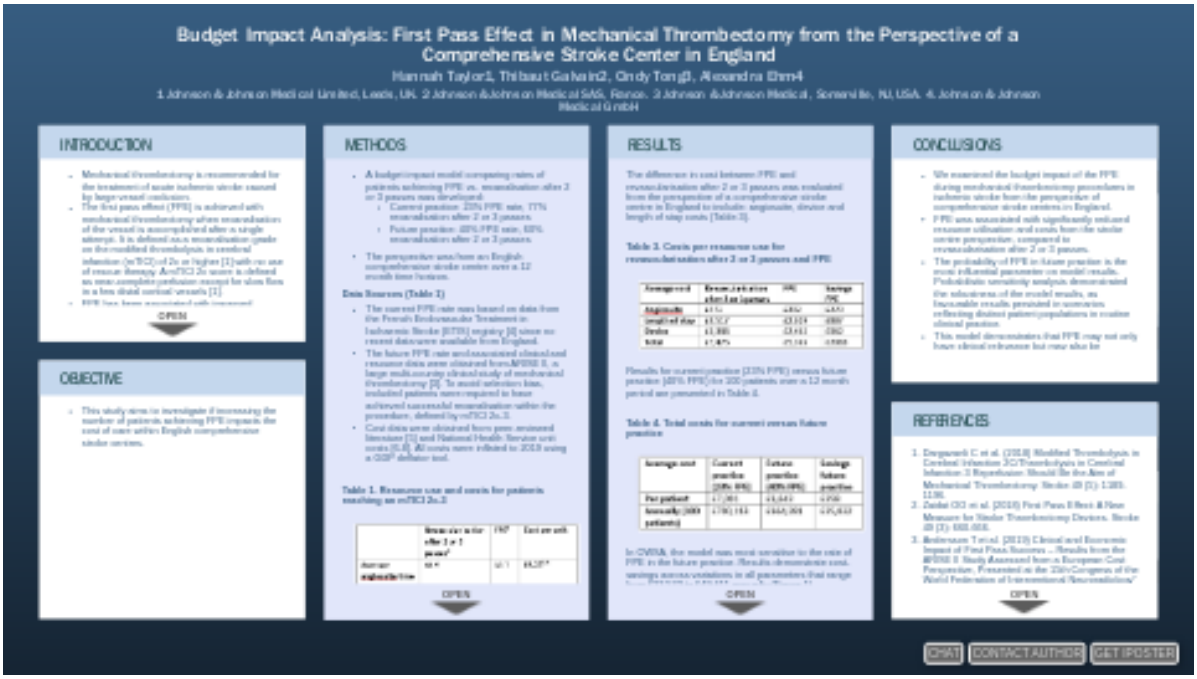
Budget Impact Analysis: First Pass Effect in Mechanical Thrombectomy from the Perspective of a Comprehensive Stroke Center in England



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INTRODUCTION

- Mechanical thrombectomy is recommended for the treatment of acute ischemic stroke caused by large vessel occlusion.
- The first pass effect (FPE) is achieved with mechanical thrombectomy when recanalisation of the vessel is accomplished after a single attempt. It is defined as a recanalisation grade on the modified thrombolysis in cerebral infarction (mTICI) of 2c or higher [1] with no use of rescue therapy. A mTICI 2c score is defined as near-complete perfusion except for slow flow in a few distal cortical vessels [1].
- FPE has been associated with improved functional outcomes after ischemic stroke [2]. If blood flow is not restored after the first attempt the same device can be used up to 3 times to attempt revascularisation.
- The ARISE II study demonstrated that patients achieving FPE had a higher rate of good functional outcome compared to patients achieving successful reperfusion on later passes (modified Rankin Scale (mRS) ≤2 80% vs. 61%, p=0.01), lower rate of embolisation into a new territory (2% vs. 11%, p=0.03) and shorter length of stay (6.1 days vs. 9.5 days, p<0.01) [3].

OBJECTIVE

- This study aims to investigate if increasing the number of patients achieving FPE impacts the cost of care within English comprehensive stroke centres.

METHODS

- A budget impact model comparing rates of patients achieving FPE vs. recanalisation after 2 or 3 passes was developed:
  - Current practice: 23% FPE rate, 77% recanalisation after 2 or 3 passes
  - Future practice: 40% FPE rate, 60% recanalisation after 2 or 3 passes
- The perspective was from an English comprehensive stroke centre over a 12 month time horizon.

Data Sources (Table 1)

- The current FPE rate was based on data from the French Endovascular Treatment in Ischaemic Stroke (ETIS) registry [4] since no recent data were available from England.
- The future FPE rate and associated clinical and resource data were obtained from ARISE II, a large multi-country clinical study of mechanical thrombectomy [3]. To avoid selection bias, included patients were required to have achieved successful recanalisation within the procedure, defined by mTICI 2c-3.
- Cost data were obtained from peer-reviewed literature [5] and National Health Service unit costs [6-8]. All costs were inflated to 2019 using a GDP deflator tool.

Table 1. Resource use and costs for patients reaching an mTICI 2c-3

	Revascularisation after 2 or 3 passes[3]	FPE[3]	Cost per unit
Average angiosuite time (minutes)	61.9	32.7	£9.23[5,6]
Average LOS stay (days)	9.5	6.1	Day 1: £689[7] Day 2-5: £413[7] Day 6+: £261[8]
Average # devices used*	1.39	1.01	£2,437[9]

*Based on the number of devices used to achieve the lab-adjudicated mTICI score from ARISE II

Scenario analysis: Two scenarios were evaluated to simulate how alternative criteria for revacularisation, which could be used in real world clinical practice, would influence FPE:

- In scenario 1, criteria for FPE was changed to from mTICI 2c-3 to mTICI 2b-3. Whilst mTICI 2c-3 is commonly used some studies use mTICI 2b-3 however this has been associated with poorer functional outcomes as it lowers the threshold to achieve successful reperfusion [1]. It was assumed using mTICI 2b-3 would increase the FPE rate for current practice to 35% and future practice would be aligned with mTICI 2b-3 results from ARISE II (52% [3]).
- In scenario 2, the patient population was expanded to all patients who received the treatment, regardless of final revascularisation status, and compared FPE patients with mTICI 2c-3 within the first pass to all remaining patients.

Sensitivity Analysis: To assess the uncertainty of the model a one-way deterministic sensitivity analysis (OWSA) was conducted by varying each model parameter individually and observing the effect on the results. Parameters were varied according to their confidence intervals or by ± 25% if not available. A probabilistic sensitivity analysis (PSA) was also performed in which

parameters were simultaneously varied by randomly drawing values from their distribution for 100 patients over 1,000 iterations. Results were presented with bootstrap 95% confidence intervals based on the percentile method. Confidence intervals and distributions used for each parameter are presented in Table 2.

Table 2. Parameters considered in the sensitivity analyses

Name	Distribution	Lower bound	Upper bound
Angiosuite cost per minute	Gamma	£6.93	£11.54
Cost per hospital bed days (day1)	Gamma	£516.43	£860.72
Cost per hospital bed days (day 2-5)	Gamma	£310.02	£516.71
Cost per hospital bed days (day 5+)	Gamma	£195.75	£326.25
Device cost (stent retriever)	Gamma	£1,828.07	£3,046.79
Average angiosuite time (minutes) FPE	Gamma	27.95	37.48
Average angiosuite time (minutes) R3P	Gamma	55.75	68.03
Average LOS (days) FPE	Gamma	5.17	7.03
Average LOS (days) R3P	Gamma	7.35	11.62
Average number of devices used FPE	Gamma	0.989	1.0325
Average number of devices used R3P	Gamma	1.263	1.527
Current practice FPE	Beta	0.208	0.247
Future practice FPE	Beta	0.334	0.465

FPE: first pass effect; R3P: revascularisation after 2 or 3 passes

RESULTS

The difference in cost between FPE and revascularisation after 2 or 3 passes was evaluated from the perspective of a comprehensive stroke centre in England to include: angiosuite, device and length of stay costs (Table 3).

Table 3. Costs per resource use for revascularisation after 2 or 3 passes and FPE

Average cost	Revascularisation after 2 or 3 passes	FPE	Savings FPE
Angiosuite	£572	£302	£270
Length of stay	£3,517	£2,629	£887
Device	£3,388	£2,462	£962
Total	£7,476	£5,393	£2083

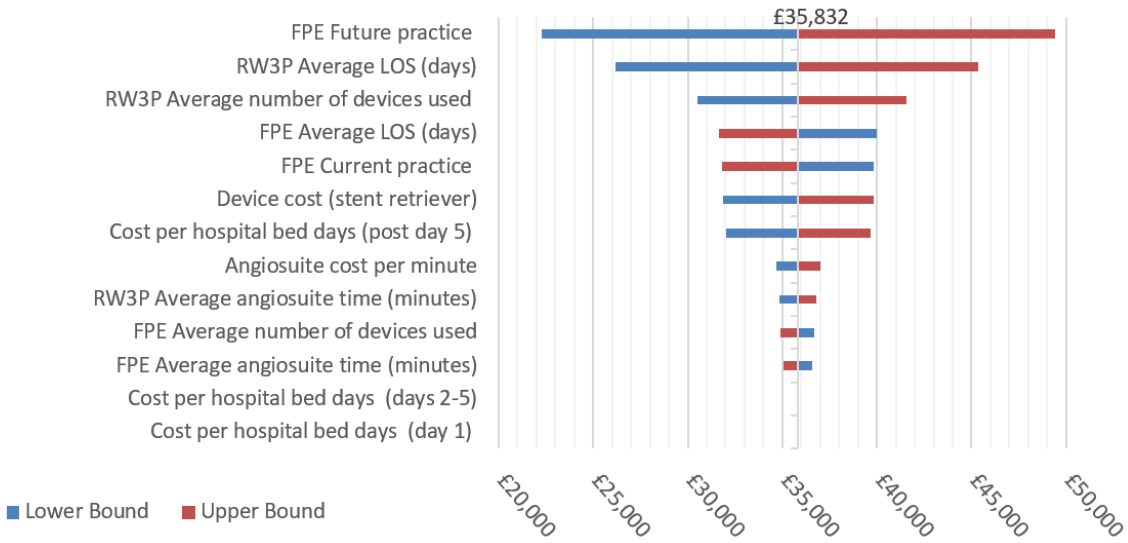
Results for current practice (23% FPE) versus future practice (40% FPE) for 100 patients over a 12 month period are presented in Table 4.

Table 4. Total costs for current versus future practice

Average cost	Current practice (23% FPE)	Future practice (40% FPE)	Savings future practice
Per patient	£7,001	£6,643	£358
Annually (100 patients)	£700,113	£664,281	£35,832

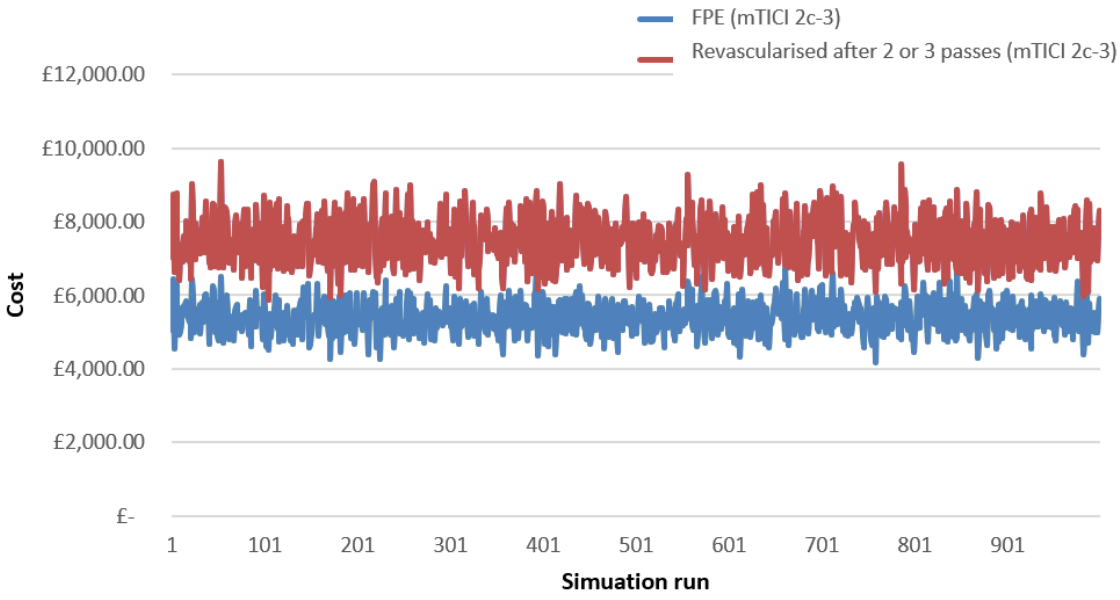
In OWSA, the model was most sensitive to the rate of FPE in the future practice. Results demonstrate cost-savings across variations in all parameters that range from £22,523 to £49,411 annually (Figure 1).

Figure 1: Tornado plot of annual savings current versus future practice



In PSA, the mean [95% Confidence Interval] annual cost of the current practice was £700,659 [£600,347; £813,003], while it was £664,594 [£572,253; £770,520], for mean annual savings of £36,064 [£19,759; £59,212]. The mean cost of FPE (mTICI 2c-3) procedure was £5,391 [£4,612; £6,232] and £7,482 [£6,367; £8,752] when 2 or 3 passes were required (mTICI 2c-3) (Figure 2).

Figure 2. FPE and revascularisation after 2 or 3 passes (mTICI 2c-3) costs per procedure according to probabilistic sensitivity analysis



The two scenario analyses had similar results for a 100 patient cohort:

- lowering the FPE criteria to mTICI 2b-3 (scenario 1): led to savings of £308 per patient and £30,792 per year
- including all patients, including those who were not successfully revascularised (scenario 2): led to savings of £316 per patient and £31,618 per year

CONCLUSIONS

- We examined the budget impact of the FPE during mechanical thrombectomy procedures in ischemic stroke from the perspective of comprehensive stroke centres in England.
- FPE was associated with significantly reduced resource utilisation and costs from the stroke centre perspective, compared to revascularisation after 2 or 3 passes.
- The probability of FPE in future practice is the most influential parameter on model results. Probabilistic sensitivity analysis demonstrated the robustness of the model results, as favourable results persisted in scenarios reflecting distinct patient populations in routine clinical practice.
- This model demonstrates that FPE may not only have clinical relevance but may also be important from an economic perspective.

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