FACTORS DRIVING THROMBOLYSIS USE AND SPEED. A RETROSPECTIVE DATA ANALYSIS AND MODELLING STUDY OF SEVEN ACUTE HOSPITALS

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Background

There remains significant variation between hospitals in the UK in both thrombolysis rates for ischaemic stroke and arrival-to-treatment times. We investigated the thrombolysis pathway, through process mapping followed by simulation studies, in seven acute hospitals to better understand what influences thrombolysis rate.

Methods

We performed an analysis of thrombolysis pathway data from seven regional hospitals (4,194 patients in total over 12 months), Table 1.

	Hospital						
	1	2	3	4	5	6	7
Proportion of patients with known stroke onset time	44%	60%	43%	54%	56%	62%	72%
Median arrival to scan (min)*	43	52	11	15	39	56	28
Median scan to thrombolysis (min)	34	43	41	48	39	21	39
Thrombolysis rate for ischaemic stroke patients scanned with time left to thrombolyse**	34%	39%	42%	32%	41%	65%	49%
Overall thrombolysis rate	6.1%	8.3%	8.5%	8.7%	9.3%	13.1%	13.3%

**For patients arriving within 4 hours of known stroke onset.*

*** Patients scanned with 30 min licence window remaining and not flagged with 'time window' as a reason not to thrombolyse in hospital SSNAP data.*

Table 1. Characteristics of the seven hospitals studied, data for stroke patients with out of hospital onset

Process data were used as the basis of a computer simulation model to investigate three factors that affect use and speed of thrombolysis, Fig. 1.

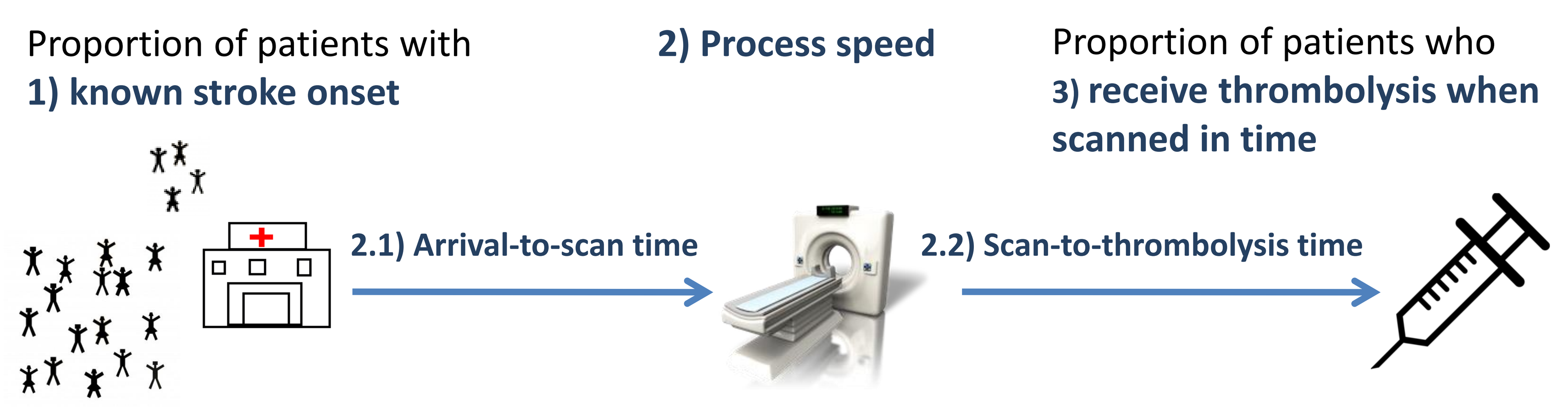

Fig. 1. The flow of patients through the thrombolysis pathway, represented by the three key factors that affect the use and speed of thrombolysis

To model the small proportion of patients who are **not recognised as having a stroke** on arrival at hospital , it is assumed that 10% of patients immediately exit the thrombolysis pathway

The computer simulation applied the observed **variation in the process** (for example, process times were sampled from a log-normal distribution).

Allowable **onset-to-treatment** time: 270 minutes for patients <80 years old
180 minutes for patients 80+ years old

Clinical benefit was estimated based on the meta-analysis performed by Emberson et al. (2014) with patients separated into <80 and 80+ age groups for the estimation of benefit based on onset-to-treatment time. Benefit is presented as the number of additional patients who are disability-free (mRS 0-1) 3-6 months later, attributable to thrombolysis, for every 1,000 arriving stroke patients (out-of-hospital onset only).

Results

Each of the seven hospitals had different pathways for delivering thrombolysis. Most variation in **process speed** was observed in the arrival-to-scan stage. Those hospitals with paramedics taking patients straight to scan had significantly faster arrival-to-scan times (median 11-15 minutes) than those hospitals that handover to ED staff prior to scanning (median 28-56 minutes).

Interviews with clinicians involved in the pathway revealed different amounts of effort into ascertaining the **stroke onset** time, and different attitudes to the risk/benefit of the use of thrombolysis (especially in milder or improving strokes) which directly affects the proportion of patients who **receive thrombolysis when scanned in time**.

The seven hospitals differed significantly in the three factors affecting thrombolysis rates and clinical benefit. A sensitivity analysis investigated the effect of variation among the three factors. Modelling demonstrated that averaging across multiple scenarios, a 1 percentage point in thrombolysis could be achieved by:

1. A 5 percentage point increase in the proportion of patients with **known stroke onset** *(Fig. 2)*
2. A 17 minute reduction in **process speed** after arrival at hospital *(Fig. 3)*
3. A 3.5 percentage point increase in the proportion of patients who **receive thrombolysis when scanned in time** *(Fig. 4)*

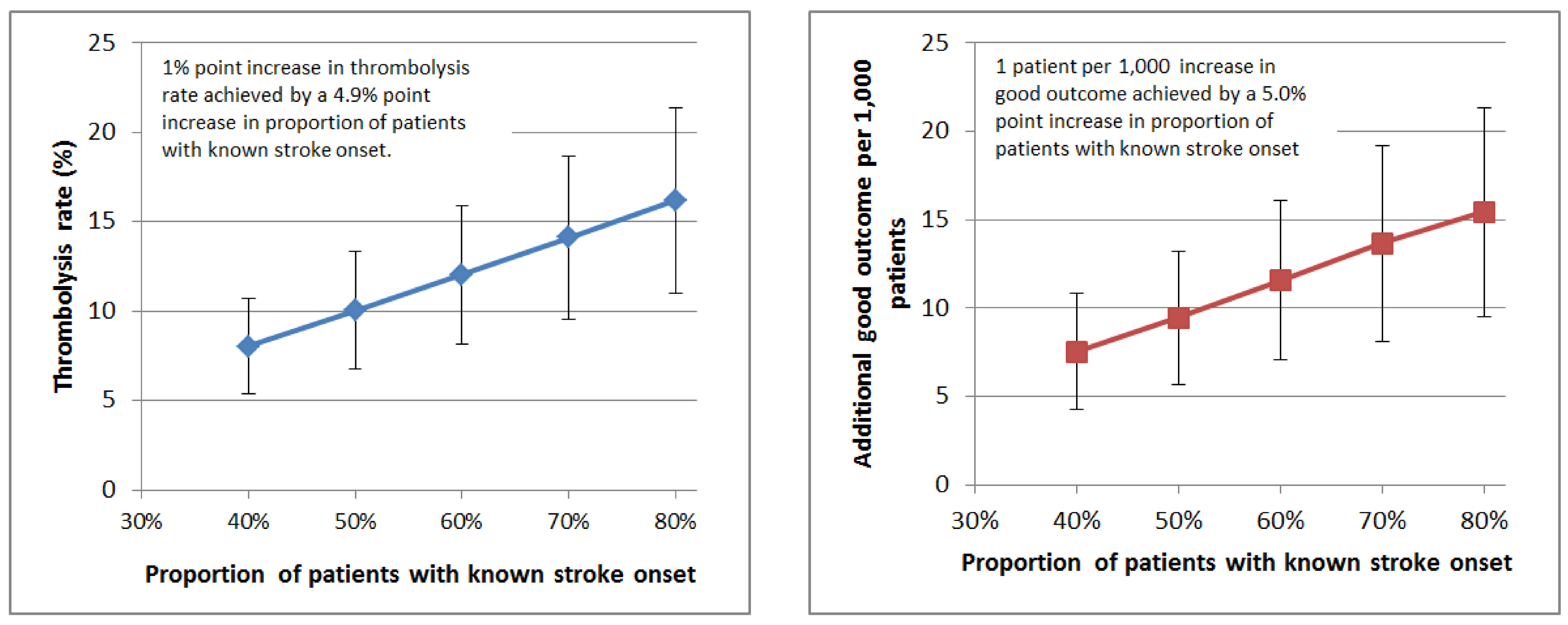

*Fig. 2. Plots showing average effects of altering the proportion of patients with **known stroke onset.** Individual points show the mean and standard deviations for all scenarios (proportion of patient scanned in time who receive thrombolysis: 25-60%; arrival-to-scan and scan-to-thrombolysis times: 15-120 min)*

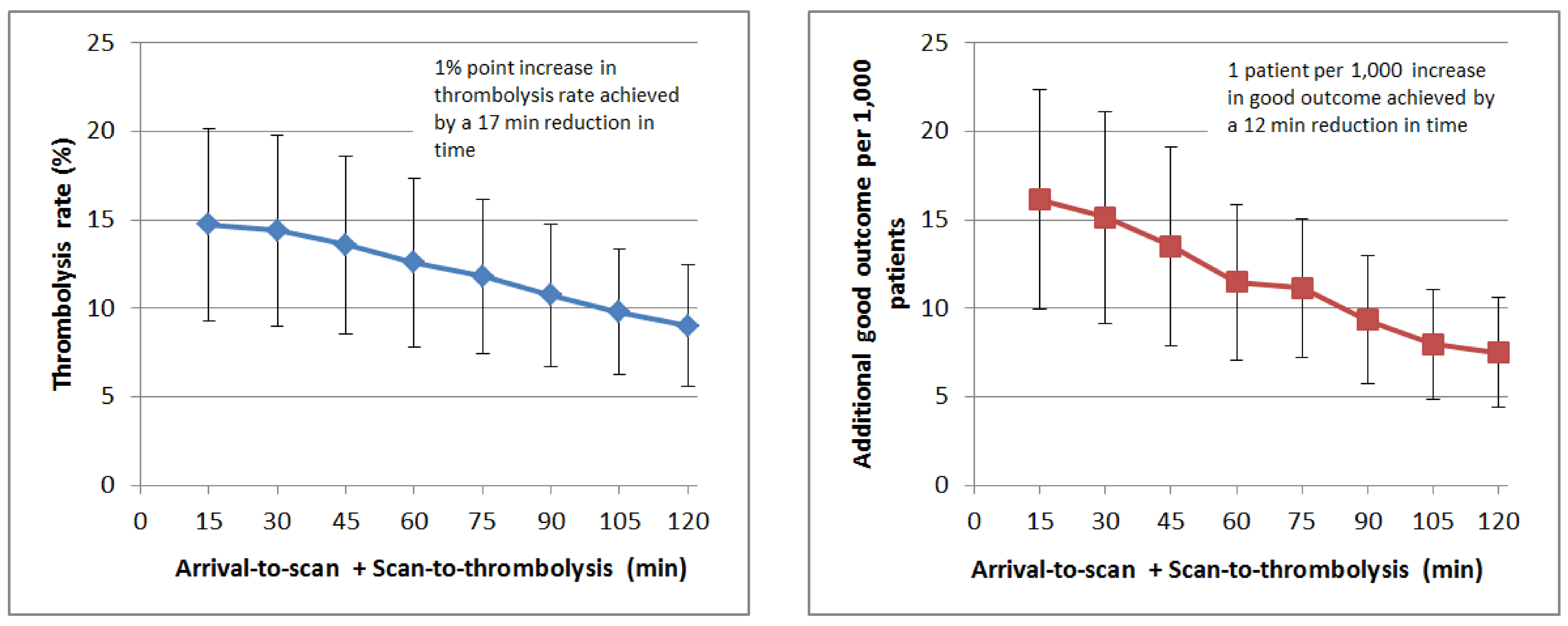

*Fig. 3. Plots showing average effects of altering hospital **process speeds** (arrival-to-scan and scan-to-thrombolysis). Individual points show the mean and standard deviations for all scenarios (proportion of patient scanned in time who are given thrombolysis: 25-60%; proportion with known stroke onset from 40-80%)*

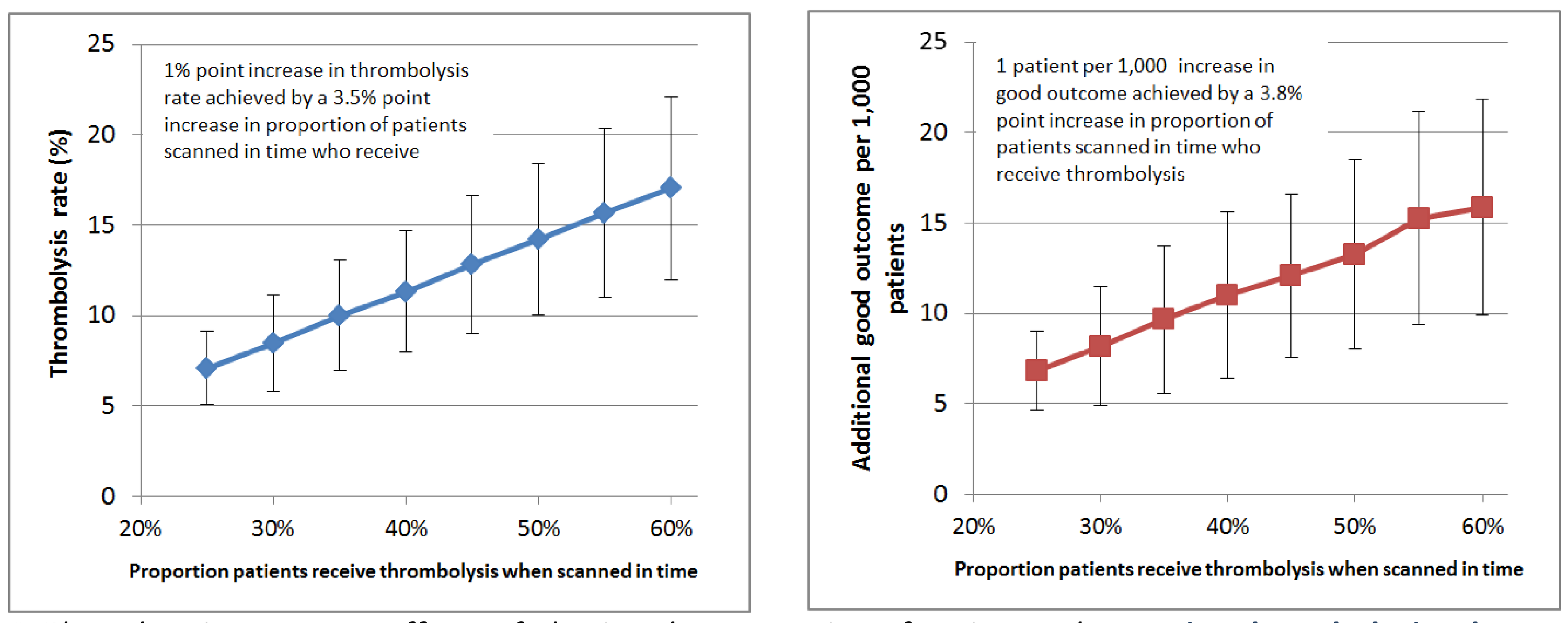

*Fig. 4. Plots showing average effects of altering the proportion of patients who **receive thrombolysis when scanned in time**. Individual points show the mean and standard deviations for all scenarios (proportion with known stroke onset: 40-80% ; arrival-to-scan and scan-to-thrombolysis times: 15-120 min)*

When combining potential improvements, modelling suggested that a **maximum thrombolysis rate of 25%** was a realistic upper target for this population. This would lead to ~15 patients per 1,000 stroke patients being disability free as a result of receiving thrombolysis, (*Fig. 5*).

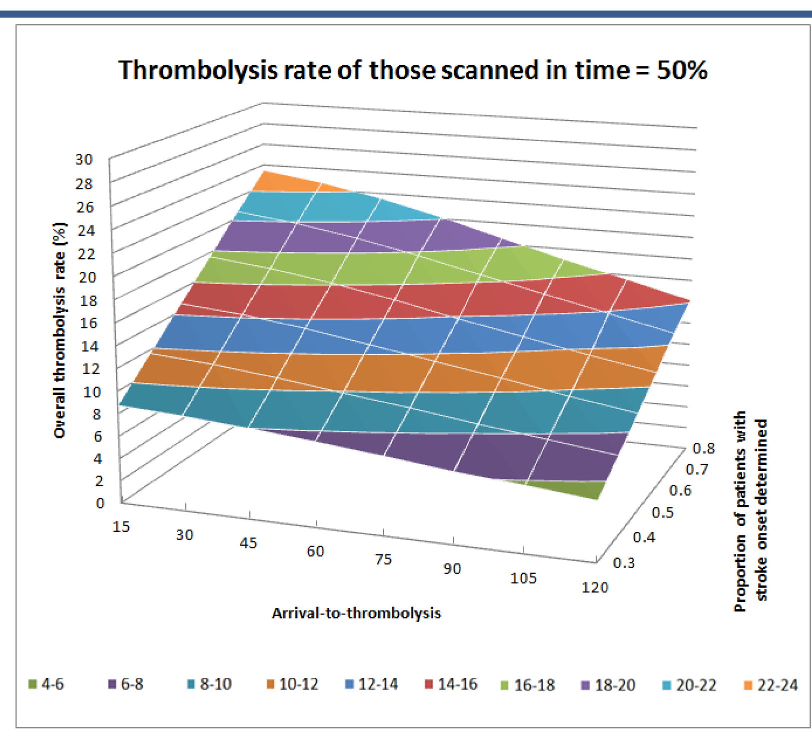

*Fig. 5. Combined effects of altering the **process speed** and proportion of patients with **known stroke onset** whilst fixing the proportion of patients who **receive thrombolysis when scanned in time** to 50% (IST-3)*

Hospitals differed in what was most limiting thrombolysis rates. For one hospital, modelling showed how the arrival-to-scan times could be extended by 40 minutes for those patients with an unknown stroke onset, and a 4 percentage point increase in thrombolysis rate could be achieved if that time were used to bring the proportion of patients with known stroke onset up to the English national average of 67%.

Conclusions

Three key factors governing thrombolysis rates and speed have been identified:

- Proportion of patients with **known stroke onset**
- ***Process speed***
- Proportion of patients who **receive thrombolysis when scanned in time**

Service improvement should target the factor(s) which are most limiting thrombolysis rate or speed. Simulation allows prediction of future performance if specific factors are targeted.

References

1 Emberson J, Lees KR, Lyden P, et al. Effect of treatment delay, age, and stroke severity on the effects of intravenous thrombolysis with alteplase for acute ischaemic stroke: a meta-analysis of individual patient data from randomised trials. Lancet 2014;384(9958):1929-35.

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