CENTRALISING STROKE SERVICES IN A MIXED URBAN AND RURAL ENVIRONMENT: WINNERS AND LOSERS?

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Background

Recent reconfigurations of urban stroke services in England have focussed on centralising hyperacute care (first 72 hours) into fewer, larger hyperacute stroke units (HASUs). Such reconfiguration has shown the potential to reduce mortality and offer improved 24/7 access to imaging and specialist staff[1]. We sought to investigate the potential impact in the mixed urban and rural setting of South West England.

Methods

To investigate the impact of reconfiguration on a large mixed urban and rural region in South West England (population 4.7 million, 201 people/km^2), we created a geographic model starting with the current 14 acute stroke centres and incrementally centralised services to 2 HASUs. The model estimated clinical benefit based on the relationship between onset-to-treatment (OTT) time (Fig. 1) and the probability of being disability free at 3-6 months[2]. Shorter OTT times result in greater clinical benefit.

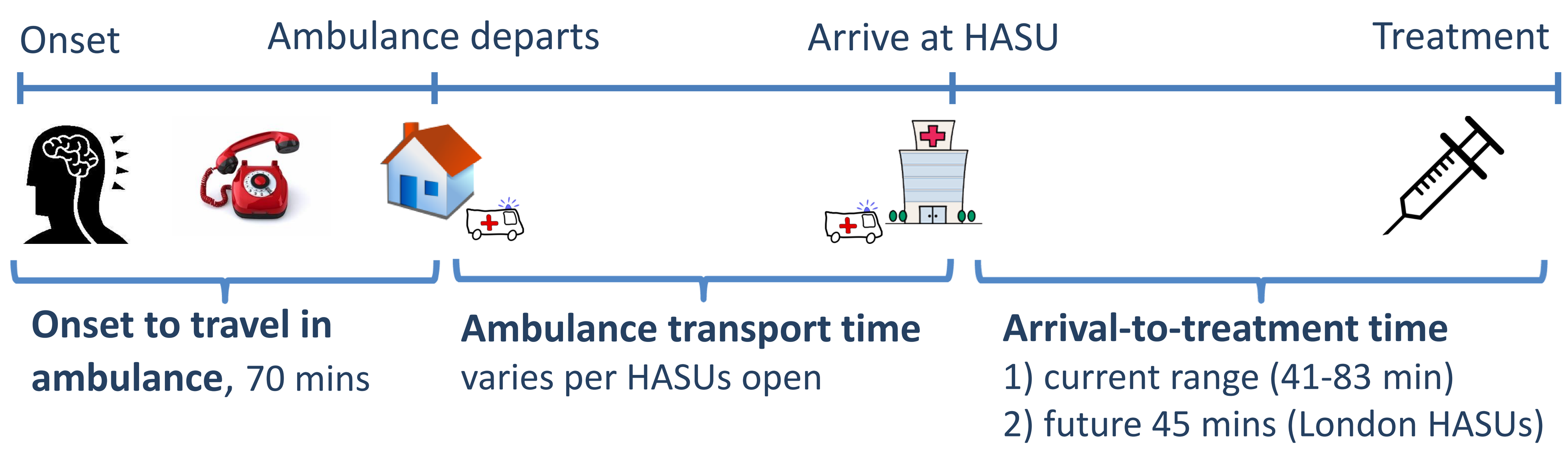


Fig. 1. Modelled onset-to-treatment time

Patients were assigned to one of 2,838 patient nodes (Fig. 2) based on registered home location (emergency stroke admissions ICD10 of I61, I63, I64 obtained from Hospital Episode Statistics, HES). Road travel times from each patient node to each hospital were estimated using Microsoft MapPoint and corrected for South Western Ambulance Service NHS Foundation Trust recorded travel time.

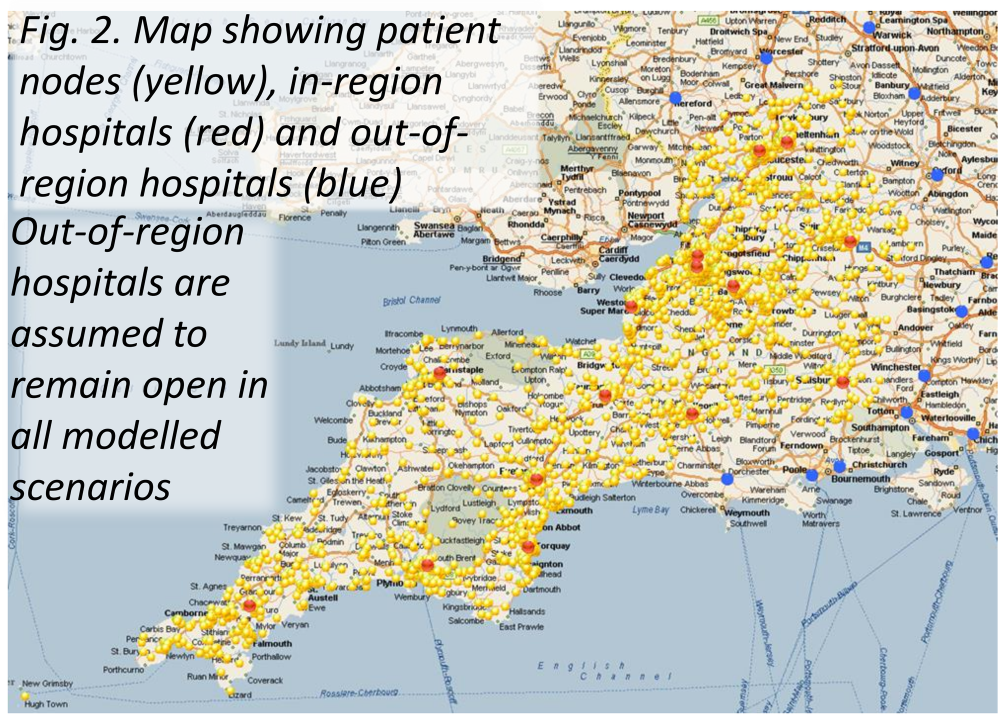


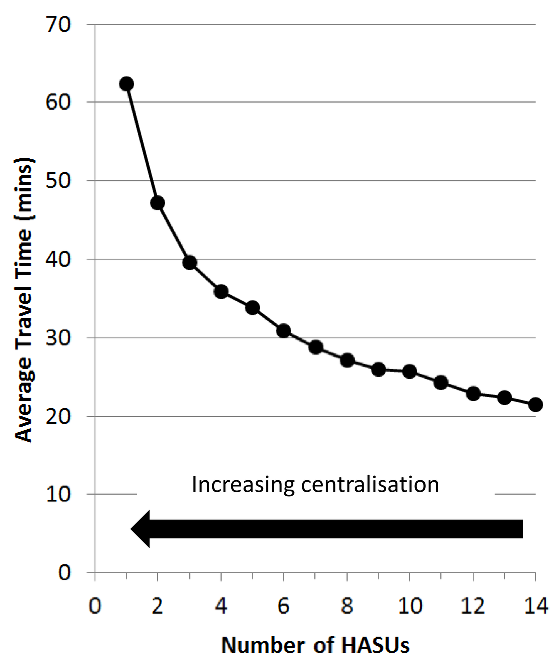
Fig. 2. Map showing patient nodes (yellow), in-region hospitals (red) and out-of-region hospitals (blue) Out-of-region hospitals are assumed to remain open in all modelled scenarios

An optimisation model was developed to identify the best HASU locations for any given number of locations. The model sought to simultaneously:

- ***minimise*** *average ambulance transport time to HASU*
- ***minimise*** *the maximum ambulance transport time to HASU for any one patient*
- ***maximise*** *the proportion of patients within 30 min ambulance transport time*
- ***maximise*** *anticipated net clinical benefit of thrombolysis*
- ***maximise*** *proportion of patients attending a HASU with at least 600 admissions/year*

Results

Reducing the number of HASUs causes increased average ambulance transport time to a HASU, from 21 minutes with all 14 units (78% population within 30 min ambulance transfer) to 62 minutes with 1 regional unit (9% population within 30 min ambulance transfer), Fig. 3.



Number of HASUs	Average ambulance transport time (mins)	Maximum ambulance transport time (mins)	% Patients within 30 mins transport time	Clinical benefit*	Percent patients attending HASU with ≥600 admissions per year	% Patients treated within region
1	62	122	9	9.0	100	38
2	47	122	24	9.7	100	76
3	40	93	30	10.0	100	79
4	36	93	37	10.2	100	79
5	34	93	45	10.3	100	88
6	31	65	47	10.4	94	80
7	29	65	54	10.5	94	90
8	27	65	59	10.6	94	91
9	26	65	63	10.7	94	96
10	26	65	63	10.7	94	96
11	24	65	68	10.8	86	96
12	23	65	73	10.8	73	98
13	22	65	74	10.8	57	98
14	21	65	78	10.9	38	98

*Clinical Benefit = additional MRS0-1 patients per 100 patients clinically suitable for thrombolysis

Fig. 3. Performance of the system with varying number of HASUs. The specific combination of HASUs represented in each row are those determined as being mathematically optimal by the model

Increased ambulance transport times may be offset by faster arrival–to-treatment (ATT) times. If selected HASUs could operate with 45 min ATT times, the current level of clinical benefit could be achieved with as few as 4 regional HASUs (Fig. 4). With 5+ HASUs there would be an expected net increase in clinical benefit.

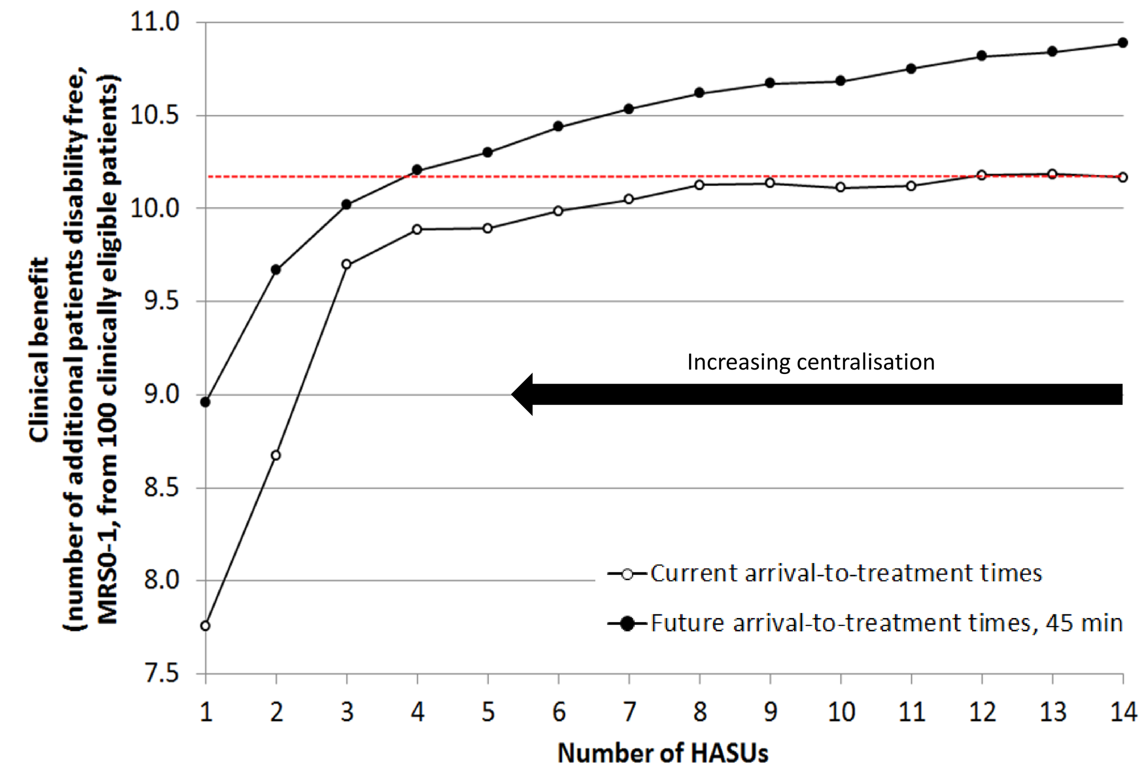


Fig. 4. A comparison of predicted clinical benefit from thrombolysis with varying numbers of HASUs. All HASUs use either their current arrival-to-treatment times (O) *or 45 min arrival-to-treatment times* (●)

The net increase in clinical benefit combines two populations:

1. those living closer to the HASUs have shorter OTT times by accessing a HASU with improved ATT times
2. those living far from the HASUs have longer OTT times as the increased ambulance transport times are not fully compensated by the improved ATT times

The inequity caused by centralisation was further explored by comparing the current performance of the stroke system, represented by all 14 HASUs operating with their current median ATT times (range 41-83 min) with centralisation being represented by a varying number of HASUs that all operate with 45 min ATT time, Fig. 5.

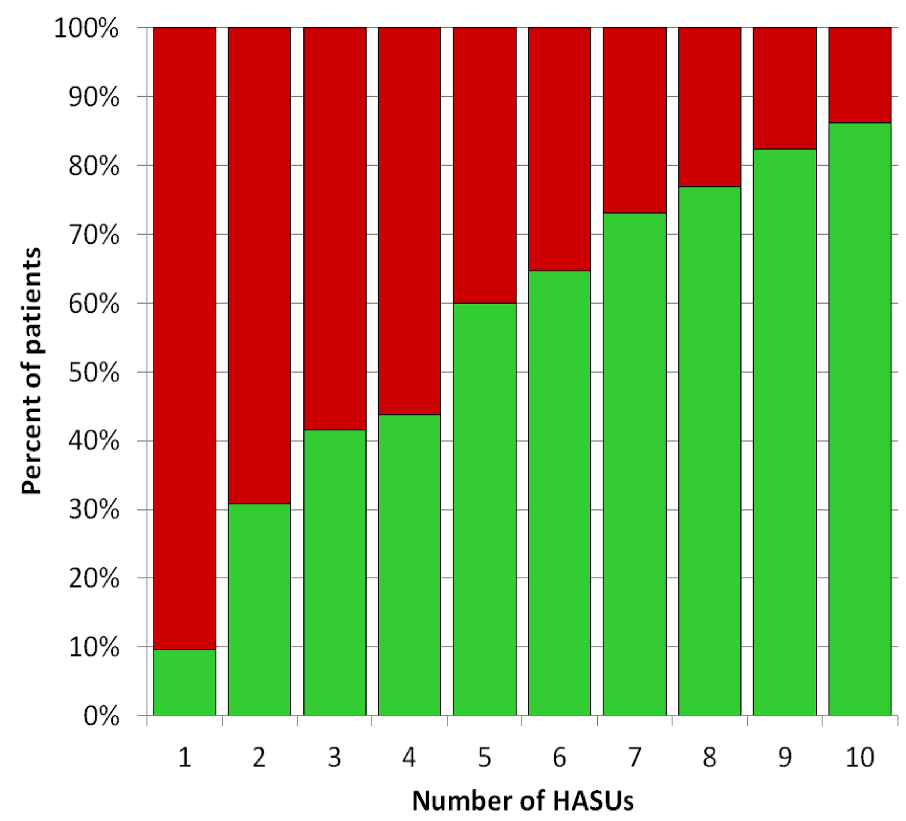


Fig. 5. The proportion of patients with reduced (green) or increased (red) OTT times for varying number of HASUs all operating with 45 min ATT time (compared to 14 HASUs with current ATT times)

With 8 HASUs, the majority of patients have a reduced OTT time (up to 44 min), but a small minority of patients may have OTT time increased by up to 48 min, Table 1.

		Mean	Minimum	1Q	Median	3Q	Maximum
Travel Time	14 HASU (current)	21	0	12	19	28	65
	8 HASU	27	0	15	25	37	90
	Change 14 to 8 HASU	🔴 7	🟡 0	🟡 0	🟡 0	🔴 8	🔴 59
OTT	14 HASU (current)	152	107	139	151	163	224
	8 HASU	143	115	130	141	153	205
	Change 14 to 8 HASU	🟢 -8	🟢 -44	🟢 -15	🟢 -8	🟢 -1	🔴 48

Note: The patient experiencing the maximum travel time is not the same patient experiencing the maximum increase in travel time. The results indicate that the maximum OTT time is reduced in the centralised system but one patient node experiences a 48 minute increase in OTT time in the centralised scenario.

Table 1. Effect of centralisation from the 14 current operating HASUs, to 8 future operating HASUs on ambulance transport time and OTT time. Changes in ambulance transport and OTT times are indicated by 🔴 *for an increase,* 🟡 *for no change and* 🟢 *for a decrease*

Conclusions

Centralisation of stroke services in a mixed urban and rural setting could lead to overall clinical benefit gain, but a significant minority of patients may experience slower OTT times.

Higher quality care in a larger specialist centre, or other interventions (such as increasing public awareness of the need for early contact of emergency centres), may possibly offset slower thrombolysis for those disadvantaged by centralisation.

This modelling raises the question of how **net overall clinical benefit of centralised services should be weighed against localised disadvantages in a mixed urban and rural population.**

References

1. Hunter RM, Davie C, Rudd A, et al. Impact on Clinical and Cost Outcomes of a Centralized Approach to Acute Stroke Care in London: A Comparative Effectiveness Before and After Model. PloS one 2013: e70420.

2. 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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