South West Strategic Clinical Network

Bigger, Better, Faster?

An options appraisal for the reconfiguration of emergency heart attack and stroke services for the South West of England

South West Cardiovascular Strategic Clinical Network

on behalf of NHS South

April 2016

NHS England INFORMATION READER BOX

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Document Status

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Table of Contents

1. Executive Summary

1.1. This report summarises the response of the South West Cardiovascular Strategic Clinical Network (SW CV SCN) to the objectives of the 2013 NHS England Urgent and Emergency Care Review (UECR). The UECR seeks to reconfigure existing acute services to establish a network of Specialist Emergency Centres for the provision of care for heart attacks (primary percutaneous coronary intervention (PPCI) for ST-segment elevation myocardial infarction (STEMI)) and hyperacute stroke. The purpose of such specialist cardiovascular centres is to maximise good outcomes through the provision of high quality services that are resilient and sustainable over the longer term, and that meet the minimum thresholds of institutional activity for these conditions laid out in professional guidance and in national policy and commissioning specifications.

1.2. The SW CV SCN was tasked by NHS South, South West with mapping the provision of hyperacute stroke, PPCI and complex cardiology services for the region. The remit of the project was to provide the clinical context and to understand the regional and local implications of national policy and standards on emergency and elective cardiac and stroke services, not including financial modelling, and to ensure an open and transparent process for providers and commissioners.

1.3. The SW CV SCN established a steering group to supervise the project, and enlisted the operational modelling expertise of academic colleagues in the SW Peninsula CLAHRC (Collaboration for Leadership in Applied Health Research and Care). The steering group reported to providers and commissioners through the SCN's Cardiac and Stroke Commissioning Advisory Groups (CAGs), and consulted with public and patient representatives through the SW Senate Citizen's Assembly and the Health & Wellbeing Boards.

1.4. A model was constructed to analyse the benefits to patients from the concentration of specialist services in a variety of geographical configurations across the South West of England, ranging from a 2-centre to a 15-centre configuration. As well as the net clinical benefit, the analysis took into consideration issues of minimum institutional activity, and co-dependency with other critical services such as vascular surgery and interventional neuroradiology.

1.5. For PPCI provision, the model confirmed that minimum institutional activity could not be sustained with the present configuration of 10 Heart Attack Centres (HACs). The clinical benefit (defined in terms of mortality at 1 year) is substantially unaltered by a reduction in the number of HACs from 10 to 4, but secondary considerations of co-dependency and the displacement of patients to centres outside the SW region support an increase in the minimum number of HACs to 6 or 7. A reduction in the number of Hyperacute Stroke Units (HASUs - providing care for the first 72 hours after acute stroke) from the present 14 to between 8 and 10 maintains the clinical benefit (defined in terms of patients with minimal disability after thrombolysis), with a varying number of patients (between 345 and 736) being displaced to acute stroke centres outside the SW region.

1.6. The project identified seven options for further consideration, ranging from a ‘least change’ option of retaining 10 HACs and 14 HASUs, to a configuration comprising 6 HACs and 8 HASUs. This latter option, whilst maximising the benefits to patients from the concentration of expertise in fewer specialist centres, also involved the greatest geographical inequity, with rural communities principally in North Devon and Wiltshire having to travel the greatest distances to access time-critical interventions in an emergency. A range of intermediate options that mitigate the geographical disbenefits without jeopardising the clinical benefits from consolidation were also identified, involving 6 or 7 HACs and 8, 9 or 10 HASUs. Additional ambulance activity for this range of options is estimated at 3.7-6.1 hours/day for emergency STEMI and stroke calls, and 7.5-10.7 hours/day for repatriation to local acute hospitals after hyperacute care.

1.7. This detailed, evidence-based analysis of the clinical case for the reconfiguration of heart attack and hyperacute stroke services within the SW region has shown that in order to develop a regional network of cardiovascular centres that is resilient to anticipated changes in demand, technology and workforce, services should be provided in either 6 or 7 HACs and between 8 and 10 HASUs. Taken as a whole region, the incremental gains from configurations at the upper end of that range are marginal. However, the disbenefits from reconfiguration are not equally spread across the region, with particular issues of emergency access for people in North Devon, Wiltshire, and in some configurations, Torbay.

1.8. The SW CV SCN makes two recommendations to local and specialised commissioners on the strength of this modelling project. First, commissioners should embark on further consultation with patients and the public on the implications of these options, and critically on the balance to be struck between the concentration of expertise in Specialist Emergency Centres and issues relating to geographical access. This is particularly relevant for NHS Northern, Eastern and Western Devon Clinical Commissioning Group (CCG) and for NHS Wiltshire CCG, where the geographical impact of reconfiguration is greatest. Second, commissioners should consider how these plans for cardiovascular disease transformation are incorporated into their Sustainability and Transformation Plan (STP) within their particular Transformation Footprint, in order to progress implementation through the decision-making process laid out in the 2015 NHS England policy ‘*Planning, Assuring and Delivering Service Change for Patients*’.

2. Plain English Summary

NHS England (the body that runs the NHS in England on behalf of the government) has set out how the NHS plans to cope in the future with the ever-increasing pressure on emergency services. These services need to improve so that patients with life-threatening conditions have the best chance of surviving and having a good outcome. Research shows that people who get quicker treatment for heart attack and stroke have a better chance of surviving and having less disability in the long run. NHS England proposes we should have Specialist Emergency Centres, where teams of specialists are available round the clock to deal with conditions like heart attack and stroke where time is critical. In big cities like London and Manchester where stroke services have been reorganised into these specialist units, more people receive emergency clot-busting treatment and more people survive their stroke.

But things aren't as simple in a big rural area like the South West of England as they might be in London or Manchester. People have to travel further to get to hospital, and when treatments are time-critical like they are for heart attack and stroke, this can affect their chances. And when there are a large number of local services, there are sometimes quite big differences in the quality of those services between different hospitals.

So the NHS in the South West ran a project that used computer models to try and work out what was the best arrangement of hospitals to provide heart attack and stroke services for nearly 5 million people across the South West, all the way from Gloucestershire to the Isles of Scilly. The computer models tried to balance the need for services to be large enough to provide round-the-clock emergency treatments, with the need for these services to be close enough to where people live so that they can get fast treatment for a heart attack or a stroke.

When we looked at the results of the computer models, none of them suggested that things should be left just as they are at the moment. That would mean that for too many people, their local service would be too small to be able to deliver round-the-clock specialist treatment for everyone who needed it. The computer model suggested a number of other options, including

reducing the number of hospitals providing emergency heart attack treatments from 10 at the moment down to 6 or 7. The model also suggested reducing the number of emergency stroke centres from 14 at the moment down to 8, 9 or 10. That would mean that some hospitals that at the moment provide heart attack and stroke services would stop doing so, and their patients would travel elsewhere.

Reducing the number of centres for emergency heart attack and stroke treatment has advantages and disadvantages. The advantage is that patients have a better chance of being cared for by a specialist in their condition, and the experience in London suggests that improves their survival after a stroke. The other main advantage is that larger specialist centres treat enough patients with their condition to get really good at treating them. The main disadvantage of having fewer centres is that in some parts of the South West, particularly areas in North Devon and Wiltshire, people would have to travel further to receive those specialist treatments. When time is critical, that can mean there are winners and losers from reorganising services into fewer centres.

After looking at the results from the computer models, the NHS in the South West needs to do two things next. The first is to consult with patients and the public about the trade-offs between better care in a specialist centre and having to travel further to receive that care. People in the areas most affected by change, where existing arrangements may no longer be an option, will need to consider which of the alternative options would be most acceptable to them. Some of the changes will affect large areas and several hospitals, so the people who buy NHS services for local people (Clinical Commissioning Groups or CCGs) aren't going to be able to decide what to do on their own. So the second thing that needs to happen is that local CCGs will need to work together to agree what the best arrangement of services should be from among the options available, and include these arrangements in their future plans. They will need to work with those affected by service change to agree when and how the changes can be implemented to deliver the most effective and sustainable service to the greatest number of people well into the future.

3. Introduction

The 2013 NHS Urgent and Emergency Care Review (UECR) (NHS England, 2013) explains the rationale behind the need to redesign urgent and emergency care services in England, and sets out the new models of care needed to achieve this. The Review outlines a fundamental shift in the way urgent and emergency care services are provided, in pursuit of a healthcare system that is safe, sustainable and that consistently provides high quality care – a policy direction endorsed in the NHS Five Year Forward View (NHS England, 2014) and reiterated in the Government's Mandate to NHS England 2016-17 (Department of Health, 2016).

Some of the stated aims of the UECR include:

1. To ensure that those people with more serious or life-threatening emergency care needs are treated in centres with the right expertise, processes and facilities to maximise the prospects of survival and a good recovery.

2. To connect all the urgent and emergency care services, so that the overall physical and mental health, and social care systems, becomes more than just the sum of their parts.

3. To design systems that facilitate getting patients to definitive specialist services, provided in specialist hospitals, as for certain conditions, such as stroke, major trauma and acute ST-segment elevation myocardial infarction (STEMI), that can be more important to those patient's outcomes than getting them to the nearest hospital.

4. To enable consultant involvement for patients considered at 'high risk' (defined as where the risk of in-hospital mortality is greater than 10%, or where a patient is unstable and not responding to treatment as expected) within one hour.

The UECR sets out the ambition to centralise the management of these more serious conditions into a smaller number of hospitals, termed Specialist (previously Major) Emergency Centres, with the capacity to manage patients with STEMI, stroke, emergency vascular surgery and interventional radiology (amongst others). It is envisaged that across England there is the need for between 40 and 70 such specialist emergency centres to ensure adequate coverage for the population.

Other policies and plans are already in place in addition to the ambitions in the UECR. The NHS Business Plan for 2014-2017 'Putting Patients First' requires service planners and commissioners to ensure the availability of resilient and sustainable seven day services where this makes a difference to clinical outcomes (NHS England Policy Directorate, 2014). From a contracting standpoint, the National Service Specification for Primary Angioplasty (NHS England 2013) specifies that primary percutaneous coronary intervention (PPCI) should be undertaken only in 24/7 centres above a particular size - ideally centres serving a population of around 1 million, with at least 300 PPCI cases/year, but with an absolute minimum of 100 PPCI cases/year. The service specification is based on British Cardiovascular Intervention Society (BCIS) professional guidelines, intended to address concerns about institutional activity, and particularly rota sustainability, system resilience and operator/institutional competence for the delivery of PPCI services. Historically in the South West, the National Service Specification has not been met by all providers, with an allowance being made through the process of 'derogation' for non-compliant services to present an action plan for achieving the specification within a specified timescale. In some instances this derogation relates to an 'office hours' or 'non-24/7' profile of service availability, with PPCI being provided by an adjacent provider outside these service hours. As acute services are increasingly called upon to deliver 24/7 healthcare of consistent quality around the clock and across the whole week, with earlier senior medical review of patients, the need for inherent, volume-based 'system resilience' becomes more pressing.

For stroke, as a locally commissioned service no similar national service specification exists, but criteria established for the Hyperacute Stroke services reconfigurations in London and Greater Manchester have specified institutional activity levels of between 600-1500 cases of acute stroke/year, with a maximum travel time to a HASU of 45 minutes, and a minimum consultant rota frequency of 1 in 6. At the same time, the minimum staffing provision for a HASU is specified (Intercollegiate Stroke Working Party, 2012), of:

- 7-day services: Consultant ward rounds twice daily (including weekends) on the HASU (reflecting the high early mortality from stroke);
- Nursing: 2.9 whole time equivalents (WTE) nurses per bed for HASU and 1.35 for Acute Stroke Unit (ASU) 7 days/week;
- Rehabilitation Therapy: 0.73 WTE Physiotherapy, 0.68 WTE Occupational Therapy, 0.68 Speech and Language Therapy per 10 beds on the HASU.

These aspects of the remodelling of hyperacute stroke care are considered to be among the main inputs that have delivered a significant mortality benefit from the London reconfiguration (Morris et al, 2014). Similar issues regarding variations in provision arise in the South West with stroke as with PPCI, with specialist acute stroke services that are either not provided 24/7, or dependent upon support from other providers, or involving lower activity than the minimum threshold of 600 acute admissions/year. Some services are based on general rather than specialist medical supervision of the stroke service outside office hours, despite 50% of all emergency admissions occurring outside these hours. The UECR specifically precludes the long term continuance of services for hyperacute stroke and PPCI based on such compromises, justified as they are by organisational rather than clinical priorities.

These national policies lead to the conclusion that Specialist Emergency Centres providing heart attack (PPCI) and hyperacute stroke (HASU) care should be centralised into units with sufficient workforce and clinical activity to ensure institutional and operator competence, system resilience and service sustainability, and to ensure that patients always come under the care of the appropriate medical specialty. The UECR would also require that planning of such services should take account of co-location with other essential related services. In the case of PPCI and HASU care, this would be with vascular surgery and interventional neuroradiology services. In the South West, vascular surgical services have already embarked on a reconfiguration, which presently varies across the region in the extent to which it has been implemented. In particular, the allocation or division of vascular surgical services between Truro and Plymouth has yet to be finally determined. To all practical purposes, this provides the region with 6 *de facto* vascular surgical centres in Truro, Plymouth, Exeter, Taunton, Bristol (Southmead) and Cheltenham. The role of interventional neuroradiology will become more important in the management of major proximal vessel occlusions in hyperacute stroke with the introduction of mechanical thrombectomy, and in consideration of the impact of this development the co-location of HASU services at sites providing neuroradiological interventions is also necessary. Much as in London however, it is not considered necessary the every HASU is co-located with a centre providing PPCI, allowing for the possibility for there to be more HASUs within a given population than HACs – this also reflects the greater incidence of acute stroke compared to STEMI, and reflects that there is a recommended 'upper boundary' for the size of a HASU (1500 stroke admissions/year). At present, there are no centres in the UK other than Salford Royal in Manchester that admit more that 1300 acute stroke cases per year, even after the London reconfiguration.

It is within this national policy framework that this report describes the project work undertaken by the South West Cardiovascular Clinical Network (SW CV SCN) in analysing the impact of the implementation of the UECR within the region, in so far as it affects complex cardiac and hyperacute stroke services.

4. Methods

4.1 Project Methods

4.1.1 Project Initiation and Terms of Reference

In October 2014 the SW CV SCN was tasked by NHS South, South West, with mapping the provision of hyperacute stroke, primary PCI and complex cardiology services for the South West region, encompassing the 11 Clinical Commissioning Groups (CCGs) from NHS Gloucestershire CCG in the north and NHS Wiltshire CCG in the east to NHS Kernow CCG encompassing Cornwall and the Isles of Scilly, a total population of close to 4.7 million. The scope and outputs from the project were described in a Project Initiation Document (Appendix 1) published in October 2014, and amended as appropriate by the Project Management Group as the project unfolded (see below). The SW CV SCN commissioned relevant expertise in operational modelling and research from the Peninsula Collaboration for Health, Operational Research & Development (PenCHORD), and academic subgroup of the Peninsula Collaboration for Leadership in Applied Health, Research and Care (PenCLAHRC). PenCLAHRC is a 5-year collaboration between the NHS and academia supported with direct funding from the Department of Health, and is one of 10 such joint academic/NHS collaborations nationally with a key focus on the implementation of applied clinical research.

4.1.2 Project Governance

The project was initiated and owned by the SW CV SCN, and was overseen by a Project Management Group (PMG) consisting of:

- The SW CV SCN Network Manager (chair) and Clinical Director(s)/Clinical Leads;
- The Director of PenCHORD and lead modeller(s);
- Public Health England representative;
- South West Ambulance Service representative;
- The Clinical Pathways and QIPP Lead for the SW SCN;
- The Information and Quality Improvement Analyst for the SW SCN;
- Other members co-opted according to necessity.

The PMG met approximately every 4-6 weeks over the lifetime of the project, and was accountable to the SW CV SCN Steering Group, and reported to the Stroke and Cardiac Commissioning Advisory Groups of the SW CV SCN, and the SCN Oversight Group, itself hosted by NHS South, South West.

Engagement with public and patient representatives (in addition to lay representation on the SW CV SCN Steering Group and the SCN Oversight Group) included presentations and a workshop at the SCN Annual Conferences in November 2014 and 2015, and a meeting with the chairs of the SW Health and Wellbeing Boards in May 2015 to discuss progress with the project and review this in the light of other priorities and public concerns.

4.1.3 Selection of configuration options for geographical modelling

The project started with no prior assumptions regarding the geographical distribution of services, but was guided by the South East Coast Clinical Senate review of Clinical Co-dependencies of Acute Hospital Services (South East Clinical Senate, 2014). Thus the project set out to include the following options:

1. The status quo (currently there are 14 providers of acute stroke services and 10 providers of PPCI services within the South West region);

2. Configurations meeting best/expert practice from National Service Specifications and other national policy guidance (as described above);

3. Co-location (co-dependency) of complex cardiac and stroke services;

4. A two-centre option - Bristol and Plymouth (being the only centres in the region that currently meet all the UECR Specialist Emergency Centre criteria for co-dependencies, allowing for the fact that cardiac and neuroscience services in Bristol are presently located on different sites);

5. A range of intermediate geographical configurations up to and including the status quo. After further discussion in the PMG, these were determined to include, in addition to the two-centre model:

i. A six centre configuration reflecting the co-dependency with the six designated or planned vascular surgical centres;
ii. A seven centre configuration representing the seven current acute hospitals that either are, or are about to be, operating PPCI 24/7. In the modelling, this also proved to be the minimum number of HASUs with admissions between 600-1500 acute strokes/year;
iii. A nine centre configuration. Nine centres proved to be the maximum number of PPCI centres expected to perform at least 100 PPCIs per year;
iv. A ten centre configuration, being the status quo for PPCI provision, except that all centres are extended to operate 24/7. This also proved to be the maximum number of HASUs that can achieve at least 500 acute stroke admissions/year;
v. A fifteen centre configuration designed to minimise onset-to-treatment times for both STEMI and acute stroke, and model the clinical benefit of being able to offer PPCI and HASU care at all regional acute trusts 24/7.

In all configurations it was assumed that the current out-of-region hospitals remain open and operate 24/7, and in discussion with counterpart SCN managers in the adjacent CV SCNs, it is known that no closures of such adjacent services are planned.

4.1.4 Anticipating demographic change

The project was required to consider the consequences of demographic change on heart attack and hyperacute stroke service provision for 10 years into the future, using Office of National Statistics data. The demographic analysis includes:

1. A prediction of age-dependant demographic change in STEMI admissions, with a forecast growth in Regional STEMI cases of approximately 18% between 2015 and 2025;

2. Demographic pressure on acute stroke incidence is greater than with STEMI, partly because of the greater increases in the 'old old' (those aged over 85). Stroke incidence is more steeply related to age than coronary artery disease, and this is particularly driven by the increasing prevalence of atrial fibrillation. Taken together, these effects result in a forecast increase in incident stroke of 29% in the 10 years from 2015-25.

These demographic projections (more details of which are presented in the Results section below) were particularly relevant to stroke, affecting some centres that are presently just below the minimum institutional activity of 600 admissions/year. The greater absolute increases in stroke over the next decade require a greater allowance to be made at both ends of the 'optimal' range of admissions of between 600-1500. Planning for increases of the order of up to 29% over the next decade involves adjustment of that range to between 500-1300 per year.

4.2 Modelling Methods

4.2.1 Hospitals Included

The following table indicates which hospitals were included in the *status quo* versions of the model, representing the current disposition of acute services:

	Hospital	Postcode	STROKE	PPCI
In-Region Hospitals	ROYAL UNITED HOSPITAL, BATH	BA1 3NG	Y	PT
	YEOVIL DISTRICT HOSPITAL	BA21 4AT	Y	N
	SOUTHMEAD HOSPITAL, BRISTOL	BS10 5NB	Y	N
	BRISTOL ROYAL INFIRMARY	BS2 8HW	Y	Y
	WESTON GENERAL HOSPITAL	BS23 4TQ	PT	N
	ROYAL DEVON & EXETER HOSPITAL	EX2 5DW	Y	Y
	NORTH DEVON DISTRICT HOSPITAL, BARNSTAPLE	EX31 4JB	Y	N
	GLOUCESTERSHIRE ROYAL HOSPITAL	GL1 3NN	Y	N
	CHELTENHAM GENERAL HOSPITAL	GL53 7AN	N	PT
	DERRIFORD HOSPITAL, PLYMOUTH	PL6 8DH	Y	Y
	GREAT WESTERN HOSPITAL, SWINDON	SN3 6BB	Y	PT
	SALISBURY DISTRICT HOSPITAL	SP2 8BJ	Y	PT
	MUSGROVE PARK HOSPITAL, TAUNTON	TA1 5DA	Y	Y
	TORBAY HOSPITAL	TQ2 7AA	Y	Y
	ROYAL CORNWALL HOSPITAL, TRURO	TR1 3LJ	Y	Y
	(FRENCHAY HOSPITAL, BRISTOL)*	BS16 1LE	NA	N
Out-Of-Region Region Hospitals	POOLE HOSPITAL	BH152JB	Y	N
	ROYAL BOURNEMOUTH HOSPITAL	BH7 7DW	Y	Y
	WARWICK HOSPITAL	CV34 5BW	Y	N
	DORSET COUNTY HOSPITAL, DORCHESTER	DT1 2JY	Y	PT
	HEREFORD COUNTY HOSPITAL	HR1 2ER	Y	N
	HORTON GENERAL HOSPITAL, BANBURY	OX16 9AL	Y	N
	JOHN RADCLIFFE HOSPITAL, OXFORD	OX3 9DU	Y	Y
	QUEEN ALEXANDRA HOSPITAL, PORTSMOUTH	PO6 3LY	Y	N
	ROYAL BERKSHIRE HOSPITAL, READING	RG1 5AN	Y	N
	NORTH HANTS DISTRICT HOSPITAL, BASINGSTOKE	RG24 9NA	Y	N
	SOUTHAMPTON GENERAL HOSPITAL	SO16 6YD	Y	Y
	ROYAL HAMPSHIRE COUNTY HOSPITAL	SO22 5DG	Y	N
	WORCESTERSHIRE ROYAL HOSPITAL	WR5 1DD	Y	Y

PT=Part Time; *Frenchay included in model for validation as it was open during the period of HES data used.

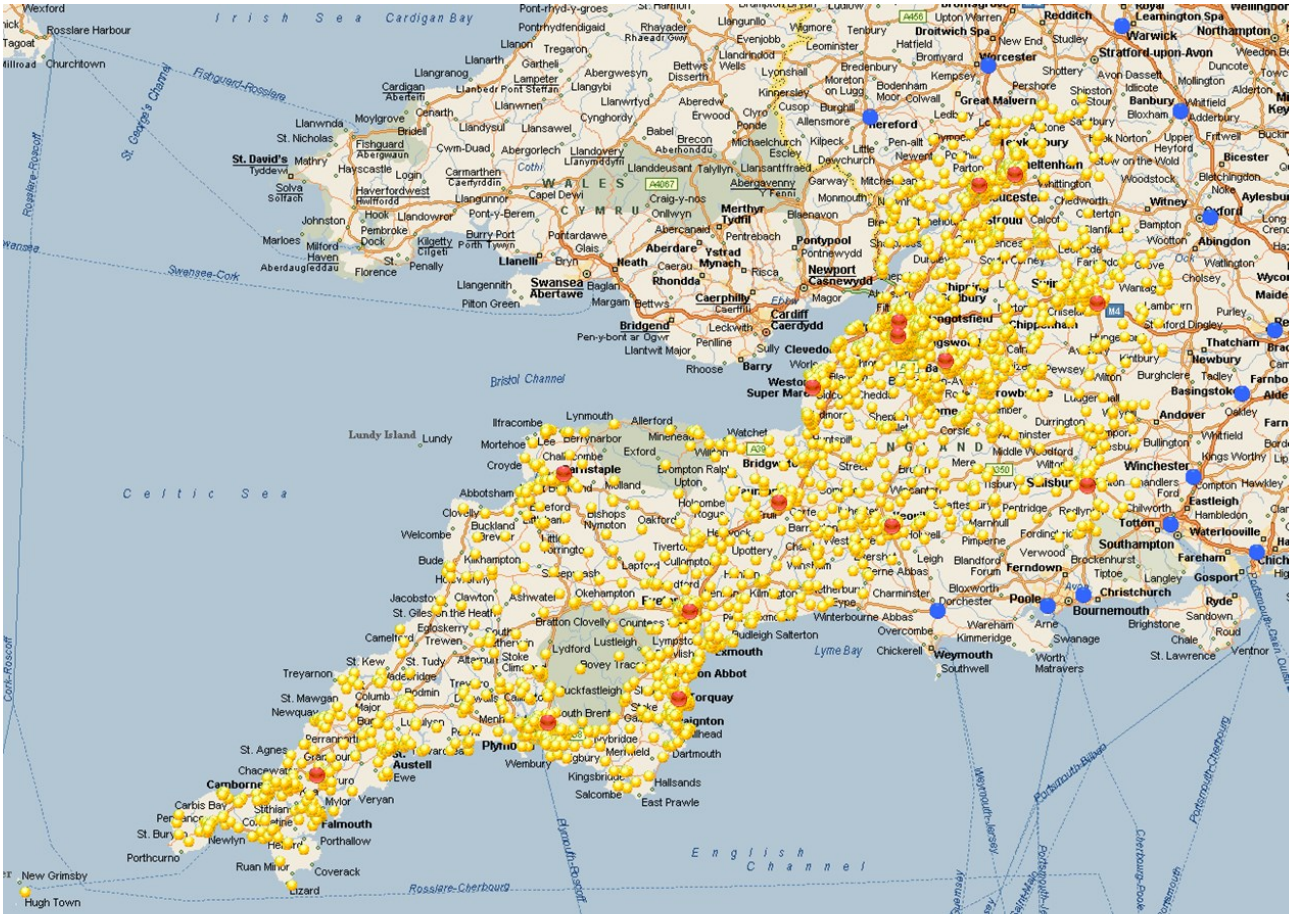
Table 4.1. Hospitals included in the model

4.2.2 Patients Included: Geography

Patients were selected by Lower Super Output Area (LSOA; an administrative area that contains approximately 1,500 people).

Patients included in analysis were those that:

- Live in the South West region (Q64-66: Bristol, North Somerset, Somerset and South Gloucestershire; Devon, Cornwall & Isles of Scilly; Bath & North East Somerset, Gloucestershire, Swindon and Wiltshire). These are selected by GP membership of Clinical Commissioning Groups (CCGs) within the region;
- OR any patient living closest (by road OR straight line distance OR driving time) to an acute hospital within the SW region.



There are 2,838 patient nodes (LSOAs). The median straight line distance between two closest neighbouring centroids is 0.52km (IQR 0.39-0.97km).

Figure 4.1 Locations of patient nodes (yellow), in-region hospitals (red) and out-of-region hospitals (blue) used in model

4.2.3 Patients Included: Diagnosis and/or procedure

All modelling is based on data retrieved from HES for the period January 2012-December 2014. Data was extracted using Lightfoot SFN Tool (http://www.lightfootsolutions.com/), for all admissions to English hospitals and then for patients allocated to the SW region using the method described above. Patients neither living in the SW region nor having a SW hospital as their closest hospital to home are not included in the modelling. Patients are selected by primary procedure code and/or primary diagnosis unless otherwise stated (in HES a patient may have only one primary procedure code and one primary diagnosis code). All patients are emergency admissions unless otherwise stated.

Cardiology patients

STEMI patients: Selected by diagnosis code (ICD10) I210-I213.

All cardiac imaging: Procedure code OPCS Y53 (approach under imaging control) as any procedure with cardiac procedure (OPCS K codes) as the primary procedure. 96.2% of these procedures are captured under Percutaneous Coronary Intervention (PCI), ablation/electrophysiological studies (EPS), device implantations, Transvascular Aortic Valve Implantation (TAVI) or 'contrast radiology of the heart' (almost entirely represented by coronary angiography).

PCI (Percutaneous coronary intervention): Procedure codes OPCS K49, K50, K75. 99.3% of these procedures are registered as imaging based (OPCS Y53).

Primary PCI is not directly available in HES. As a surrogate we use patients with both a primary diagnosis of STEMI and a primary procedure code of PCI.

Ablation/EPS: Procedure codes OPCS K57.1, K57.2, K57.4-K57.7, K58.1-2, K58.6, K62.1-K62.3. 96.3% of these procedures are registered as imaging based (OPCS Y53).

Devices: Procedure codes OPCS K59, K60, K61. 83.5% of these procedures registered as imaging based (OPCS Y53).

TAVI: Procedure OPCS K26 returns all plastic repair of aortic valve. We estimate that 11.0% were performed in the catheter laboratory (from hospital numbers of TAVI reported in NICOR [see below] compared with all K26 procedures in HES).

Contrast radiology: Procedure code OPCS K63. 99.1% of these procedures are registered as imaging based (OPCS Y53).

Stroke patients

Stroke patients are identified from those in-patients with primary diagnosis codes (ICD10) of I61, I63, I64.

4.2.4 Comparative and additional data sets

In addition to HES data the following data sets were accessed:

- **NICOR** (National Institute for Cardiovascular Outcomes Research) for STEMI/PCI and other catheter laboratory procedures. NICOR data has been used as a comparative data set for cardiovascular modelling, and no modelling is based on NICOR data. Originally it was intended to use NICOR data for modelling due to the high confidence that clinicians have in the dataset – most clinicians or their audit staff directly enter data themselves, whereas HES depends upon administrative coders. Two problems were found which prevented use of NICOR data for modelling: 1) incomplete geographic data (home location of patients): in total 15% of geographic data were missing, and up to 65% missing for individual hospitals; 2) incorrect attribution of activity: e.g. NICOR data attributed pacemaker fitting to North Devon District Hospital, which is known not to fit pacemakers. The hospital recorded in NICOR is the hospital which returns the data for a patient, and this is not always the hospital where the procedure took place. Comparisons with NICOR data are described in the Results section of the report. Some results reported include an adjustment for the observed difference between admission numbers recorded in HES and those in NICOR.
- **SSNAP** (Sentinel Stroke National Audit Programme). SSNAP provides an alternative count of stroke admissions to hospitals, along with other clinical audit data. SSNAP has been used only to check hospital admissions against those reported in HES.
- **South Western Ambulance Service NHS Foundation Trust** (SWASFT) data. Ambulance data was used to calibrate travel times obtained from Microsoft MapPoint. Detailed ambulance data was only available for the Western part of the region and was not used directly in modelling. SWASFT guidelines were used for determining the operating hours of primary PCI centres.
- **Acute Hospital Trust Data**. Data from hospitals was used for the total number of TAVI procedures carried out. Information on the number of catheter laboratories and the staffing and resourcing of those labs was also provided directly by individual hospitals.

4.2.5 Travel times

Travel times (by road) were obtained from Microsoft MapPoint using the MPMileCharter add-in. In order to calibrate these time the actual ambulance travel times for 5,033 journeys (for suspected stroke admissions) were compared with the MapPoint estimates. Actual travel times were found to be, on average, 7.8% longer than predicted by MapPoint by regression analysis. The interquartile range of actual/predicted travel times was 0.92-1.31 (median 1.09). As a result, all MapPoint travel times have had a 7.8% upward adjustment applied for modelling purposes.

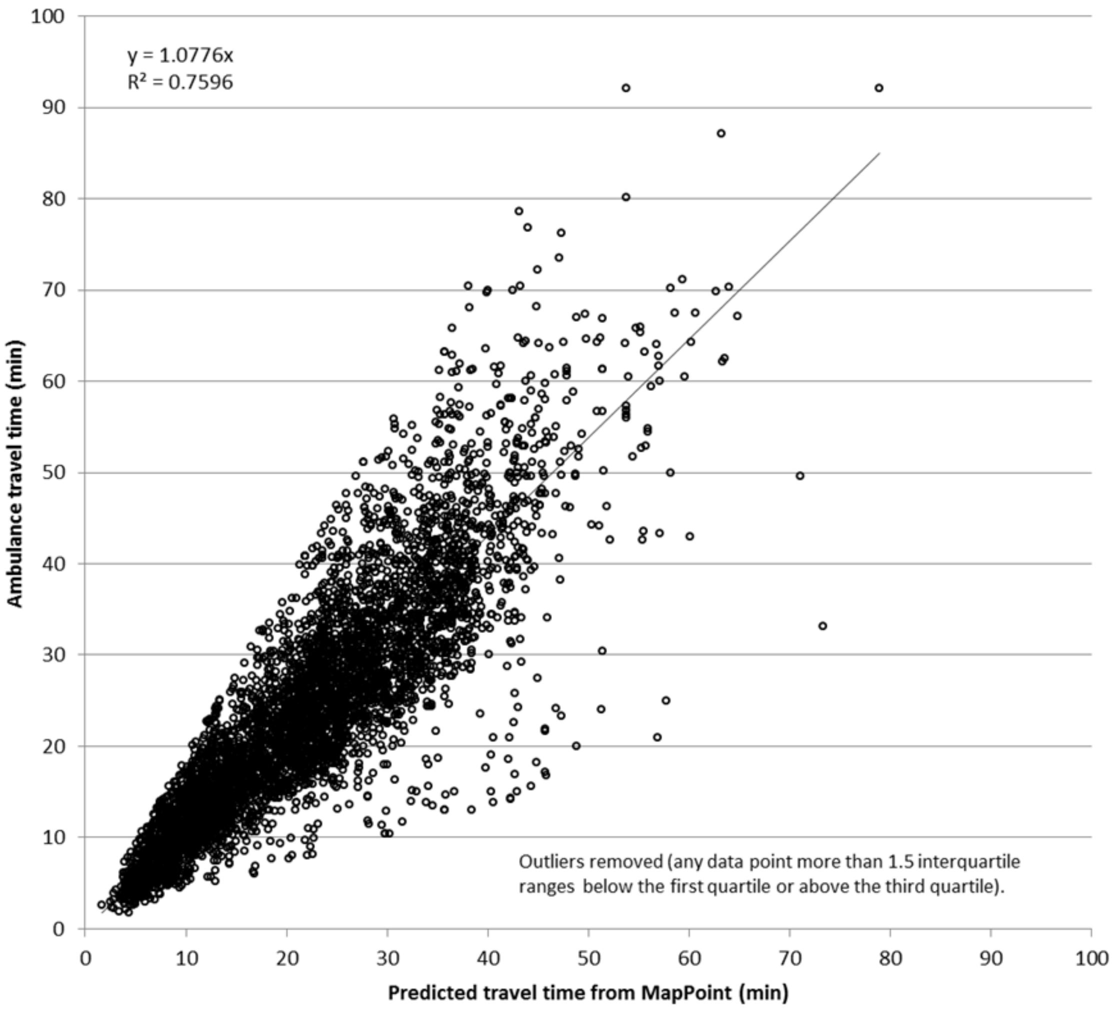


Figure 4.2 Comparison of predicted (MapPoint) and actual ambulance travel times

Average ambulance speed is 44km/h (27mph). Depending on month average speeds vary by up to 1.7km/h (1.0mph) away from overall average speed, and vary by up to 5.4km/hr (3.3mph) away from overall average speed by time of day.

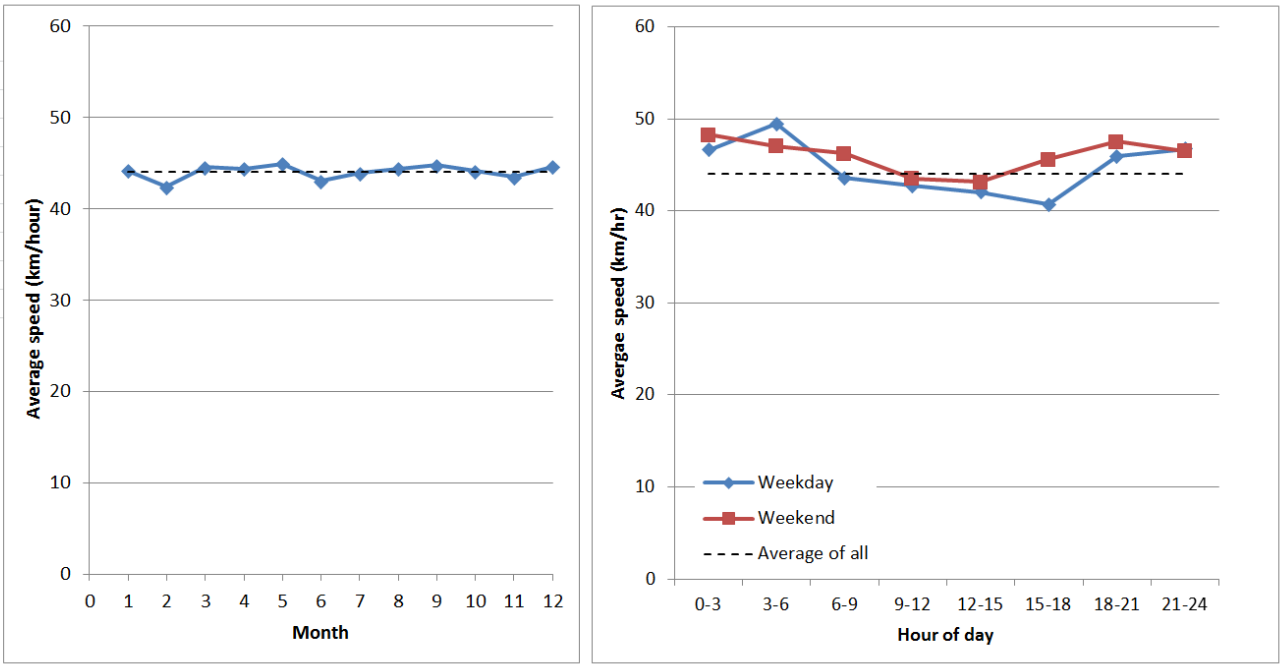
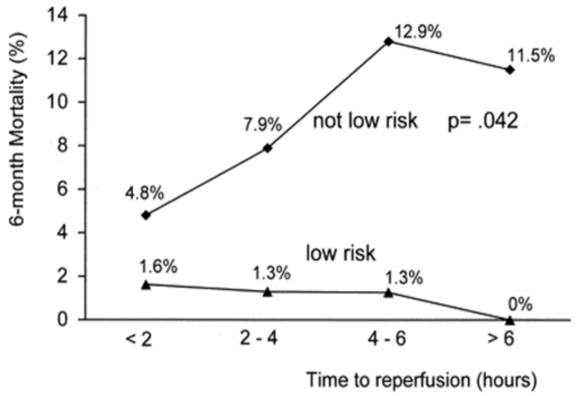


Figure 4.3 **Average ambulance speeds by month and hour**

4.2.6 Relationship between onset-to-treatment and outcome

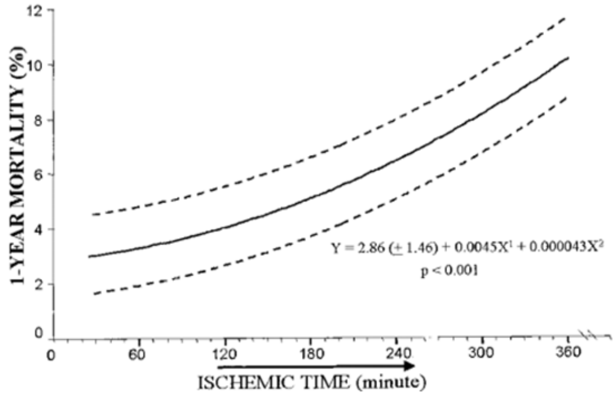
STEMI/PCI: relationship between time-to-treatment and one year mortality

The outcome measure used for PCI was one-year mortality. The relationship between time of onset-to-treatment for primary PCI was taken from a study by De Luca et al (2004). That study of 1,791 STEMI patients produced results in broad agreement with a previous study by Antoniucci et al (2002), except that the later paper produced a mathematical model of time-to-treatment and outcome which is used in the modelling. For example, delaying treatment by an hour from 120min to 180min predicted a 27% relative increase in one-year mortality, from 4.0% to 5.1%.



Antoniucci, D; Valenti, R; Migliorini, A; et al. (2002) Relation of time to treatment and mortality in patients with acute myocardial infarction undergoing primary coronary angioplasty. American Journal Of Cardiology 89:1248-1252

929 (71%) patients not low risk, 294 (29% patients) low risk.



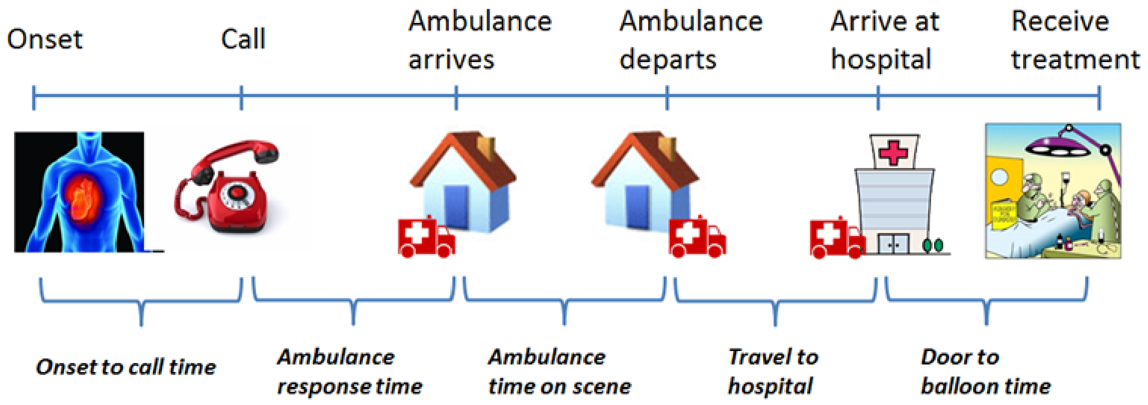
Giuseppe De Luca, Harry Suryapranata, Jan Paul Ottervanger, Elliott M. Antman (2004) Time Delay to Treatment and Mortality in Primary Angioplasty for Acute Myocardial Infarction. Every Minute of Delay Counts. Circulation.109: 1223-1225

1791 STEMI patients treated with primary angioplasty

A working assumption is that travel time affects the time of treatment but not the proportion of patients treated.

Figure 4.4 Relation between time to treatment and mortality for STEMI

In order to model onset-to-treatment times other than ambulance transport need to be assumed. Widimsky et al (2010) estimated that time to first medical contact in the UK is 68 minutes. Ambulance data puts average call-to-ambulance arrival at 8 minutes and thus onset-to-call can be assumed to be 60 minutes. Ambulance on scene time was obtained from ambulance data and averaged 40 minutes. Ambulance travel time to hospital varies in the model and a national average door-to-balloon time of 40 minutes was adopted from the Myocardial Ischaemia National Audit Project (MINAP audit report, 2014).

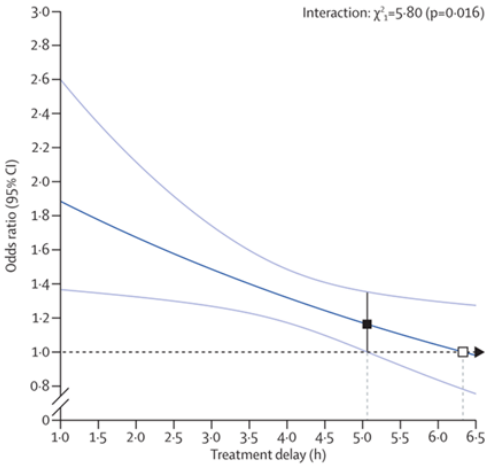


- Onset to call = 60 min
- Ambulance response time = 8 min
- Ambulance time on scene = 40 min
- Ambulance travel time = variable
- Door-to-balloon time = 40 min

Figure 4.5 Modelled onset-to-treatment times for STEMI

Stroke: relationship between time-to-treatment and outcome

The outcome measure used for stroke was the number of patients having an excellent outcome, defined by a modified Rankin Scale score (mRS) of 0–1 (i.e. no symptoms (mRS 0) or no disability despite symptoms (mRS 1)) at 3–6 months. The mRS is a 7-point ordinal scale of participation ranging from a score of 6 (dead) to a score of 0 (fully independent with no symptoms). The relationship between onset-to-treatment and an excellent outcome used in the model was described by Emberson et al (2014) based on a meta-analysis of individual patient data from clinical trials (6,756 patients in nine randomised controlled trials). A baseline (untreated) rate of an excellent outcome of 29.5% from the meta-analysis was used. For example, delaying treatment from 120min to 180min would be predicted to reduce the proportion of patients with an excellent outcome from 41.2% to 38.3% (an additional 2.9% of patients who do not have an excellent outcome).



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.

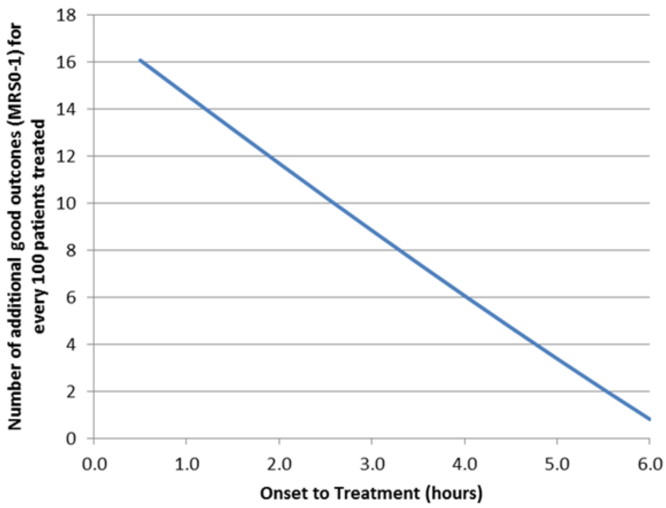
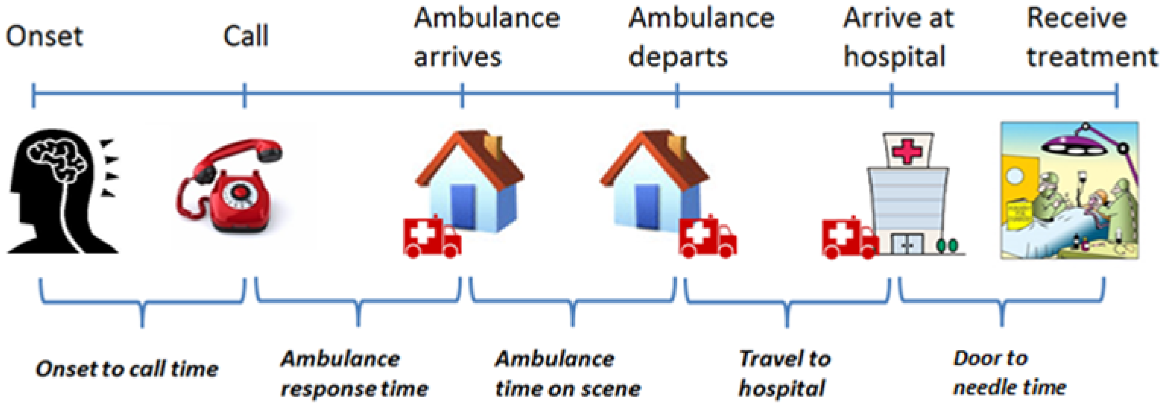


Figure 4.6 Relation between time to treatment and outcome for ischaemic stroke

A median onset-to-call time of 30 minutes were taken from Mosley et al (2007). Ambulance data puts average call-to-ambulance arrival at 8 minutes. Ambulance on scene time was obtained from ambulance data and averaged 32 minutes. Ambulance travel time to hospital varies in the model and an average door-to-treatment time of 45 minutes was adopted for the purposes of the modelling, being the average door-to-treatment time for the London HASUs from the Sentinel Stroke National Audit Programme (SSNAP annual report, 2015).



- Onset to call = 30 min
- Ambulance response time = 8 min
- Ambulance time on scene = 32 min
- Ambulance travel time = variable
- Door-to-needle time = 45 min

Figure 4.7 Modelled onset-to-treatment times for ischaemic stroke

4.2.7 Selecting optimal hospital locations

An assumption in the model is that patients will attend the closest suitable hospital that provides the relevant service.

The model selects hospitals that:

1. Minimise the average ambulance travel time
2. Minimise the maximum ambulance travel time (for any single patient)
3. Maximise the proportion of patients within 30 minutes ambulance travel time
4. Maximise the proportion of patients attending a unit performing at least 100 PPCI per year or has at least 600 emergency stroke admissions per year
5. Minimise the predicted mortality rate (STEMI/PPCI) or maximise the number of patients with an excellent outcome (stroke)
6. Maximise the proportion of patients attending a unit within the SW region*.

*The proportion of patients attending a SW region HASU (as opposed to an out-of-region hospital) was originally included as an optimisation score in the model. This parameter was removed as it conflicted with minimising average travel distance for patients (and conflicted with optimising the clinical outcome). When the proportion of patients treated within the region is prioritised the model will preferentially select centres on the boundary between regions (hospitals in the East of the region in our model) to the detriment of average travel times. This parameter was therefore used as a secondary criterion but not used as a primary parameter to select centres.

The model may select centres based on just one parameter or on a combination of parameters. When a combination of parameters was used all parameters were weighted equally. The algorithm was used to find either the 'optimal' solution possible, or to generate a list of near-optimal solutions that could be prioritised according to secondary criteria (such as the proportion of patients treated outside the SW region).

Each item was scored between 0 and 1, with the extremes set at the worst and best possible results for any given parameter. The scoring is shown in the table below (note that stroke and STEMI/PCI are different due to the different number of both in-region and out-of-region centres available in the model).

	Stroke		**STEMI/PCI**	
Optimisation measure	**Score=0**	**Score=1**	**Score=0**	**Score=1**
Average travel (mins)	74.8	21.4	83.4	24.6
% within target travel time	6.9	78.1	9.4	70.6
Maximum travel (mins)	224.1	65.2	224.1	92.2
Clinical benefit (per 100 patients treated; see text)	8.08	10.89	93.7	95.1
% patients attending unit above threshold clinical activity*	37.7	100	96.5	100

*Patients attending a centre with at least 100 STEMI/PCI or 600 emergency stroke admissions per year

Table 4.2 Range of optimisation scores for stroke and STEMI/PCI

When selecting any one centre the score for each centre was calculated (clinical benefit was calculated for each individual LSOA taking into account the number of patients and the distance for those patients to the centre). The net clinical benefit was then summed (as opposed to the clinical benefit being calculated on just the average travel time for all patients). The model scored solutions, either based on a single parameter or on a combination of all parameters. The resultant score was then used to rank solutions. When selecting more than one centre all possible combinations are assessed (there are, for example, 3432 possible ways of selecting 7 centres out of 14) and the solutions were then ranked by overall score.

5. Results

5.1 Primary PCI

5.1.2 Comparison of HES and NICOR data

HES data was cross-checked against data from NICOR, particularly from the BCIS (British Cardiovascular Intervention Society) dataset on PCI. In the BCIS dataset STEMI-PPCI accounted for 91% of all emergency PCI. When HES data was used those patients with STEMI and PCI in primary diagnosis/procedure accounted for 91% of the BCIS STEMI-PPCI (and 82% of all BCIS emergency PCI; column 'HES1' in table below). If HES data was extended to include STEMI and PCI in any diagnosis/procedure (not just primary diagnosis/procedure) then HES admissions accounted for, on average, 98% of the BCIS STEMI-PPCI (and 89% of all BCIS emergency PCI; column 'HES2' in table below).

The total regional number of procedures varies from 1,656 to 2,018 per year depending on both how tightly patients are defined and the data source.

Individual hospital differences between HES and NICOR exist. Plymouth, for example, has more STEMI-PCI than are recorded in BCIS/NICOR. Exeter has fewer procedures in HES than in NICOR.

Most of the results in this report use the results directly output by the model (based on HES data for patients with STEMI and PCI in primary diagnosis/procedure). Some results also report an uplifted number of procedures which calibrate the HES results to all emergency PCI recorded in BCIS. In the table below the equivalent column is HES-ADJ.

CENTRE	BCIS Emergency PCI	BCIS STEMI PPCI	HES1	HES2	HES-ADJ
BRISTOL ROYAL INFIRMARY	651	563	517	526	630
ROYAL CORNWALL HOSPITAL	257	212	248	259	302
DERRIFORD HOSPITAL	197	189	204	211	248
ROYAL DEVON & EXETER HOSPITAL	291	286	220	249	268
TORBAY HOSPITAL	168	163	163	180	198
MUSGROVE PARK HOSPITAL	185	180	127	144	155
ROYAL UNITED HOSPITAL, BATH	88	71	72	78	88
CHELTENHAM GEN HOSPITAL	89	83	51	81	62
GREAT WESTERN HOSPITAL	79	69	42	48	51
SALISBURY DISTRICT HOSPITAL	15	14	14	15	16
ALL	**2,018**	**1,828**	**1,656**	**1,790**	**2,018**
Per cent BCIS admissions		91%	82%	89%	100%

BCIS Emergency PCI: All emergency PCI recorded in BCIS

BCIS STEMI PCI: Indication limited to Primary PCI for STEMI

HES1: STEMI/PCI in primary diagnosis/procedure

HES2: STEMI/PCI in any diagnosis/procedure

HES-ADJ: HES1 uplifted by average ratio of HES1 to BCIS

Data are average admissions for calendar years 2012&2013

(More restricted date range than used elsewhere due to more limited NICOR data)

Table 5.1 Comparison of NICOR (BCIS) and HES data

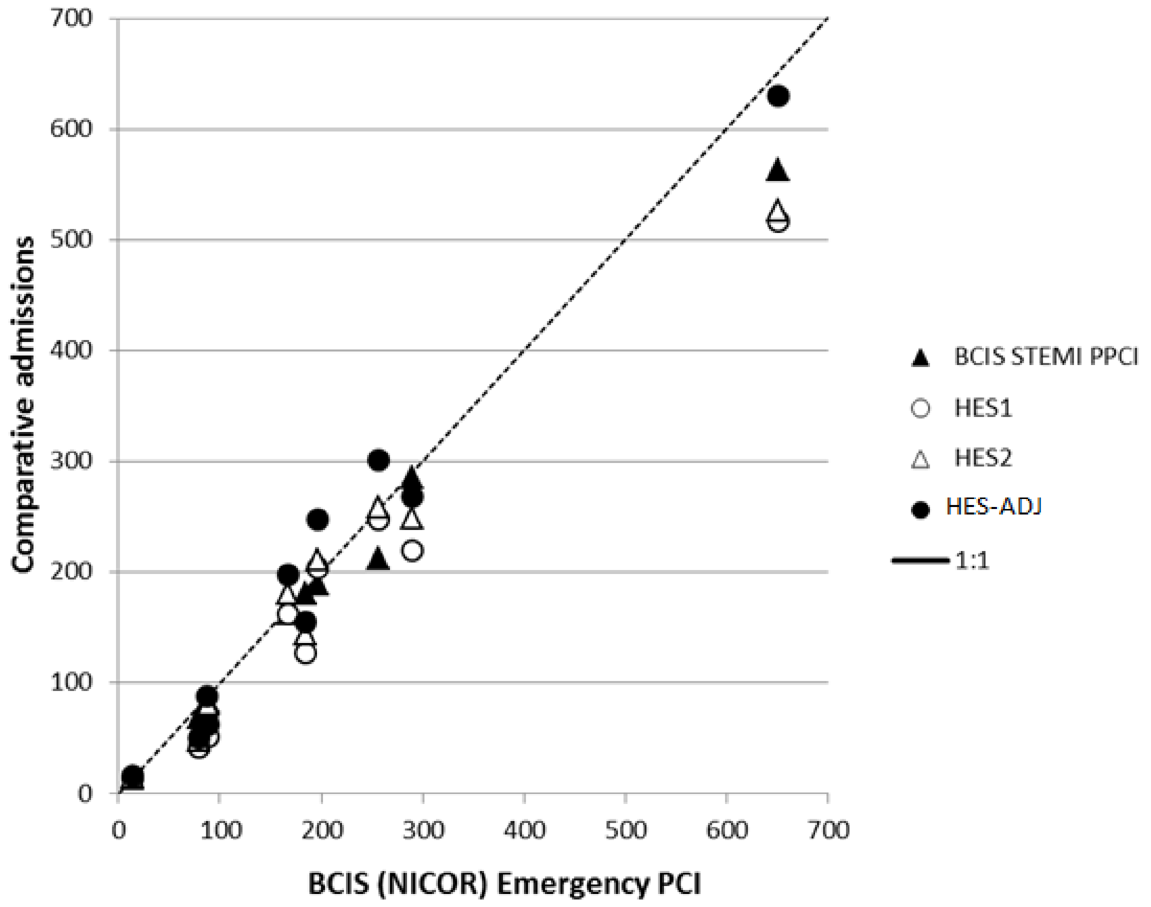


Figure 5.1 **Admissions according to the dataset used**

5.1.2 Emergency STEMI admissions by patient home location and hospital

96.3% of patients living within the region attend either their closest hospital or a hospital that is no further than 5 miles further than their closest hospital. It is therefore a reasonable working assumption in the modelling that people will attend a centre local to their home address (this assumption is further tested in model validation below).

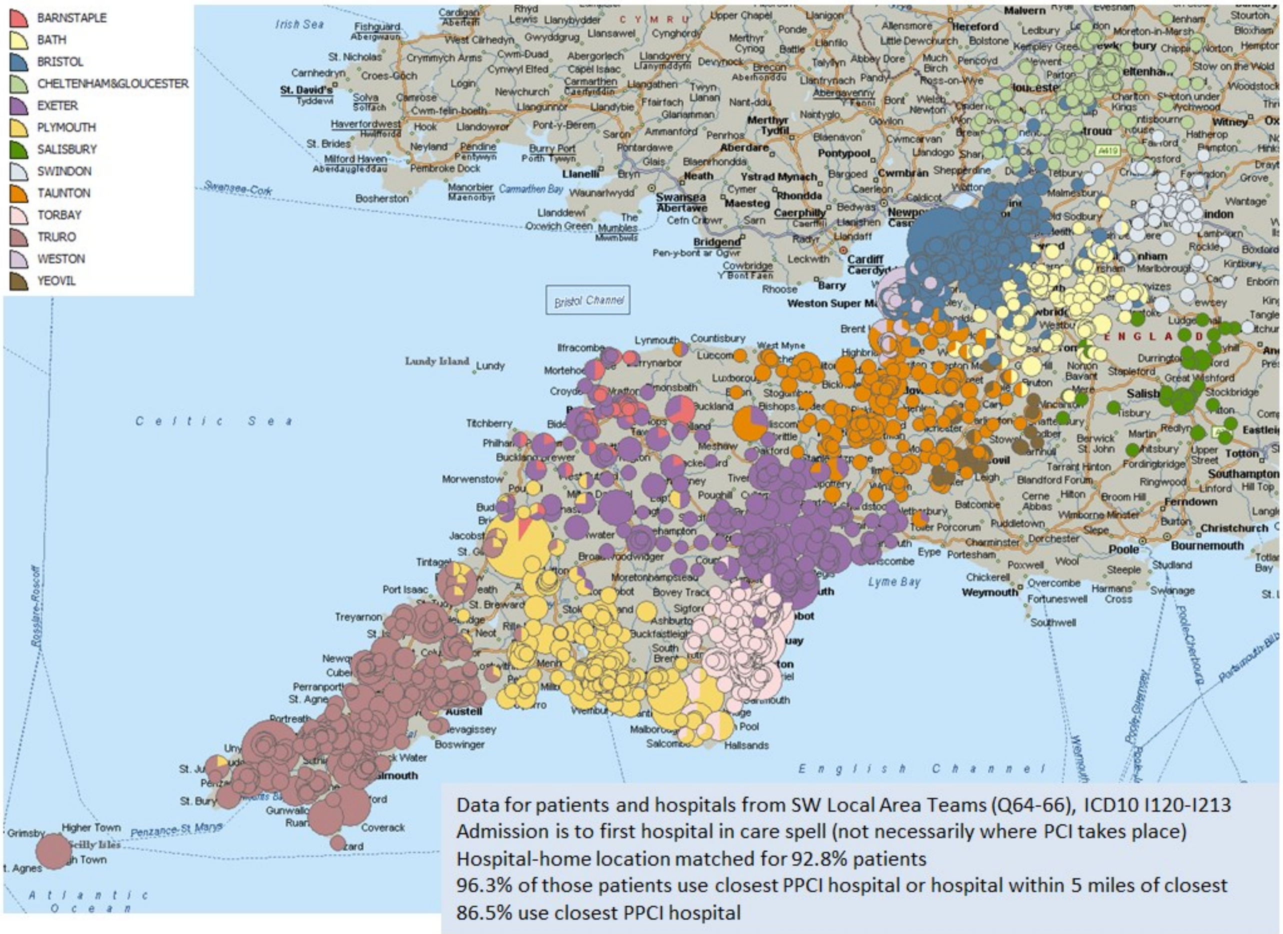


Figure 5.2 Emergency STEMI admissions by patient home location and hospital attended

The closest (shortest travel time) hospital offering office-hours PPCI estimated by MapPoint travel times is shown in Figure 5.3 below.

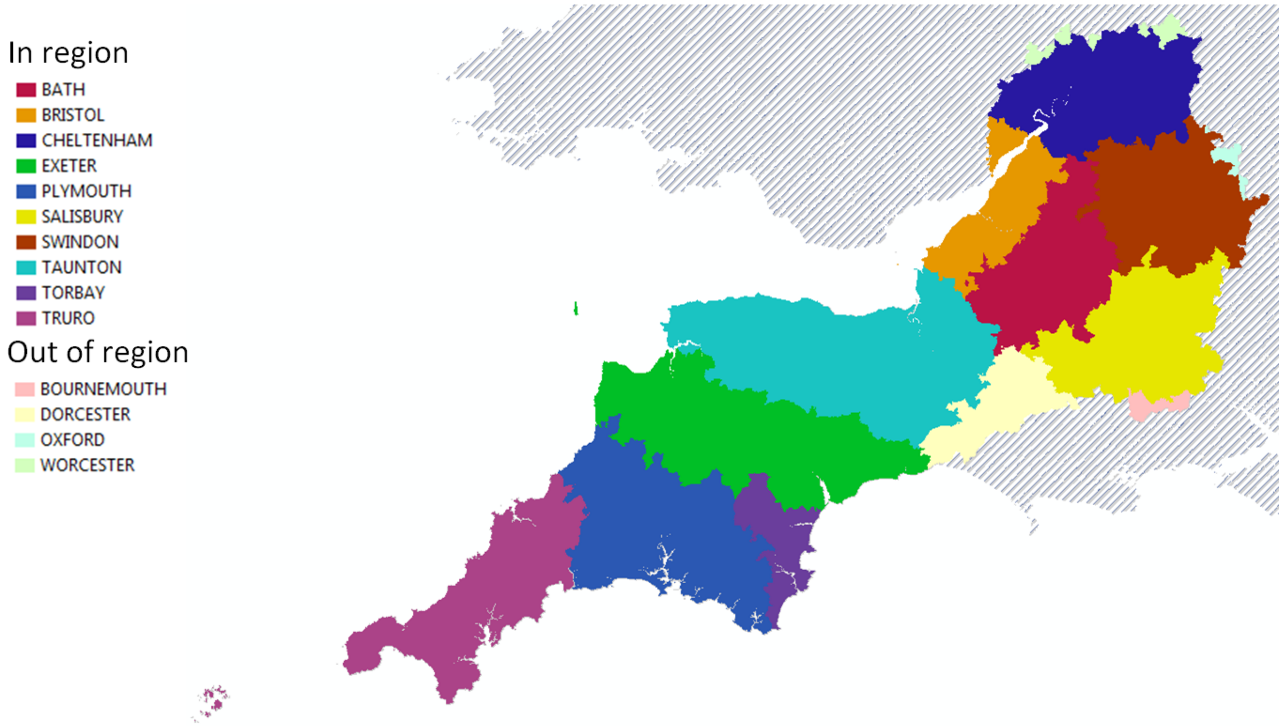


Figure 5.3 Closest current PPCI hospital (office hours) by road travel time

5.1.3 Patients from out of region, and the rate of conversion from STEMI to PPCI

Overall 9.1% of STEMI admissions were from patients registered to a GP not in the South West Region. Salisbury and Yeovil take the highest proportion of out of region patients (23% and 24%) respectively. The model was set-up to include all patients who live closest to a hospital within the region, rather than just the patients registered to a GP within the region.

The rate of conversion from emergency STEMI admission to a PPCI varies between hospitals from 65% to 88%. All the hospitals offering part time PPCI have a conversion rate of below 70% with the full time services generally having a conversion rate of 70-80% with UH Bristol having a conversion rate of more than 80% (88%). The data do not provide reasons for the difference, which may be due to differences in practice between the trusts, or reflect the selection of cases for onward referral from centres not presently offering 24/7 services.

Hospital	Emergency admissions						Emergency + transfer PCI for STEMI patients
	All	SW Patients	Outside patients	% non-regional patients	PCI	PCI Rate on emergency admission	
UHS BRISTOL NHSFT	480	408	72	15%	421	88%	524
ROYAL CORNWALL HOSPS NHST	311	288	22	7%	241	77%	241
PLYMOUTH HOSPS NHST	265	255	10	4%	198	74%	198
ROYAL DEVON & EXETER NHSFT	256	236	20	8%	198	77%	212
S. DEVON H.C. NHSFT	213	198	15	7%	153	72%	153
TAUNTON & SOMERSET NHSFT	173	153	20	12%	133	77%	133
ROYAL UNITED HOSPS BATH NHSFT	102	95	7	7%	68	67%	68
GLOUCESTERSHIRE HOSPS NHSFT	87	81	6	7%	55	63%	55
N. BRISTOL NHST	59	58	1	2%	17	28%	17
GREAT WESTERN HOSPS NHSFT	53	49	4	7%	34	65%	34
SALISBURY NHSFT	26	20	6	23%	17	65%	17
WESTON AREA HEALTH NHST	24	22	2	7%	0		
NORTHERN DEVON H.C. NHST	24	21	2	10%	0		
YEOVIL DISTRICT HOSP NHSFT	15	12	4	24%	0		

STEMI PCI rate = 1651 PCI (from emergency/transfer) / 2090 emergency patients = 79%

Table 5.2 Out of region patients and conversion rate of emergency STEMI patients to PCI

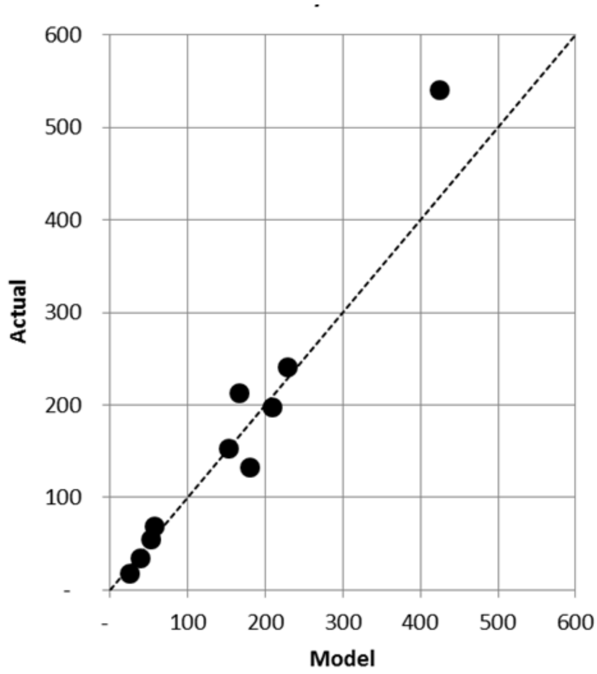
Overall there were 2,090 emergency STEMI admissions (primary diagnosis) and 1,651 PCI of STEMI patients (primary diagnosis/procedure, emergency or transfer admissions). In the model we have therefore estimated the number of STEMI-PCI as 0.79xtotal STEMI admissions. The model is based on emergency STEMI admissions as the source data.

5.1.4 Model validation

For model validation all current centres offering PPCI were open in the model. Where a centre offers PPCI part-time it is assumed that the operating hours are 8am-6pm Mon-Fri (actual operating hours all vary slightly).

There is a very high overall correlation (R^2=0.96) between predicted and actual admissions. It is noted that Exeter receives 45 more patients per year than modelled, and Taunton receives 43 fewer patients than predicted. An arrangement has existed that North Devon patients are transported to Exeter though Taunton is often the closest hospital. There are ~35-40 STEMI patients that the model directs to Taunton (as the closest hospital) when in reality they have in the past been taken to Exeter. If patients were taken to the closest hospital we would expect the number of patients taken to Exeter to reduce by 35-40 per year and admissions to Taunton to increase correspondingly. In model validation the model under-predicted admissions to Bristol by ~120 admissions per year. This may be due to Bristol, being a tertiary centre, attracting more patients or may be due to migration into the city for work. This under-prediction should be borne in mind when predicting likely outcomes of any service reconfiguration.

	PPCI (STEMI * 0.79)	
	Model	Actual
Bristol	424	541
Exeter	167	212
Plymouth	209	198
Cheltenham	53	55
Truro	228	241
Taunton	180	133
Bath	57	68
Swindon	39	34
Salisbury	25	17
Torbay	153	153
Yeovil		
Weston		
Barnstaple		
Total	**1,535**	**1,651**



Actual = HES PCI from emergency/transfer STEMI patients.
Model assumes part time units are operating 8am-6pm Mon-Fri

R-square = 0.96

Figure 5.4 Model validation: predicted vs. actual STEMI-PCI

5.1.5 Predicted impact of all units offering 24/7 PPCI

A working assumption in the modelling is that any centre designated to offer PPCI will provide a 24/7 service. If this is the case work will migrate from Bristol (and to a lesser extent Taunton) towards the units that currently operate part time (Bath, Cheltenham, Swindon & Salisbury).

If all units operate 24/7 then Swindon and Salisbury still do not achieve the institutional minimum threshold of 100 STEMI-PCI per year. The 22% adjustment for the average difference between HES and NICOR admissions would bring Swindon but not Salisbury above the minimum threshold of 100 PPCI per year.

	PPCI Service	Mixed full & part time	All full time	Change
BRISTOL TOTAL	24/7	424	303	-122
ROYAL CORNWALL HOSPS NHST	24/7	228	228	0
PLYMOUTH HOSPS NHST	24/7	209	209	0
ROYAL DEVON & EXETER NHSFT	24/7	167	166	-1
S. DEVON H.C NHSFT	24/7	153	153	0
TAUNTON & SOMERSET NHSFT	24/7	180	157	-23
ROYAL UNITED HOSPS BATH NHSFT	PART TIME	57	132	75
GLOUCESTERSHIRE HOSPS NHSFT	PART TIME	53	122	70
GREAT WESTERN HOSPS NHSFT	PART TIME	39	92	52
SALISBURY NHSFT	PART TIME	25	57	32

Model assumes out-of-region hospitals are open. If all regional hospitals are open 24/7 then approx. 100 STEMI-PCI admissions per year would be brought from out of region back into region.

Table 5.3 Impact of all centres offering full time PPCI

5.1.6 Relationship between the number of centres offering PPCI and the average travel time

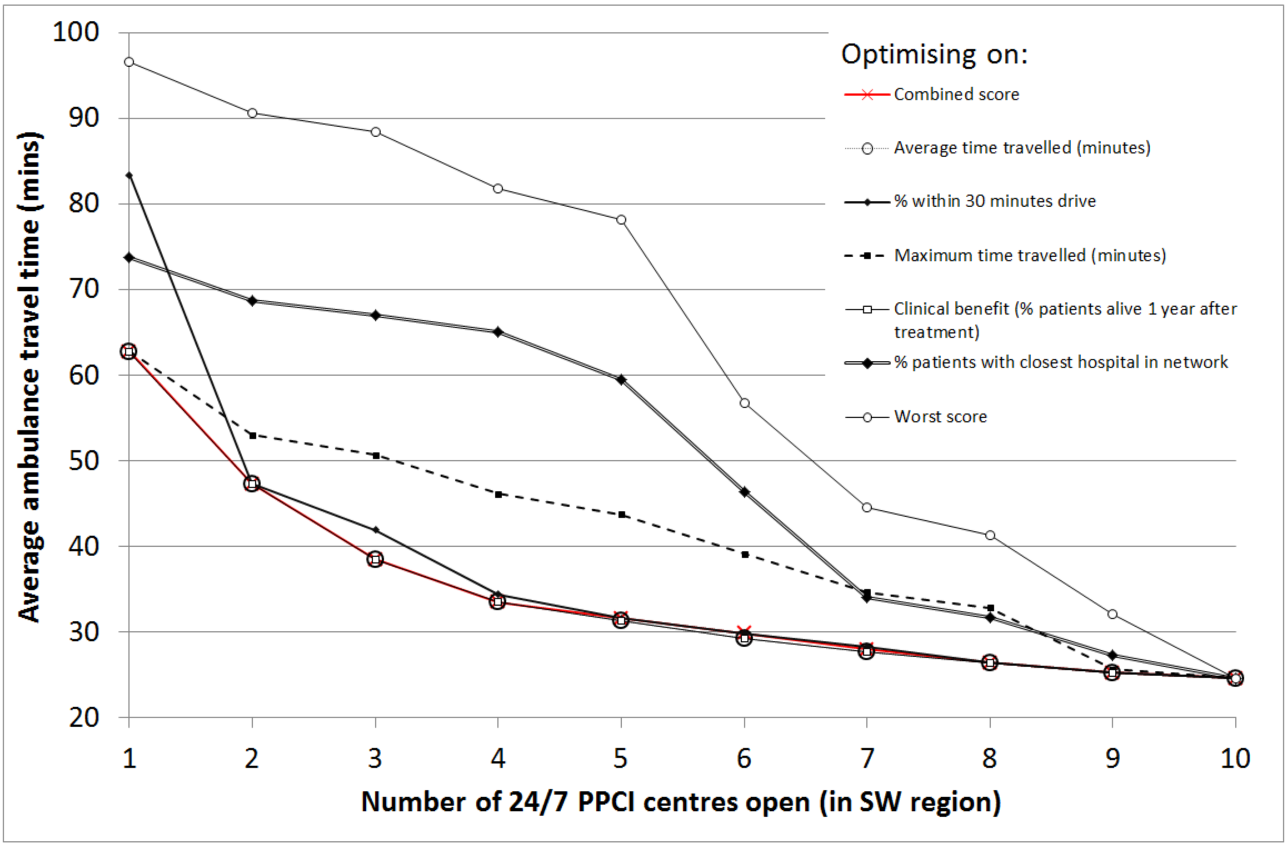


Figure 5.5 Average ambulance travel time by number of PPCI centres

With one centre in the region the best average travel time possible is ~62 minutes. There are diminishing returns as more centres are added, with the optimal average travel time being ~32 minutes with 5 centres and ~25 minutes with 10 centres.

The model allows for the average travel time to be estimated if the selection of centres is based on alternative parameters. Of note is the effect of optimising the model solely on maximising the number of patients treated within the SW region. When the selection of centres is based on this parameter alone the average travel time to hospital with 5 centres open is ~60 minutes compared to ~32 minutes when the selection is based solely on average travel time. The model preferentially selects centres towards the eastern boundary which prevents patients having to leave the region, but causes significant disadvantage to those further west in the region. As the proportion of patients being treated within network is not a patient–centred performance indicator this parameter was removed from the 'combined score' which seeks to find solutions that optimise across all parameters. The number or proportion of patients being treated out of region is reported, but is used as a secondary consideration in the model.

The combined score (optimising on average travel time, the proportion of patients within 30 minutes of a PPCI centre, the predicted clinical benefit, the maximum distance any one patient has to travel and the proportion of patients attending a centre performing at least 100 PPCIs per year) produced very similar average travel distances to a model optimising on average travel distance alone.

In order to simplify the presentation of results graphs from hereon in will show the results of using the combined score as well as showing the range of possible optimal solutions if other parameters are given higher priority (the grey shaded area on each graph). The lower border for the range of solutions shows the best possible result if the model optimises only the parameter that is being reported. The worst possible solution for any given number of hospitals is also shown. As an example solution the effect of selecting the 6 planned vascular surgical centres (Bristol, Plymouth, Exeter, Taunton, Cheltenham, Truro) is also shown.

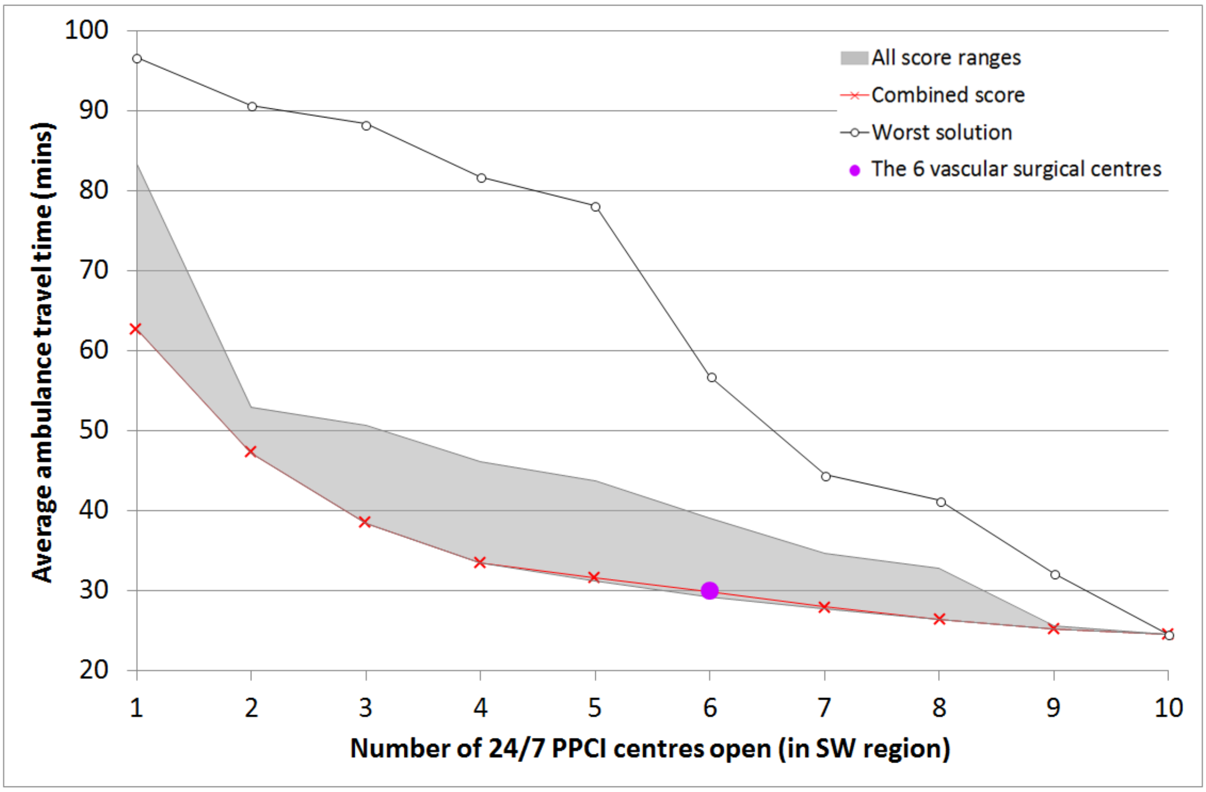


Figure 5.6 Average ambulance travel time by number of PPCI centres (simplified)

5.1.7 Relationship between the number of centres offering PPCI and the maximum travel time

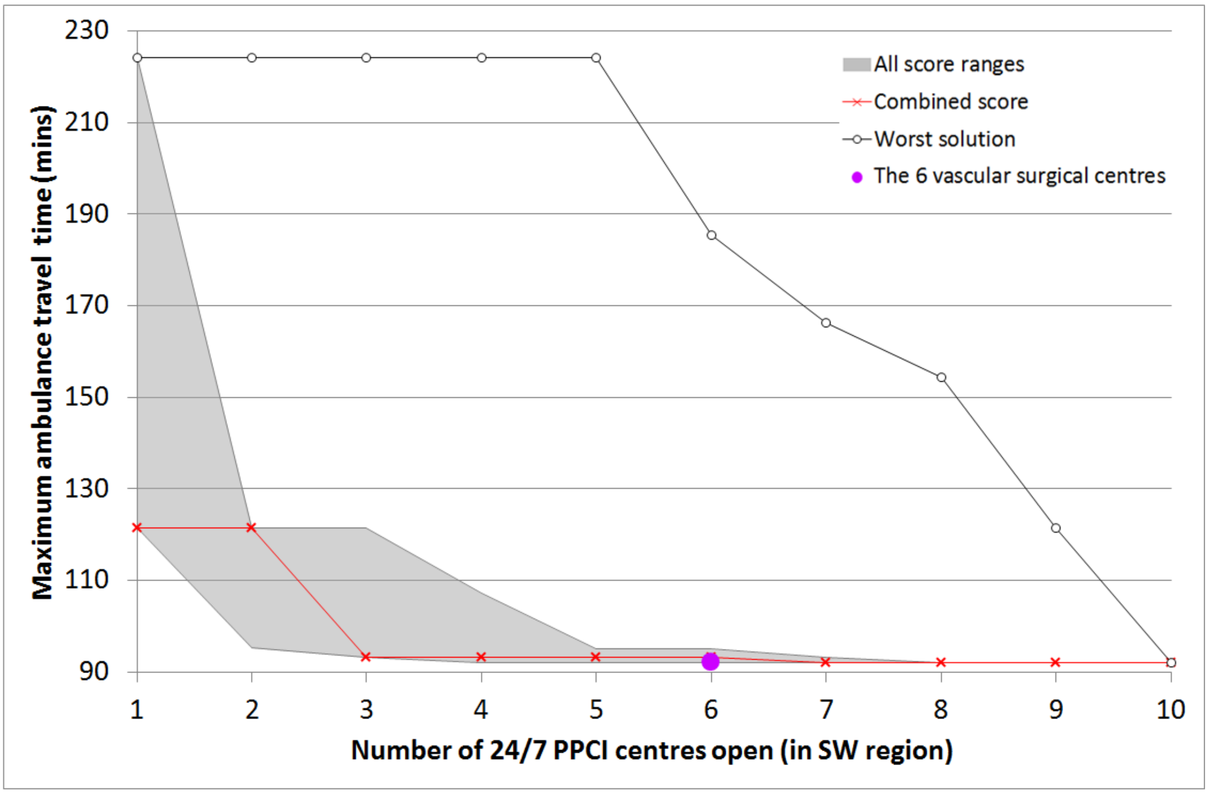


Figure 5.7 Maximum ambulance travel time by number of PPCI centres

The shortest possible maximum travel time for 2-10 hospitals is in the range 90-95 minutes. The patients with longest travel times are those around the western end of Barnstaple bay (the Hartland peninsula). The combined score produces results very similar to the optimal solution from 3 centres and upwards.

5.1.8 Relationship between the number of centres offering PPCI and the proportion of patients living within 30 minutes ambulance travel of a Heart Attack Centre

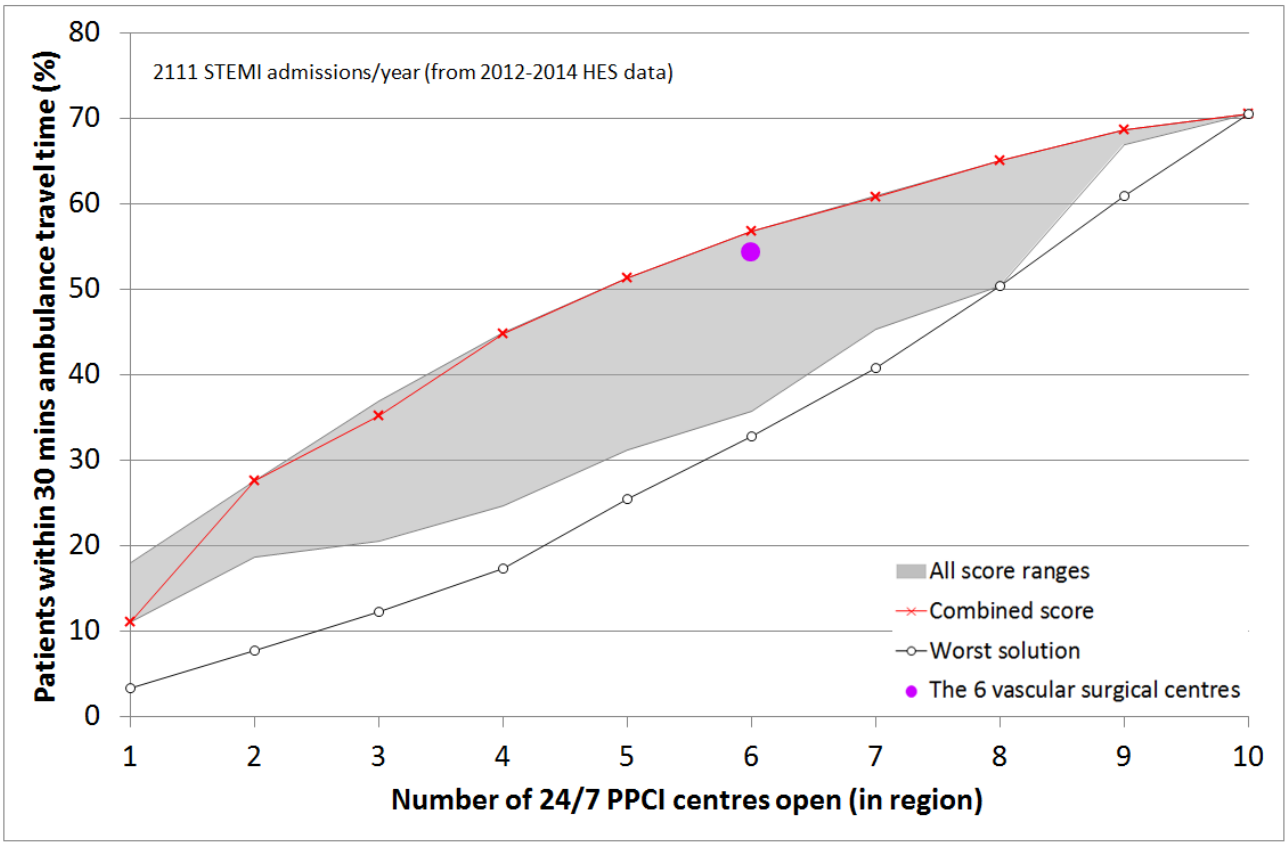
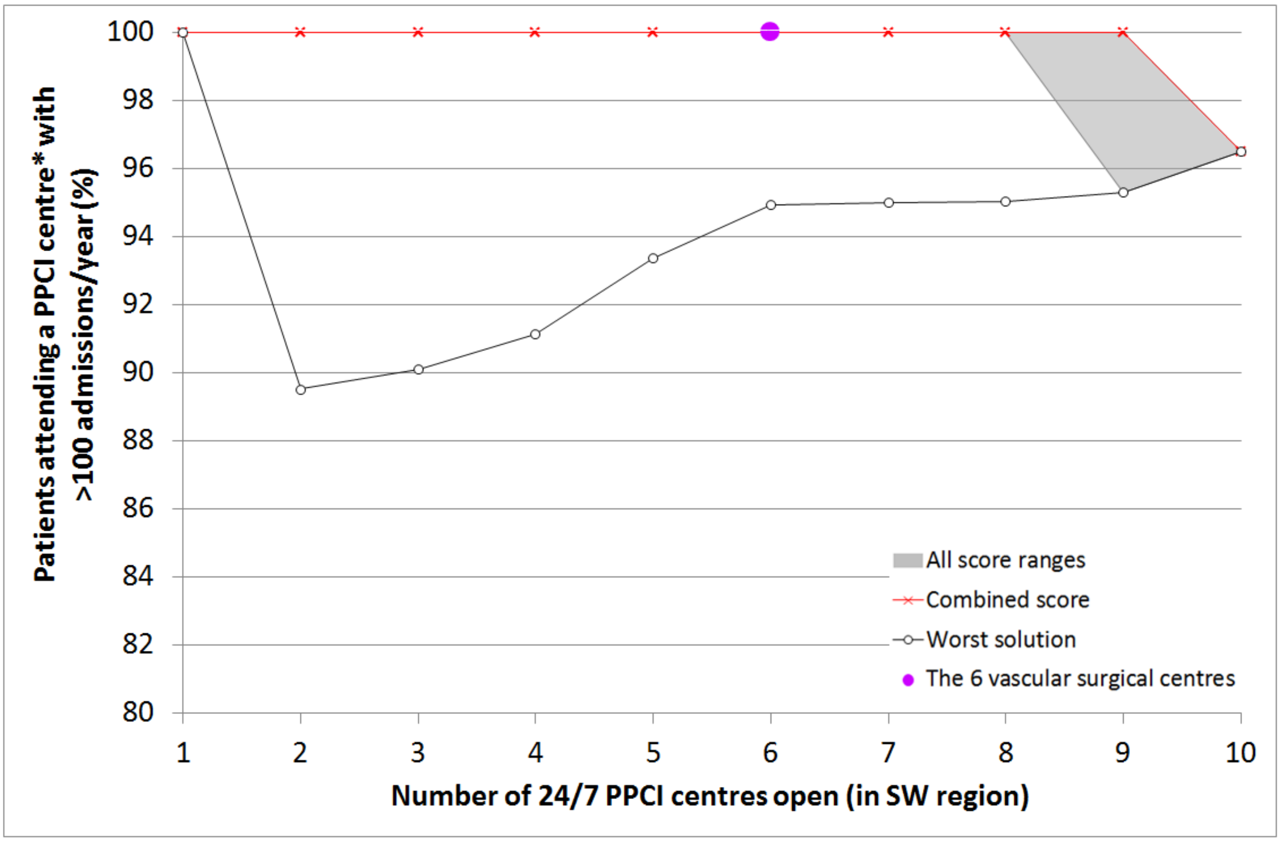


Figure 5.8 Proportion of patients within 30 mins ambulance travel time by number of PPCI centres

As centres are added, there is a steady increase in the proportion of patients within 30 minutes ambulance travel time. This is as expected as centres are built close to population centres. The combined score produces results very similar to the best possible score with, for example, ~52% and 70% of population being within a 30 min ambulance drive with 5 and 10 PPCI centres respectively.

5.1.9 Relationship between the number of centres offering PPCI and the proportion of patients attending a Heart Attack Centre performing at least 100 PPCI per year



*These results count in-region patients only.

Figure 5.9 Proportion of patients attending a PPCI centre treating >100 patients/year by number of PPCI centres

The model predicts that it is not possible to have 10 centres all performing more than 100PPCI per year (even if a 22% up-lift of admissions to convert from HES STEMI-PCI to NICOR emergency-PCI). When using the combined score all solutions with 9 PPCI centres or fewer have all patients admitted to a 100 PPCI/year centre.

5.1.10 Relationship between the number of centres offering PPCI and the clinical benefit (1 year mortality)

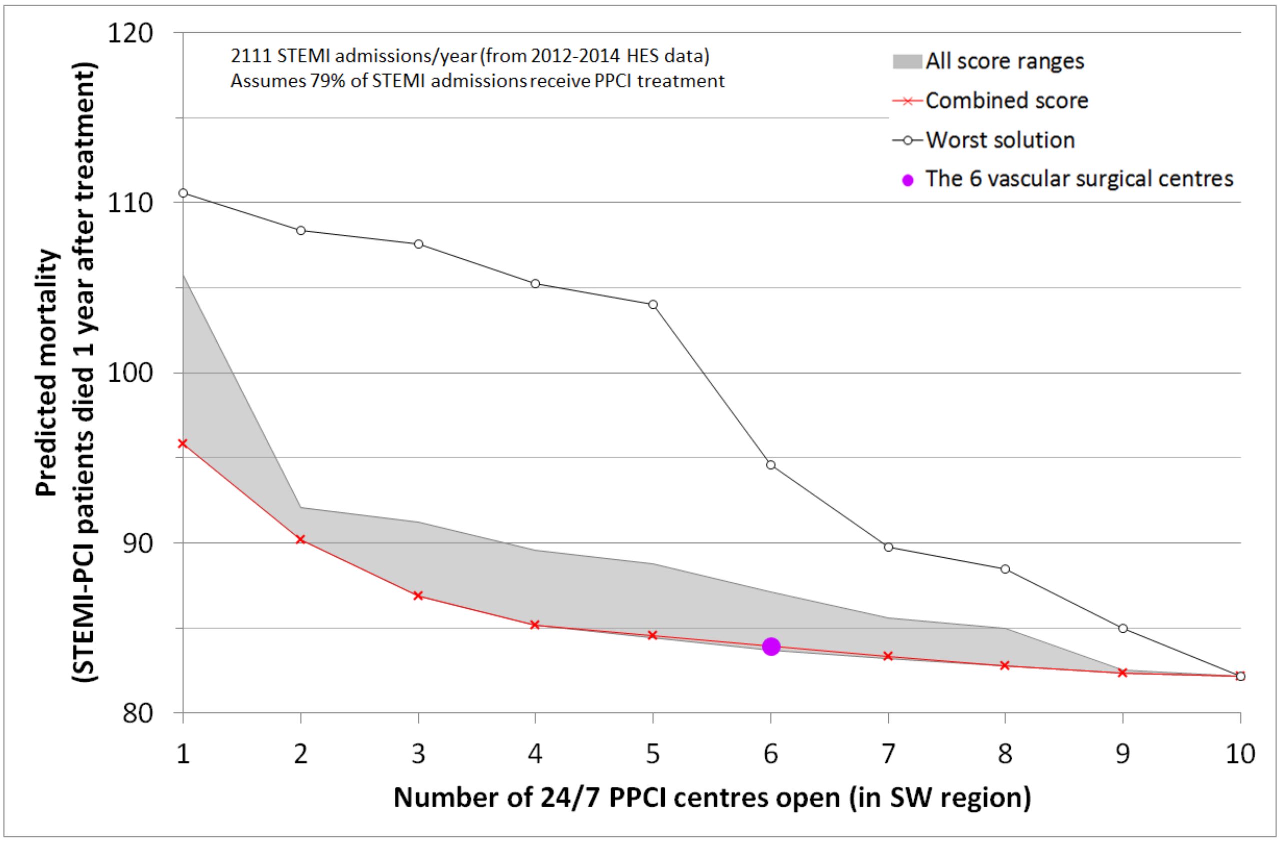


Figure 5.10 Predicted 1-year mortality by number of PPCI centres

The least number of deaths after PPCI is predicted to be approximately 82 per year; this increases to about 95 per year with a single centre (if that centre is picked to minimise the total number of deaths). The combined score produces results very similar to the best possible score; the predicted one year mortality increases from about 82 to 84 when moving from 10 to 6 PPCI centres. The relatively minor effect of centralisation is due to (1) a shallow relationship between time to PPCI and mortality, and (2) average travel times being increased by just 5 minutes between 10 and 6 PPCI centres. These results do not take into account the potential advantage to door-to-balloon time of having fewer, more experienced centres.

The modelled 1 year mortality rate equates to about 5% of STEMI-PCI patients. According to MINAP (2014), the 30-day mortality rate for patients admitted to hospital with an initial diagnosis of STEMI during the three year period 2011-2014 was 8.1%. One key difference in rates is that MINAP reports mortality for all STEMI patients, whereas the model predicts mortality for only those receiving PPCI (approximately 80% of all STEMI patients). MINAP reports significantly different mortality rates for those patients admitted to a PPCI centre and those admitted elsewhere. The reported mortality rate for those admitted to a PPCI centre (both those receiving and not receiving PPCI) was 7.2% of 63,408 patients, with a mortality rate of 14.3% for 9,261patients admitted to non-interventional centres.

We conducted a national HES query of patients admitted with a primary diagnosis of STEMI for the period of 2011-2014. That query reported that in-hospital mortality rates for emergency admissions of 4.0% for those receiving PCI and 15.4% for those not receiving PCI, with an overall in-hospital mortality rate of 7.3%. In HES, 71% of STEMI patients (emergency admissions) received PCI.

Reported mortality rates are therefore highly dependent upon the patient group being studied, with significantly higher mortality rates for those not receiving PCI (which may be due to both patients unsuitable for PPCI having a higher mortality rate and suitable patients not receiving PPCI). In this report we assume that approximately 80% of patients receive PPCI and predict mortality solely for that group, leaving aside the higher mortality rates for those not receiving PPCI.

5.1.11 Relationship between the number of centres offering PPCI and the number of patients treated within the SW region

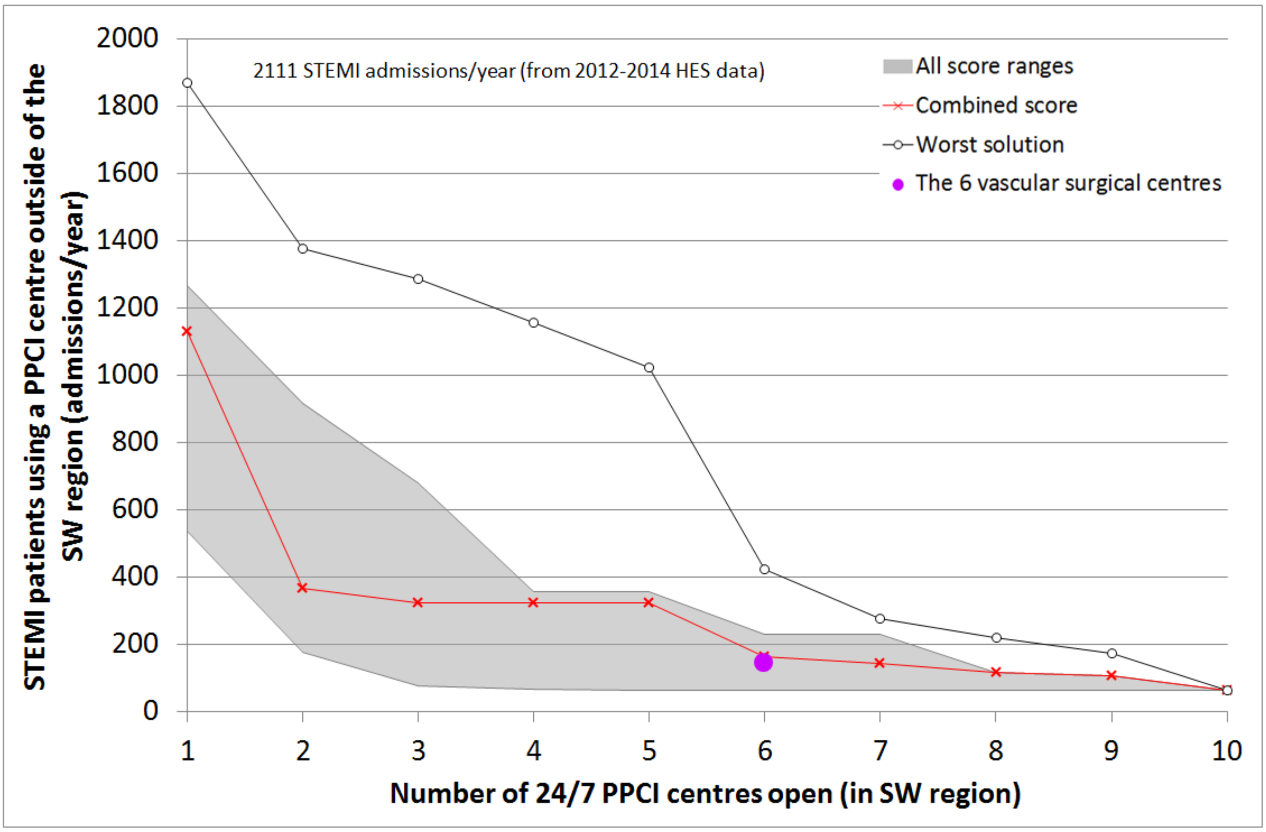


Figure 5.11 Number of STEMI patients treated outside the region by number of PPCI centres

The proportion of patients treated within the SW region is not a patient-centred performance indicator and is not included in the scoring to identify optimal solutions. It is reported for all combinations. When this measure is a priority the model will be biased towards opening hospitals on the Eastern edge of the region in order to prevent movement of patients to the East. This disadvantages the average and maximum travel times and the overall clinical impact. The combined score does track reasonably close to the optimal result in the 6-10 centre solution. With fewer than six centres there is an increasing compromise between optimising the proportion of patients treated in region and the outcome-based parameters in the model. More information on where patients are displaced to outside of the region is given in the detailed results for specific scenarios.

5.1.12 Relationship between the number of centres offering PPCI and the capability to meet 120 and 150 minutes call-to-treatment times

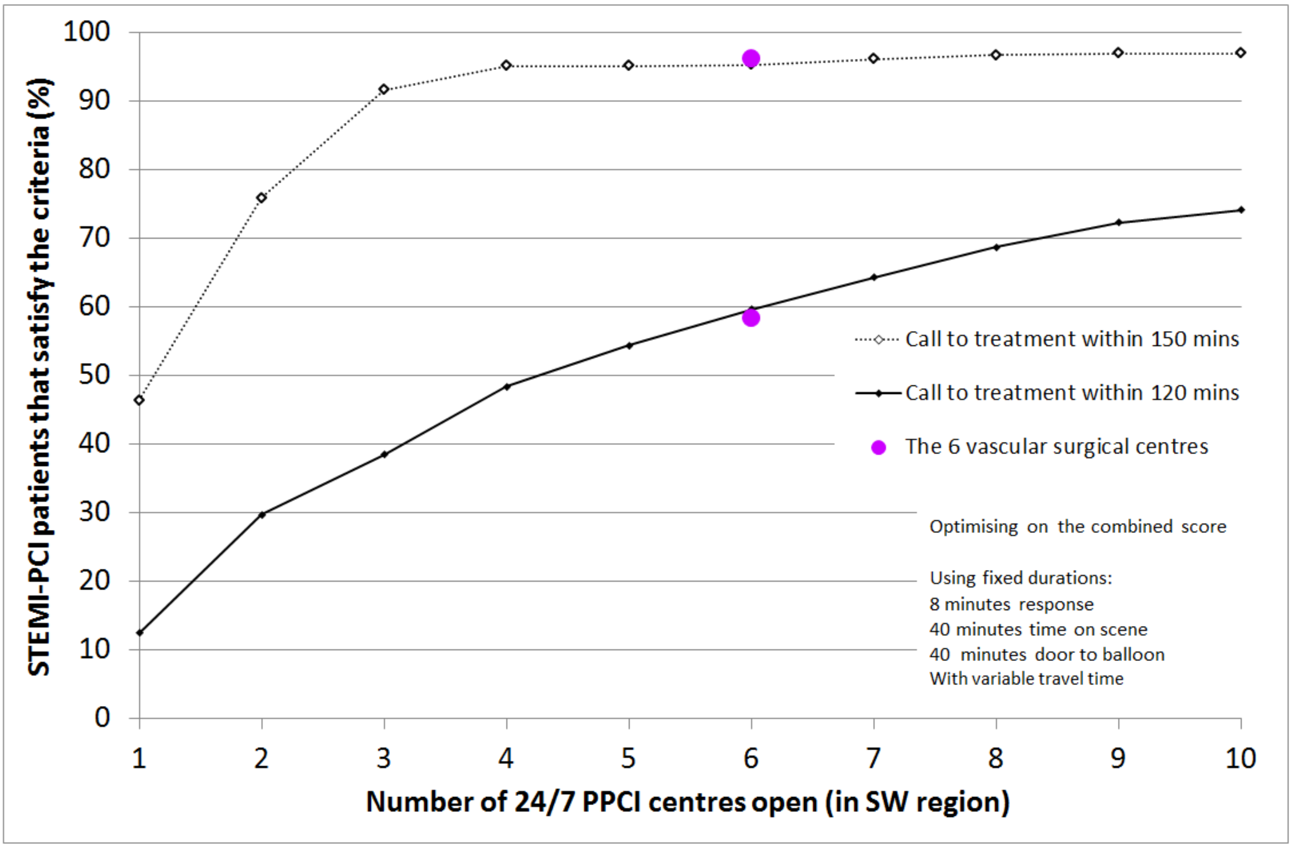


Figure 5.12 Call-to-treatment professional standards by number of PPCI centres

Current call-to-treatment times average 88 minutes excluding transport to hospital. In order to meet 120 min call-to-treatment time ambulance travel must be less than 32 minutes, whereas achieving call-to-treatment times of 150 min allows for travel up to 62 minutes. The capability to achieve 120 min call-to-treatment times therefore currently approximates the proportion of patients within 30 minutes ambulance travel of a hospital. This is difficult to achieve for a very high proportion of patients in a rural setting.

Meeting 150 min call-to-treatment times, allowing for ~60 minutes ambulance travel time, is much more readily achieved for a high proportion of patients.

Achieving 120 min call-to-treatment times in a very high proportion of patients is likely to require reduction in ambulance on-scene time and/or a reduction in hospital door-to-treatment times.

5.1.13 Relationship between the number of centres offering PPCI and the required emergency ambulance time

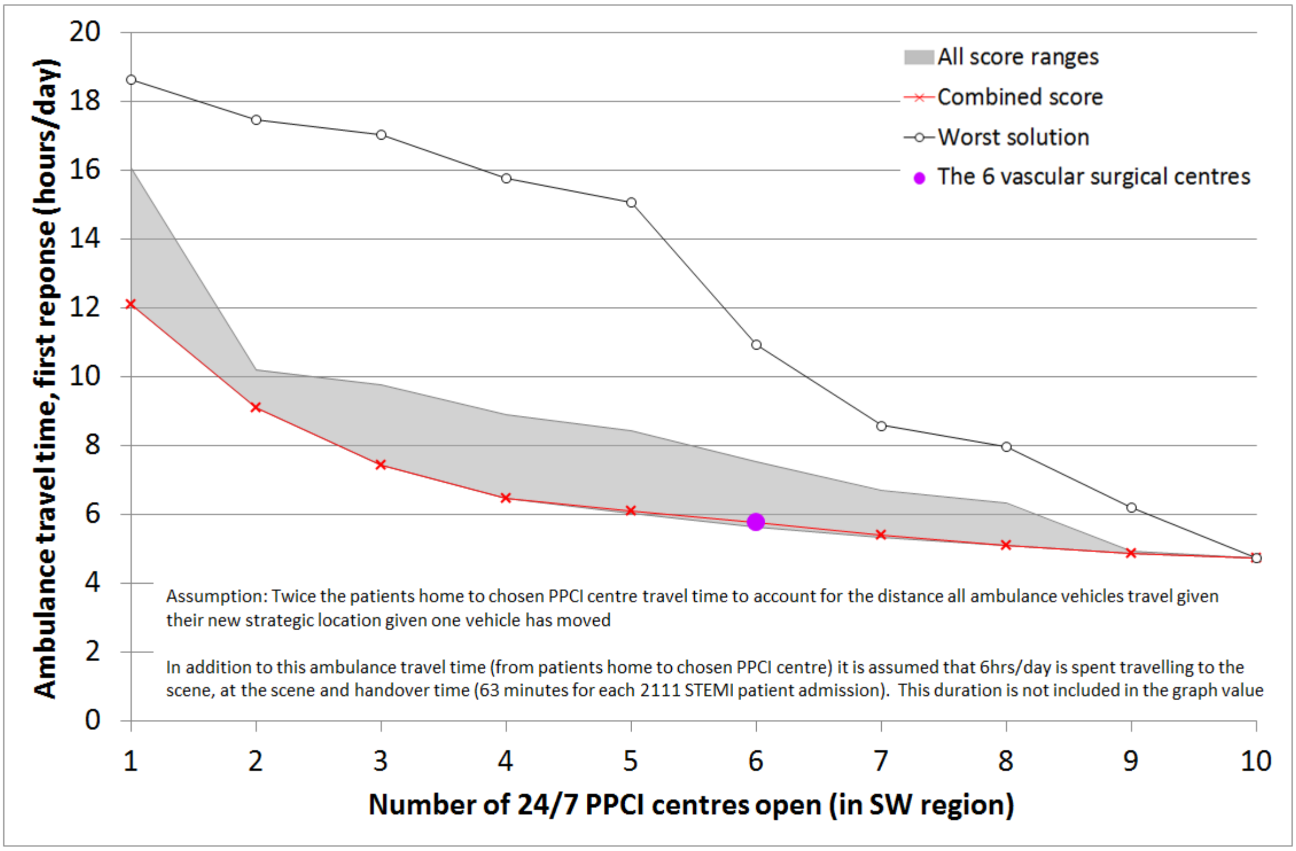


Figure 5.13 Total ambulance travel time by number of PPCI centres

Ambulance travel time is based on the number of STEMIs in region (not the number of STEMI-PCI; STEMIs are ~20% higher than STEMI-PCI). The use of ECG-detected ST-segment elevation for the diagnosis of STEMI is sensitive and specific; recent published series report a false-positive rate for paramedic-activation of the catheter lab for PPCI of 11.5% (Lu et al, 2016).

We estimate that there is an average ~6 hours per day fixed ambulance time (irrespective of travel time to centres). In addition to this fixed time there is the travel time to the nearest PPCI centre and a similar travel time back to the location the ambulance started. The amount of travel time is estimated to be ~5 hours per day at present. This would increase by about 1 hour per day with centralisation down to 5-7 centres. Further centralisation brings significantly increased ambulance time, up to 4 additional hours/day with centralisation to two regional centres.

5.1.14 Relationship between the number of centres offering PPCI and the required repatriation ambulance time

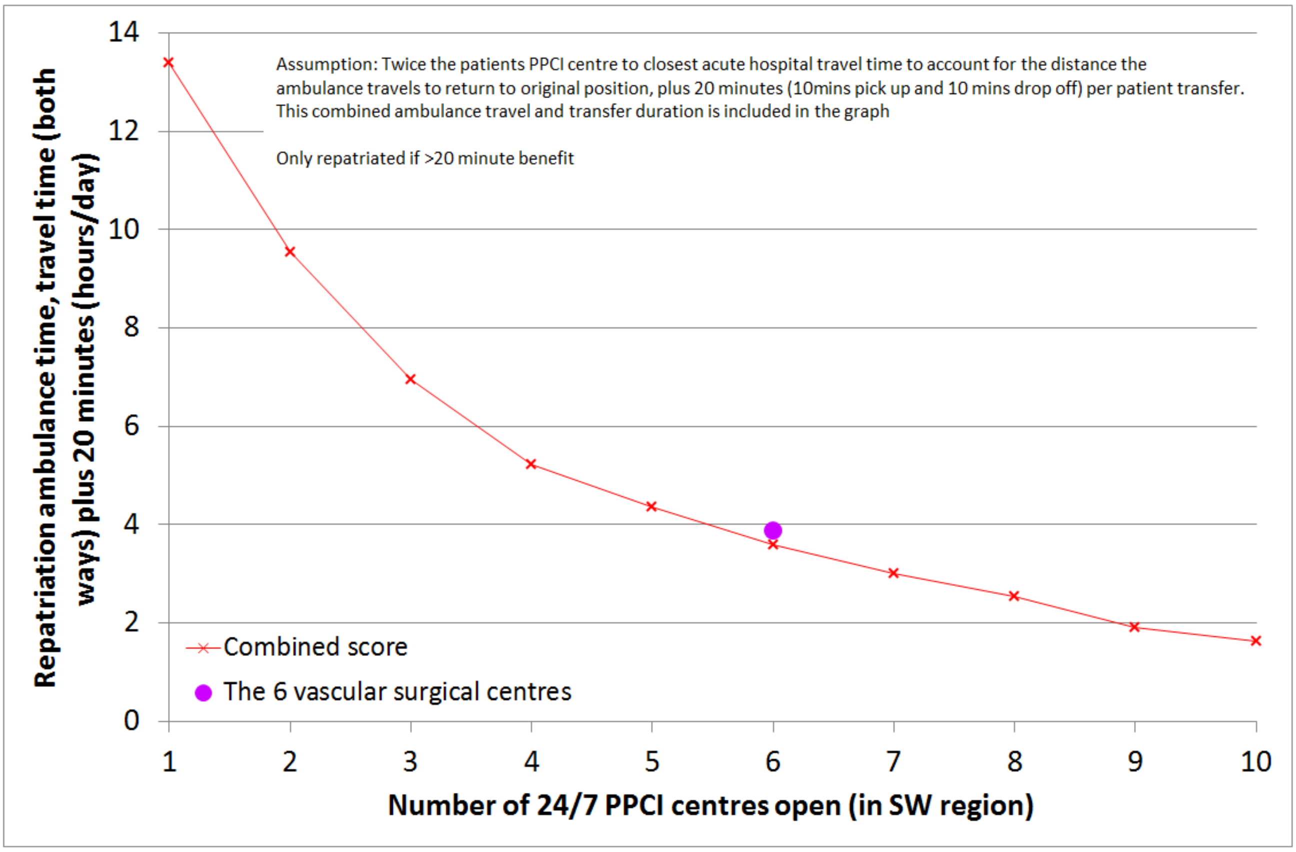


Figure 5.14 Total ambulance travel time for repatriation by number of PPCI centres

In the above chart we have taken a 'worst case' example of where all patients require repatriation back to their closest acute hospitals after an initial stay in a HAC. In reality, most patients go straight home after PPCI treatment rather than to their local acute hospital.

With 6 regional centres we would expect an average of 4 hours ambulance time to be taken per day in repatriating all patients back to their local hospital. We assume 10 minutes collect and drop-off times. Reducing the number of HACs below 6 leads to increasing requirements for repatriation (~10 hours per day with a two centre solution).

5.1.15 Optimal and near-optimal solutions

Previous plots have shown 'optimal' solutions based on either a single parameter (such as optimising solely on average ambulance travel time) or optimising the combined score of multiple parameters. It should be stressed that though there may be one calculated 'optimal' combination of centres there may also be many similar scoring combinations that are 'near optimal'. There may be reasons, not included in the model, for selecting a particular configuration from this near-optimal selection. For example in the table below the solution for six centres is shown. The highlighted line shows what are expected to be the six regional vascular-surgical centres. This configuration is a near-optimal solution in the model and it may be preferable (due to co-localising PPCI and vascular surgery) to the mathematically 'optimal' solution. The model shows that in selecting these six centres there would be very little compromise compared with selecting the modelled optimal solution.

When selecting any six centres from 10 the model produces over 20 'near-optimal' solutions with minimal compromise compared with the 'optimal' solution.

		The score definition												
	Scores (%max)	Average Time Travelled (mins)	Max Time Travelled (mins)	Patients Within 30 Mins Travel (%)	Clinical Benefit (% patients alive 1 year after treatment)	Patients Attending Hospital With >100 Admissions (%)	Patients Using Hospital In Network (%)	In region hospitals open (all out of region hospitals are open)					
The optimal solution	**92.0**	**30**	**93**	**57**	**95.0**	**100**	**92**	**Bristol**	**Exeter**	**Cheltenham**	**Plymouth**	**Torbay**	**Truro**
21 near optimal solutions (within 3 percentage points)	91.9	30	93	56	95.0	100	88	Bristol	Exeter	Plymouth	Swindon	Torbay	Truro
	91.8	30	92	55	95.0	100	86	Bristol	Exeter	Plymouth	Taunton	Torbay	Truro
	91.4	30	92	54	95.0	100	93	Bristol	Exeter	Cheltenham	Plymouth	Taunton	Truro
	91.3	29	95	55	95.0	100	93	Bristol	Cheltenham	Plymouth	Taunton	Torbay	Truro
	91.3	30	93	55	95.0	100	86	Bath	Bristol	Exeter	Plymouth	Torbay	Truro
	91.3	30	92	53	95.0	100	89	Bristol	Exeter	Plymouth	Swindon	Taunton	Truro
	91.2	29	95	54	95.0	100	89	Bristol	Plymouth	Swindon	Taunton	Torbay	Truro
	91.1	30	93	54	95.0	100	94	Bristol	Exeter	Cheltenham	Plymouth	Swindon	Truro
	90.8	30	93	54	95.0	100	93	Bath	Bristol	Exeter	Cheltenham	Plymouth	Truro
	90.6	30	92	53	95.0	100	87	Bath	Bristol	Exeter	Plymouth	Taunton	Truro
	90.6	30	93	53	95.0	100	89	Bath	Bristol	Exeter	Plymouth	Swindon	Truro
	90.6	30	95	53	95.0	100	87	Bath	Bristol	Plymouth	Taunton	Torbay	Truro
	90.4	31	93	53	95.0	100	88	Bristol	Exeter	Plymouth	Salisbury	Torbay	Truro
	90.0	31	93	52	95.0	100	96	Bristol	Exeter	Cheltenham	Plymouth	Salisbury	Truro
	89.8	31	92	51	95.0	100	89	Bristol	Exeter	Plymouth	Salisbury	Taunton	Truro
	89.7	30	95	51	95.0	100	89	Bristol	Plymouth	Salisbury	Taunton	Torbay	Truro
	89.6	31	93	53	94.9	100	93	Bath	Exeter	Cheltenham	Plymouth	Torbay	Truro
	89.6	31	92	51	94.9	100	86	Bath	Exeter	Plymouth	Taunton	Torbay	Truro
	89.3	31	92	50	94.9	100	94	Bath	Exeter	Cheltenham	Plymouth	Taunton	Truro
	89.3	32	93	52	94.9	100	88	Bath	Exeter	Plymouth	Swindon	Torbay	Truro
	89.2	31	95	51	95.0	100	94	Bath	Cheltenham	Plymouth	Taunton	Torbay	Truro

Red highlights the six vascular surgical centres.

Table 5.4 Optimal and near-optimal solutions for PPCI

5.1.16 Relationship between the number of centres offering PPCI and the clinical benefit when ambulance on-scene time or hospital door-to-treatment time is reduced

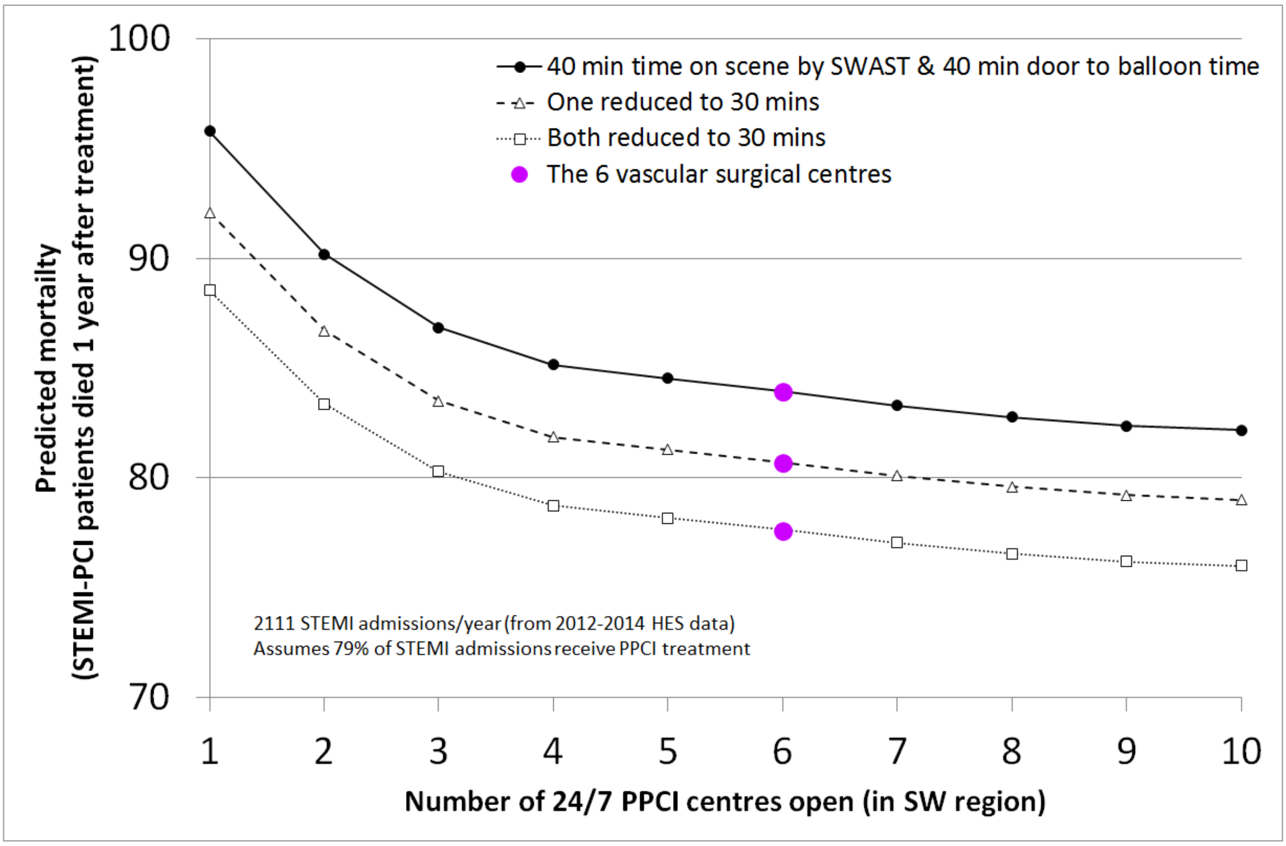


Figure 5.15 Predicted 1-year mortality by number of PPCI centres and reductions in time to treatment

As described above, reducing the number of PPCI centres from 10 to 6 would be expected to result in 84 rather than 82 deaths per year if performance elsewhere in the system was unchanged.

A reduction of other times in the system could be expected to help mitigate longer travel times. A 10 minutes average time saving from onset-to-treatment (such as by reducing ambulance on-scene time or hospital door-to-treatment time) would be expected to lead to an increase in lives saved of approximately three patients per year.

It should be noted though that the benefit of reducing times other than travel time will be spread across all patients whereas the increase in average travel time is focussed on those areas around any centre no longer designated as a HAC.

5.1.17 Specific configurations: two, six, seven, nine, ten and fifteen Heart Attack Centres

As described in Methods, the following specific configurations were chosen for more detailed analysis:

Scenario	1	2	3	4	5	6
# Hospitals	2	6	7	9	10	15
In region hospitals	Bristol 1	Bristol 1	Bristol 1	Bristol 1	Bristol 1	Bristol 1
	Plymouth	Plymouth	Plymouth	Plymouth	Plymouth	Plymouth
		Cheltenham	Cheltenham	Cheltenham	Cheltenham	Cheltenham
		Taunton	Taunton	Taunton	Taunton	Taunton
		Truro	Truro	Truro	Truro	Truro
		Exeter	Exeter	Exeter	Exeter	Exeter
			Torbay	Torbay	Torbay	Torbay
				Swindon	Swindon	Swindon
				Bath	Bath	Bath
					Salisbury	Salisbury
						Bristol 2
						Barnstaple
						Weston
						Yeovil
						Gloucester
Out of region hospitals	Bournmouth	Bournmouth	Bournmouth	Bournmouth	Bournmouth	Bournmouth
	Dorchester	Dorchester	Dorchester	Dorchester	Dorchester	Dorchester
	Oxford (JR)	Oxford (JR)	Oxford (JR)	Oxford (JR)	Oxford (JR)	Oxford (JR)
	Southampton	Southampton	Southampton	Southampton	Southampton	Southampton
	Worcester	Worcester	Worcester	Worcester	Worcester	Worcester

Table 5.5 Heart Attack Centre configurations selected for detailed analysis

A summary of key parameters is shown in the table below for these configurations:

Scenario	1	2	3	4	5	6
# Hospitals	2	6	7	9	10	15
In region hospitals	Bristol 1	Bristol 1	Bristol 1	Bristol 1	Bristol 1	Bristol 1
	Plymouth	Plymouth	Plymouth	Plymouth	Plymouth	Plymouth
		Gloucester	Gloucester	Gloucester	Gloucester	Gloucester
		Taunton	Taunton	Taunton	Taunton	Taunton
		Truro	Truro	Truro	Truro	Truro
		Exeter	Exeter	Exeter	Exeter	Exeter
			Torbay	Torbay	Torbay	Torbay
				Swindon	Swindon	Swindon
				Bath	Bath	Bath
					Salisbury	Salisbury
						Bristol 2
						Barnstaple
						Weston
						Yeovil
						Cheltenham
Average travel (mins)	47	30	28	25	25	21
Maximum travel (mins)	122	92	92	92	92	65
Patients within 30 mins (%)	28	54	61	69	71	80
Patients using hospital in network (%)	83	93	93	95	97	99
Mortality	90	84	**83**	83	82	81
Patients attending hopsital with >100 admissions (%)	100	100	100	100	96	82
Patients with call-to-treatment time of 120 min	30	58	64	72	74	83
Patients with call-to-treatment time of 150 min	76	96	96	97	97	100
First response, ambulance travel time (hours/day)*	9.1	5.8	5.4	4.9	4.7	4.1

* Twice time/distance from home to hospital. In addition there are 6 hours per day travelling to scene, on scene and handover (63 min per patient)

Table 5.6 Key parameter outputs for selected Heart Attack Centre configurations

The spread of ambulance travel times is shown in the following box and whiskers plot.

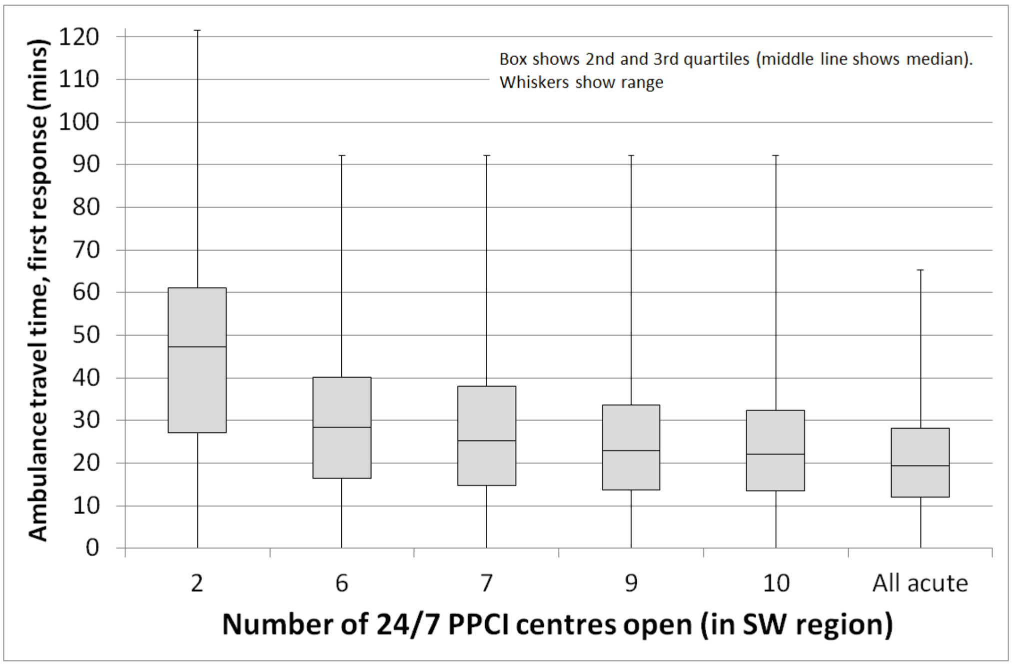


Figure 5.16 Ambulance travel times by number of Heart Attack Centres

A further breakdown of ambulance travel times is shown below. The *change* in travel times (relative to a 10 centre solution) are also shown.

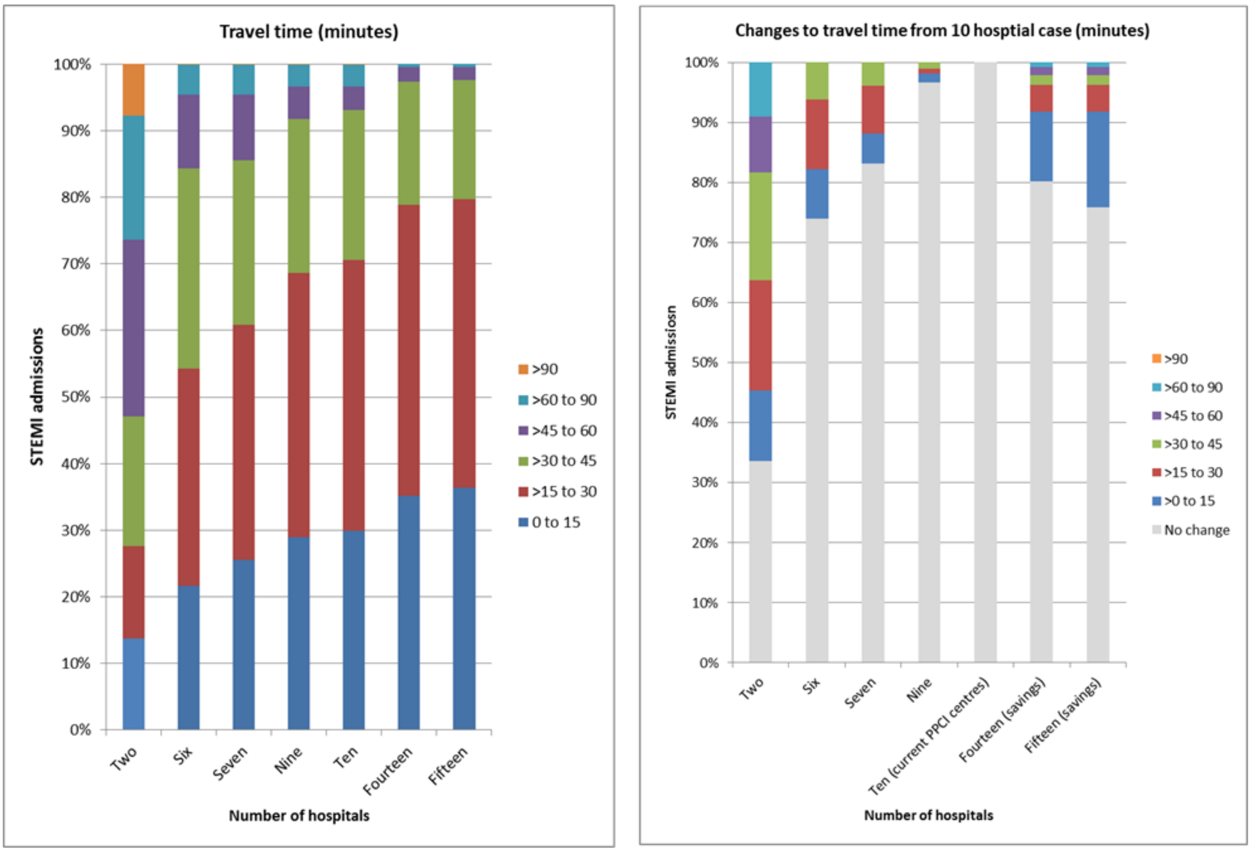


Figure 5.17 Ambulance travel times and change in travel times by number of Heart Attack Centres

When reducing the number of centres to six or seven centres there are a small proportion of patients who are significantly affected, with travel time increased by more than 30 minute for 3-6% of patients. With a two centre solution more than 35% of patients would have their travel time extended by more than 30 minutes and nearly 10% would have travel time extended by more than 60 minutes (with ~8% of patients having an ambulance travel time of more than 90 minutes to their closest PPCI centre).

The tables below show the number of admissions to each centre, either using uncorrected HES STEMI-PCI (primary diagnosis and procedure codes) or adjusted by 22% after calibration against total emergency PCI in NICOR data.

PROCEDURES				All hospitals full time					
		Historic mix full/part	Chelt to full time	10	9	7	6	2	15
In-region acute trusts currently offering PPCI	BRISTOL INFIRMARY	424	389	303	303	453	453	603	140
	DERRIFORD HOSP	209	209	209	209	209	220	774	208
	CHELTENHAM GENERAL HOSP	53	159	122	122	187	187	-	**54**
	MUSGROVE PARK HOSP	180	180	157	157	158	158	-	**80**
	CORNWALL HOSP	228	228	228	228	228	228	-	228
	DEVON & EXETER HOSP	167	167	166	166	166	308	-	132
	TORBAY HOSP	153	153	153	153	153	-	-	153
	THE GREAT WESTERN HOSP	**39**	**39**	**92**	106	-	-	-	**91**
	UNITED HOSP	**57**	**57**	132	138	-	-	-	120
	SALISBURY DISTRICT HOSP	**25**	**25**	**57**	-	-	-	-	**43**
In-region acute trusts currently not offering PPCI	GLOUCESTERSHIRE HOSP	-	-	-	-	-	-	-	**72**
	N. DEVON DISTRICT HOSP	-	-	-	-	-	-	-	**65**
	SOUTHMEAD HOSP	-	-	-	-	-	-	-	112
	WESTON GENERAL HOSP	-	-	-	-	-	-	-	**82**
	YEOVIL DISTRICT HOSP	-	-	-	-	-	-	-	**67**
Out-of-region acute trusts currently offering PPCI (SW patients only)	DORSET COUNTY HOSPITAL	15	15	35	44	51	51	102	4
	WORCESTERSHIRE HOSPITAL	60	7	7	7	7	7	101	5
	JOHN RADCLIFFE HOSP	26	9	4	4	13	13	42	4
	THE BOURNEMOUTH HOSPITAL	11	11	3	8	8	8	8	3
	SOUTHAMPTON GENERAL HOSP	21	21	-	23	36	36	37	-
Total out of region		133	62	49	85	114	114	290	16

Bold red shows when less than 100 PPCI per year anticiptaed.

Model validation suggests that Bristol may attract ~120 more PPCI per year than predicted by geographical modelling.

Table 5.7 Numbers of PPCI admissions for the selected configurations, using HES data

PROCEDURES: Include a 22% uplift HES → NICOR calibration		Historic mix full/part	Chelt to full time	All hospitals full time 10	9	7	6	2	15
In-region acute trusts currently offering PPCI	BRISTOL INFIRMARY	517	474	370	370	552	552	735	171
	DERRIFORD HOSP	255	255	255	255	255	268	944	254
	CHELTENHAM GENERAL HOSP	65	194	149	149	228	228	-	**66**
	MUSGROVE PARK HOSP	220	220	191	191	193	193	-	98
	CORNWALL HOSP	278	278	278	278	278	278	-	278
	DEVON & EXETER HOSP	204	204	202	202	202	376	-	161
	TORBAY HOSP	187	187	187	187	187	-	-	187
	THE GREAT WESTERN HOSP	**48**	**48**	112	129	-	-	-	111
	UNITED HOSP	**70**	**70**	161	168	-	-	-	146
	SALISBURY DISTRICT HOSP	**30**	**30**	**70**	-	-	-	-	**52**
In-region acute trusts currently not offering PPCI	GLOUCESTERSHIRE HOSP	-	-	-	-	-	-	-	**88**
	N. DEVON DISTRICT HOSP	-	-	-	-	-	-	-	**79**
	SOUTHMEAD HOSP	-	-	-	-	-	-	-	137
	WESTON GENERAL HOSP	-	-	-	-	-	-	-	100
	YEOVIL DISTRICT HOSP	-	-	-	-	-	-	-	**82**
Out-of-region acute trusts currently offering PPCI (SW patients only)	DORSET COUNTY HOSPITAL	18	18	43	54	62	62	124	5
	WORCESTERSHIRE HOSPITAL	73	9	9	9	9	9	123	6
	JOHN RADCLIFFE HOSP	32	11	5	5	16	16	51	5
	THE BOURNEMOUTH HOSPITAL	13	13	4	10	10	10	10	4
	SOUTHAMPTON GENERAL HOSP	26	26	-	28	44	44	45	-
Total out of region		162	76	60	104	139	139	354	20

Bold red shows when less than 100 PPCI per year anticipated.

Model validation suggests that Bristol may attract ~160 more PPCI per year than predicted by geographical modelling.

Table 5.8 Numbers of PPCI admissions for the selected configurations, using an adjustment for NICOR data

5.1.18 Specific configurations: two, six, seven, nine, ten and fifteen Heart Attack Centres - maps of travel times and change in travel times

Shown below are maps showing expected travel time and changes in travel time (compared with the current configuration of 10 centres). Of note is that the areas with the longest travel times in the configurations described are not necessarily those most affected by any changes. This is due to North Devon currently having the longest travel times, and patients living there will continue to have the longest travel times. The effects of the newly modelled changes are felt mostly in the East of the region.

The maps show modelled ambulance travel times, and the numbers of patients in each travel-time category, by geography.

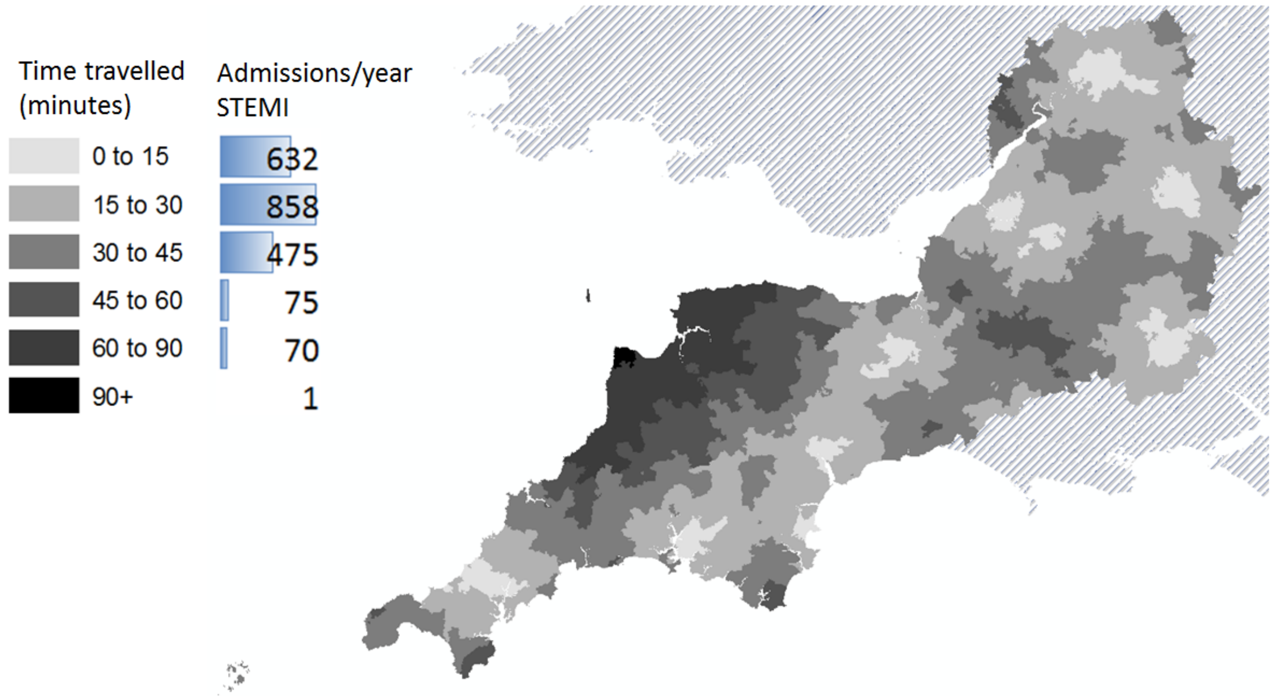


Figure 5.18 Modelled ambulance travel times: 10 Heart Attack Centres operating 24/7

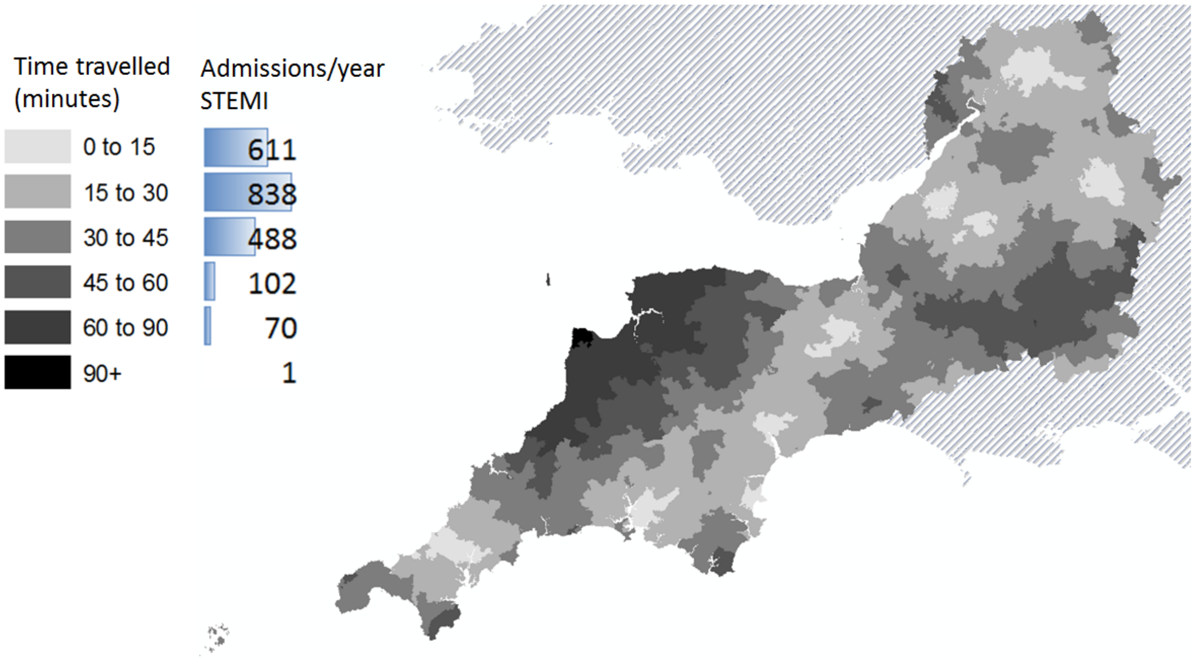


Figure 5.19 Modelled ambulance travel times: 9 Heart Attack Centres

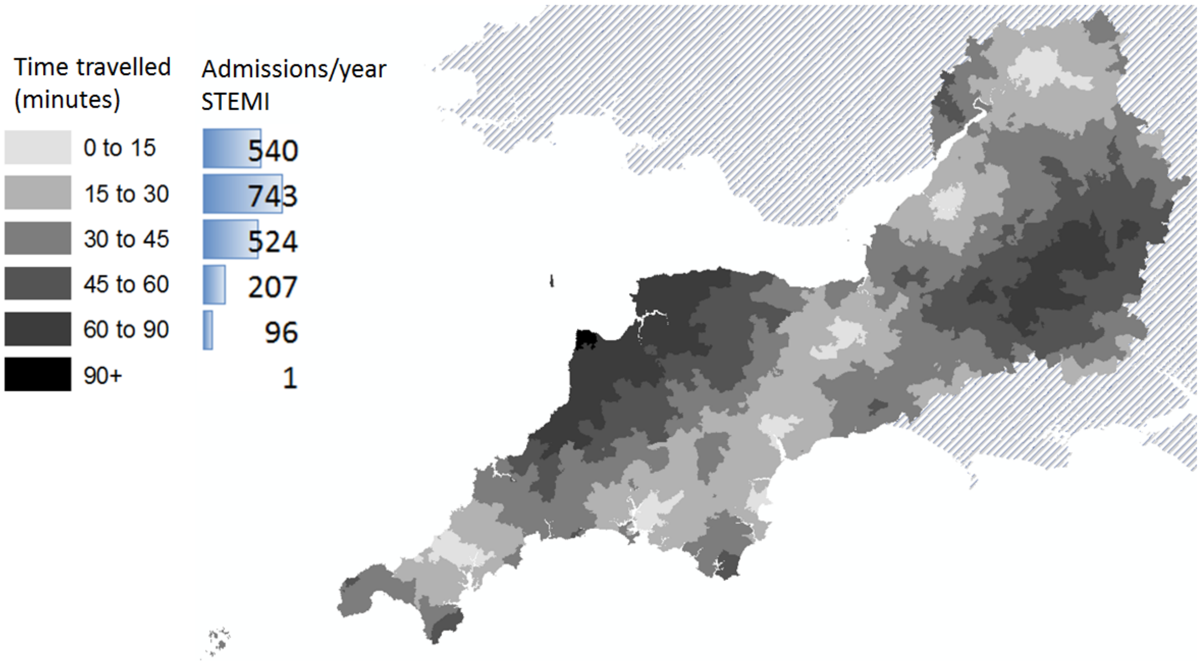


Figure 5.20 Modelled ambulance travel times: 7 Heart Attack Centres

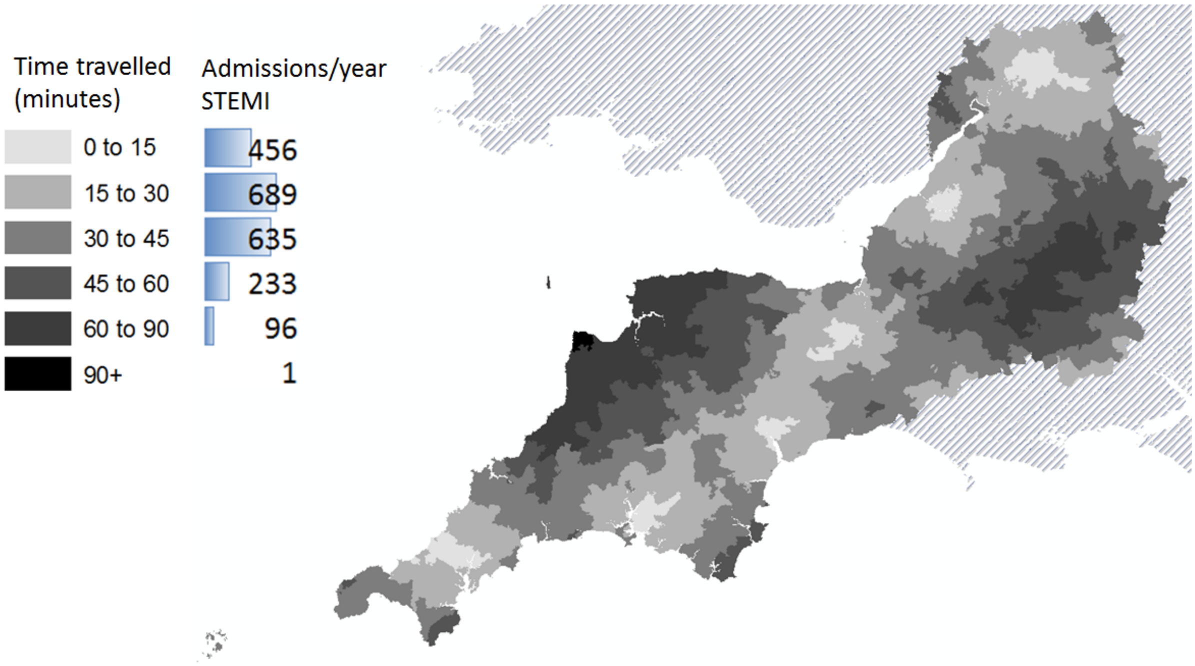


Figure 5.21 Modelled ambulance travel times: 6 Heart Attack Centres

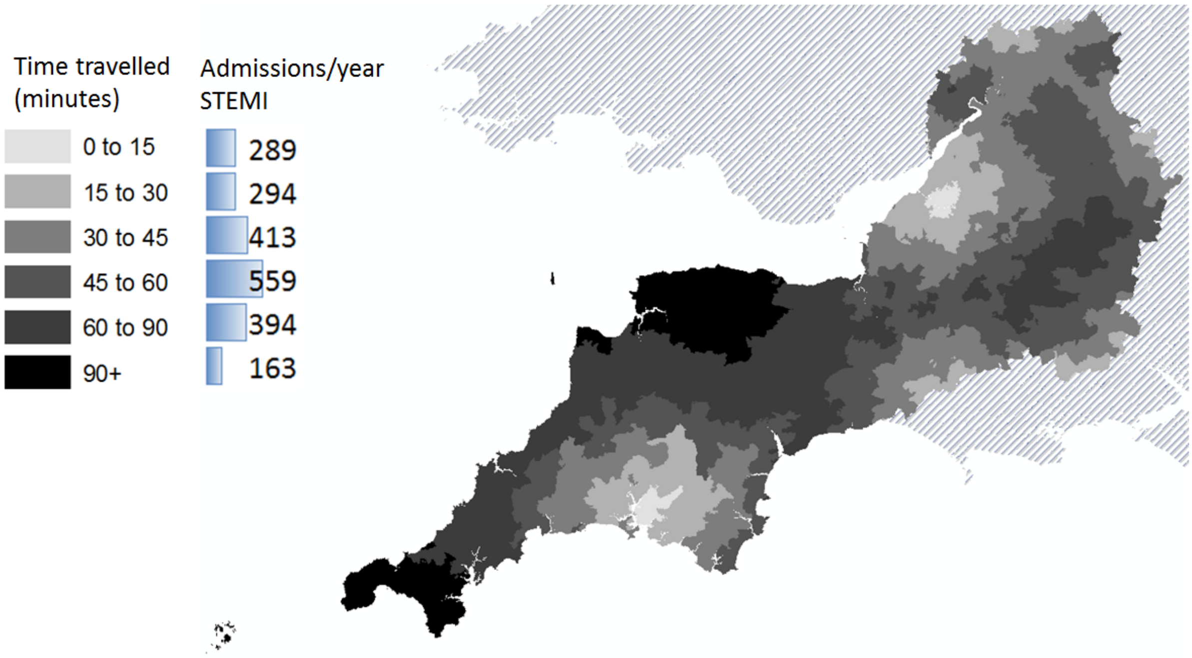


Figure 5.22 Modelled ambulance travel times: 2 Heart Attack Centres

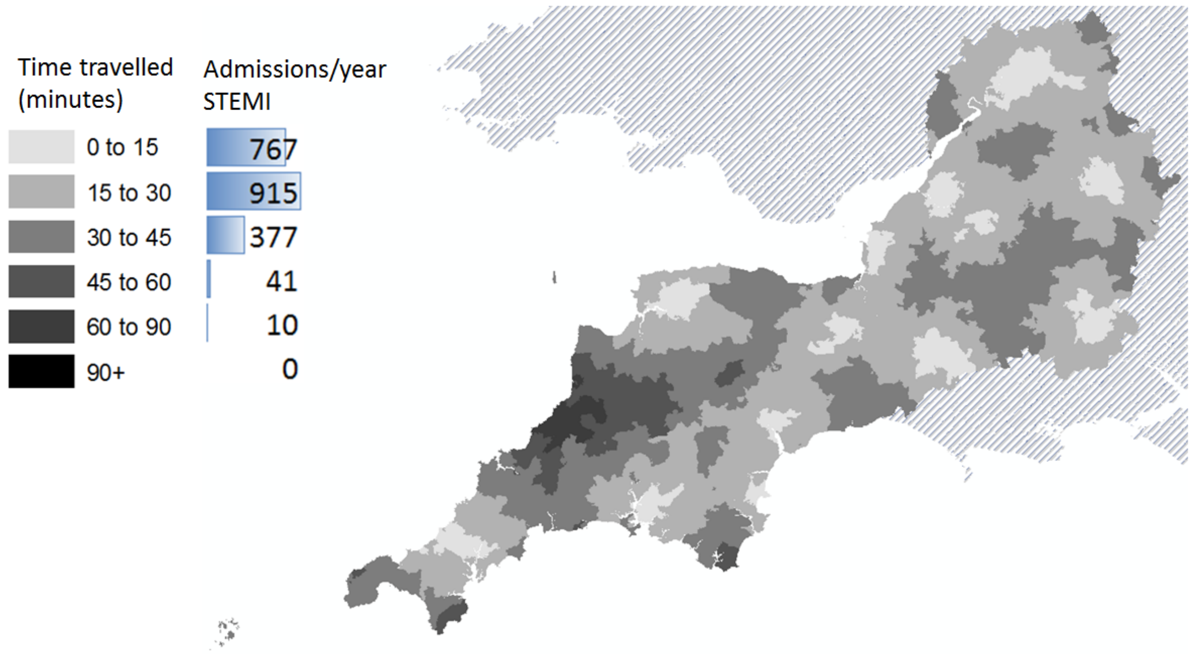


Figure 5.23 Modelled ambulance travel times: 15 Heart Attack Centres

The following maps show modelled changes in ambulance travel times (compared with the present 10 centres), and the numbers of patients in each travel-time category, by geography.

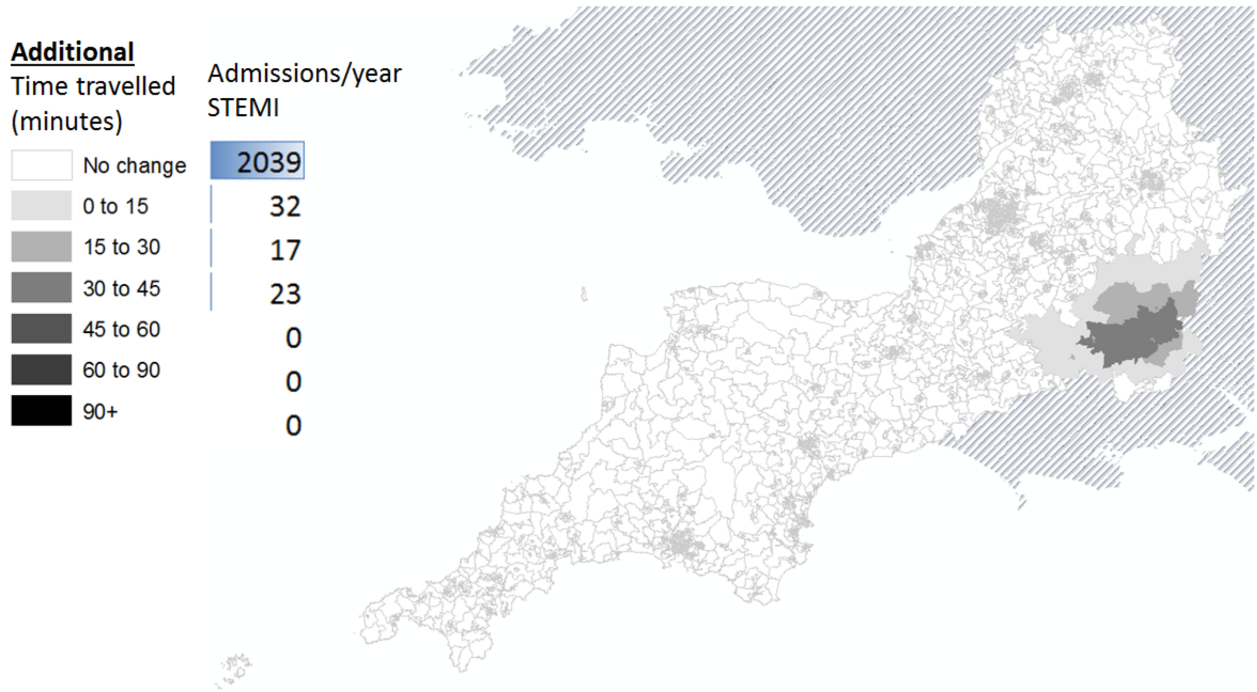


Figure 5.24 Changes in modelled ambulance travel times: 9 Heart Attack Centres

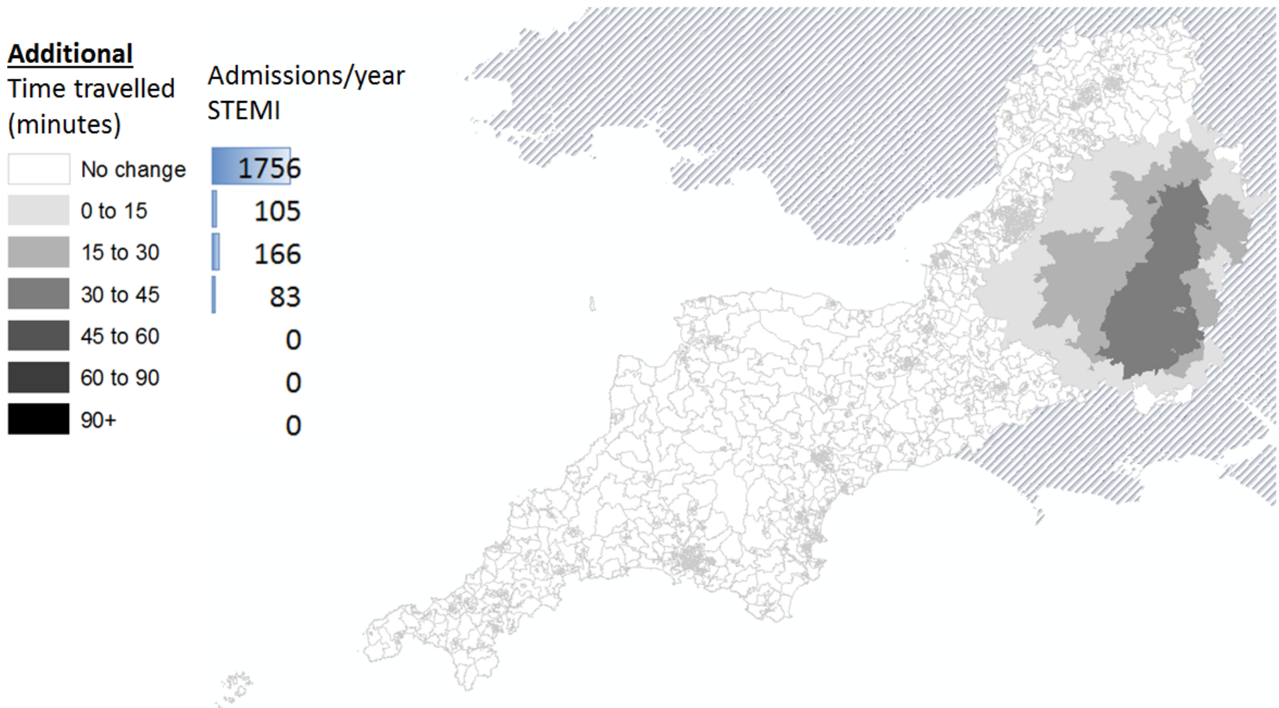


Figure 5.25 Changes in modelled ambulance travel times: 7 Heart Attack Centres

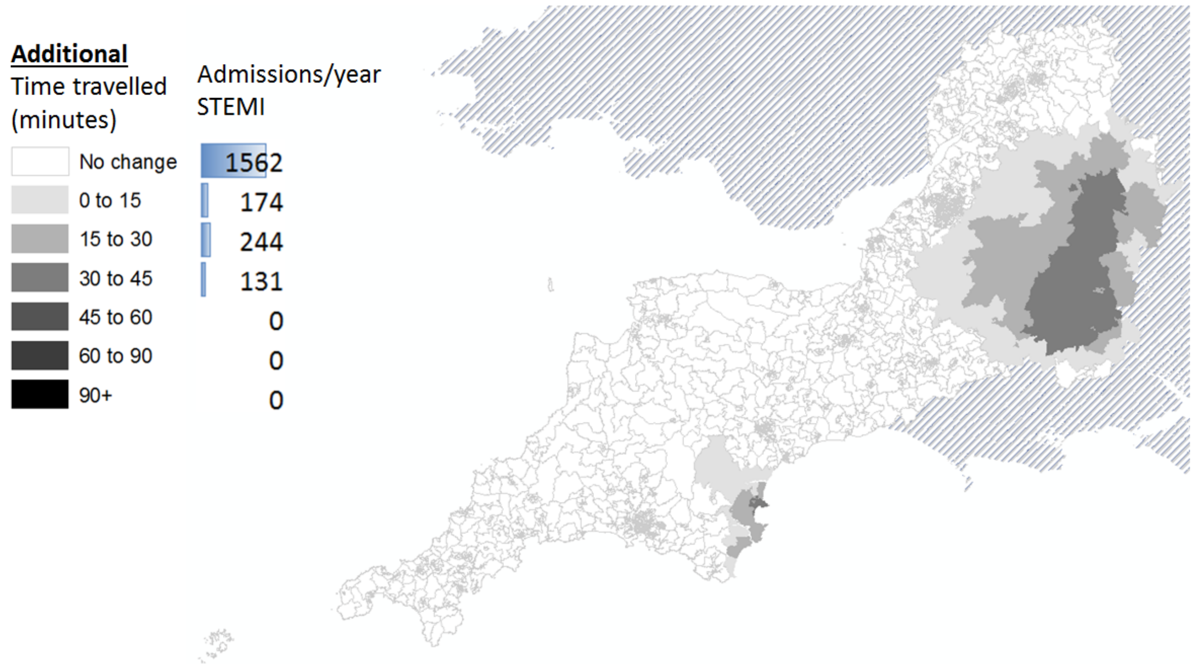


Figure 5.26 Changes in modelled ambulance travel times: 6 Heart Attack Centres

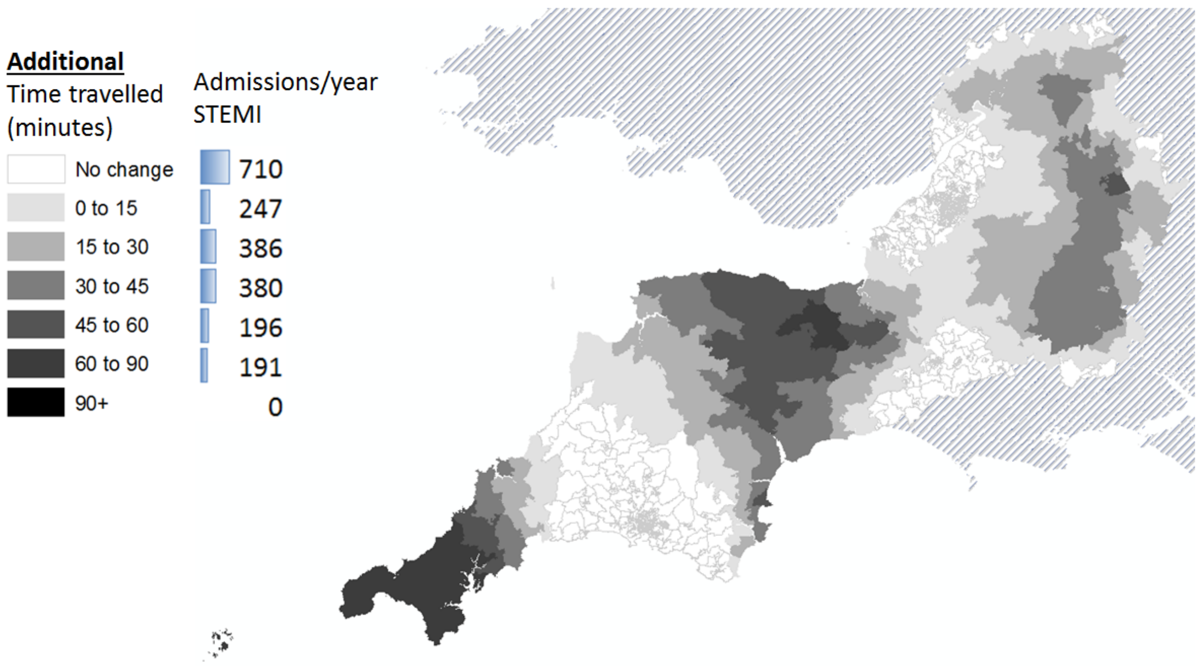


Figure 5.27 Changes in modelled ambulance travel times: 2 Heart Attack Centres

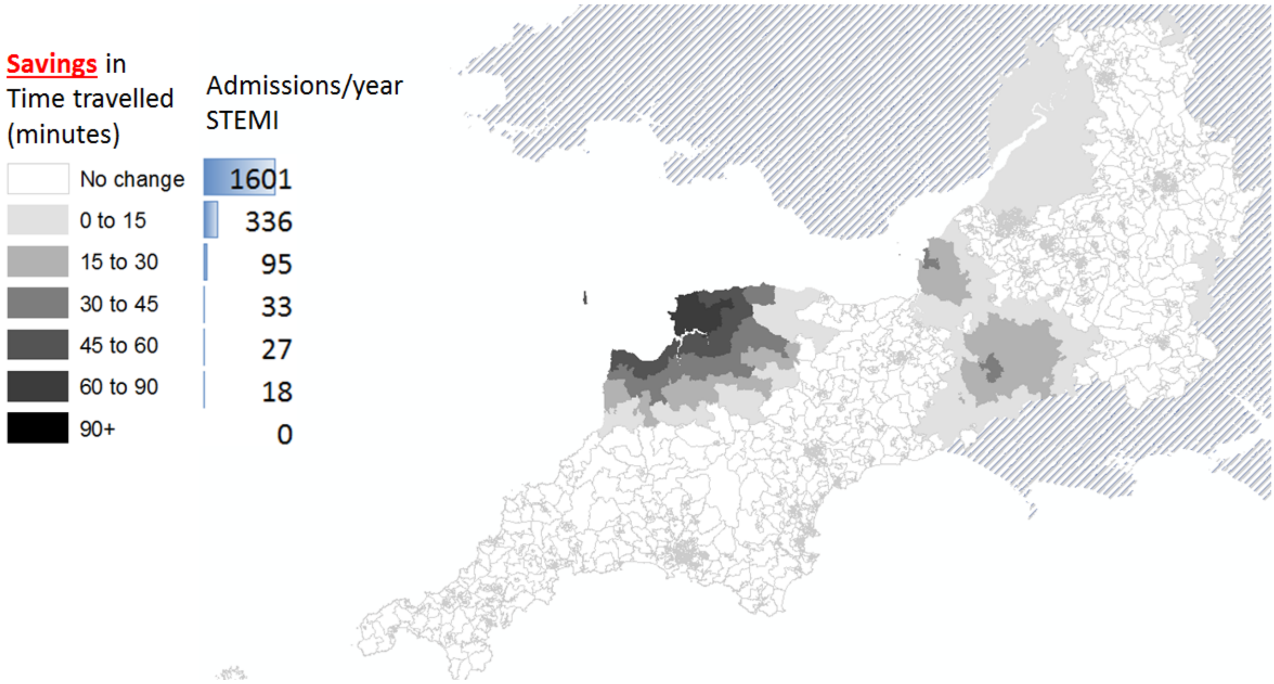


Figure 5.28 Changes in modelled ambulance travel times: 15 Heart Attack Centres

5.2 Other Catheter Laboratory Procedures

5.2.1 Catheter laboratory procedures by population, categorised by centre

We investigated whether there were geographical differences in referral/procedure rates according to which hospital a patient lives nearest to. The hypothesis under test was 'patients living nearest to an acute trust not performing a given procedure will be less likely to receive treatment with that procedure'.

The catchment population is calculated by summing the population closest to each hospital. This is different to NHS England hospital catchment populations which are calculated based on admissions (a hospital offering more procedures will have a high catchment population as it attracts patients who may live closer to another acute hospital that offers fewer procedures).

EP/Ablation

There was significant variation in the number of EP/ablation procedures carried out. While there appears to be significant variation between local populations, there appears no significant effect of whether a hospital offers a procedure on whether a patient living closest to that hospital receives treatment.

Closest Acute Hospital	Offers Ablation-EP?	Total population (000's)	65+ population (000's)	Ablation-EP admissions/year	Admissions/'000 total population	Admissions/'000 65+ population
MUSGROVE PARK HOSP		250	57	124	0.50	2.18
WESTON GENERAL HOSP		228	49	108	0.47	2.18
SALISBURY DISTRICT HOSP		159	30	67	0.42	2.19
THE GREAT WESTERN HOSP		408	69	139	0.34	2.03
BRISTOL (BRI & SOUTHMEAD)	Y (BRI)	787	124	237	0.30	1.91
DEVON & EXETER HOSP	Y	323	73	133	0.41	1.83
GLOUCESTERSHIRE HOSP		321	60	109	0.34	1.82
CHELTENHAM GENERAL HOSP		227	45	78	0.35	1.74
UNITED HOSP		436	83	134	0.31	1.62
YEOVIL DISTRICT HOSP		253	58	88	0.35	1.51
N. DEVON DISTRICT HOSP		179	43	66	0.37	1.54
DERRIFORD HOSP	Y	462	91	135	0.29	1.48
CORNWALL HOSP	Y	416	93	110	0.26	1.18
TORBAY HOSP		256	64	73	0.28	1.14
Grand Total (in region)	NA	4,704	939	1,600	0.34	1.70

Table 5.9 Geographical variation in EP/ablation procedures

Devices

There was significant variation in the number of device procedures carried out. As almost all hospitals offer device procedures it is not possible to detect any effect of provision of the procedures and the number of local people receiving treatment with that procedure.

Closest Acute Hospital	Offers Devices?	Total population (000's)	65+ population (000's)	Devices admissions/year	Admissions/'000 total population	Admissions/'000 65+ population
MUSGROVE PARK HOSP	Y	250	57	284	1.14	5.00
WESTON GENERAL HOSP		228	49	223	0.98	4.53
SALISBURY DISTRICT HOSP	Y	159	30	122	0.76	4.00
THE GREAT WESTERN HOSP	Y	408	69	358	0.88	5.22
BRISTOL (BRI & SOUTHMEAD)	Y (BRI)	787	124	462	0.59	3.72
DEVON & EXETER HOSP	Y	323	73	335	1.04	4.61
GLOUCESTERSHIRE HOSP	Y	321	60	280	0.87	4.69
CHELTENHAM GENERAL HOSP	Y	227	45	171	0.75	3.79
UNITED HOSP	Y	436	83	374	0.86	4.53
YEOVIL DISTRICT HOSP	Y	253	58	281	1.11	4.82
N. DEVON DISTRICT HOSP		179	43	183	1.03	4.28
DERRIFORD HOSP	Y	462	91	435	0.94	4.78
CORNWALL HOSP	Y	416	93	463	1.11	4.96
TORBAY HOSP	Y	256	64	224	0.88	3.51
Grand Total (in region)	NA	4,704	939	4,196	0.89	4.47

Table 5.10 Geographical variation in device procedures

Contrast radiology of the heart

There was a moderate amount variation in the number of coronary angiography procedures performed. As almost all hospitals offer angiography it is not possible to detect any effect of provision of the procedures and the number of local people receiving treatment with that procedure.

Closest Acute Hospital	Offers Contrast Radiology?	Total population (000's)	65+ population (000's)	Contrast Radiology admissions/year	Admissions/'000 total population	Admissions/'000 65+ population
MUSGROVE PARK HOSP	Y	250	57	794	3.18	13.97
WESTON GENERAL HOSP		228	49	715	3.14	14.52
SALISBURY DISTRICT HOSP	Y	159	30	567	3.56	18.64
THE GREAT WESTERN HOSP	Y	408	69	1,079	2.64	15.72
BRISTOL (BRI & SOUTHMEAD)	Y	787	124	1,644	2.09	13.24
DEVON & EXETER HOSP	Y	323	73	1,121	3.47	15.44
GLOUCESTERSHIRE HOSP	Y	321	60	994	3.10	16.65
CHELTENHAM GENERAL HOSP	Y	227	45	587	2.59	13.03
UNITED HOSP	Y	436	83	1,162	2.67	14.09
YEOVIL DISTRICT HOSP		253	58	858	3.39	14.70
N. DEVON DISTRICT HOSP		179	43	672	3.76	15.66
DERRIFORD HOSP	Y	462	91	1,326	2.87	14.57
CORNWALL HOSP	Y	416	93	1,717	4.13	18.39
TORBAY HOSP	Y	256	64	734	2.86	11.48
Grand Total (in region)	NA	4,704	939	13,970	2.97	14.88

Table 5.11 Geographical variation in diagnostic coronary angiography procedures

PPCI (STEMI-PCI)

There was very little geographical variation in the number of STEMI-PCI procedures performed.

Closest Acute Hospital	Offers non emergency PCI?	Total population (000's)	65+ population (000's)	Non emergency PCI admissions/year	Admissions/'000 total population	Admissions/'000 65+ population
MUSGROVE PARK HOSP	Y	250	57	254	1.02	4.47
WESTON GENERAL HOSP		228	49	280	1.23	5.68
SALISBURY DISTRICT HOSP	Y	159	30	239	1.50	7.84
THE GREAT WESTERN HOSP	Y	408	69	377	0.92	5.49
BRISTOL (BRI & SOUTHMEAD)	Y	787	124	685	0.87	5.52
DEVON & EXETER HOSP	Y	323	73	391	1.21	5.39
GLOUCESTERSHIRE HOSP		321	60	334	1.04	5.60
CHELTENHAM GENERAL HOSP	Y	227	45	213	0.94	4.74
UNITED HOSP	Y	436	83	436	1.00	5.28
YEOVIL DISTRICT HOSP		253	58	254	1.00	4.35
N. DEVON DISTRICT HOSP		179	43	200	1.12	4.66
DERRIFORD HOSP	Y	462	91	533	1.15	5.85
CORNWALL HOSP	Y	416	93	540	1.30	5.79
TORBAY HOSP	Y	256	64	288	1.12	4.50
Grand Total (in region)	NA	4,704	939	5,023	1.07	5.35

Table 5.12 Geographical variation in PPCI procedures

5.2.2 Other catheter laboratory procedures: actual procedure numbers vs. modelled numbers

The graphs and table below show the actual and predicted admissions for different procedure types. The predicted numbers are based on allocating all patients to their closest hospital offering that procedure. The results show that the actual admission numbers are generally in good agreement with those predicted by choosing the most local centre. Two exceptions to this rule are observed:

- Devices: Bristol perform significantly more and Yeovil perform significantly fewer device procedures than predicted geographically.
- EP/Ablation: There are generally significantly fewer procedures performed in-region than expected from modelling where patients live. This is due, at least in part, to commissioning arrangements that sends patients out of region even when an in-region EP/ablation hospital is the nearest option.

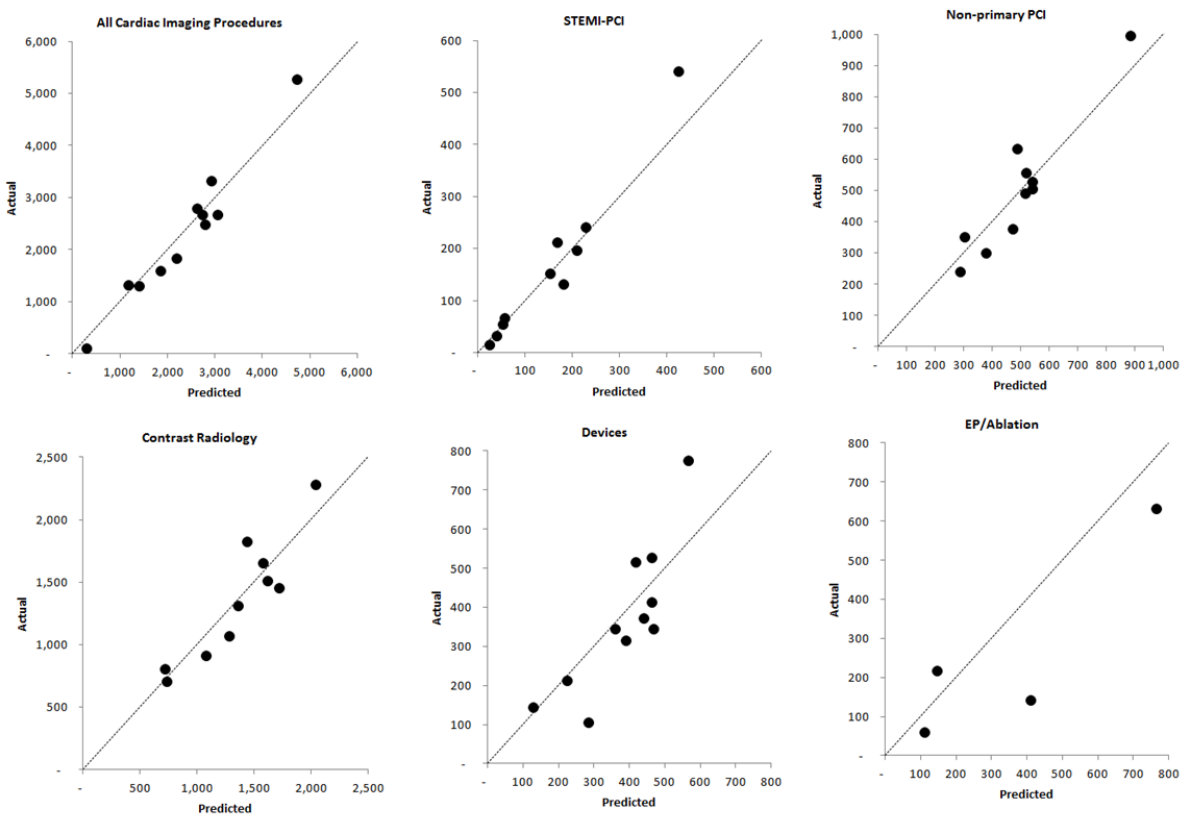


Figure 5.29 Actual versus modelled elective catheter laboratory activity by procedure

	EP/Ablation		Devices		TAVI		Contrast Radiology		All PCI		PPCI (STEMI * 0.79)		Non PPCI		All modelled		Other
	Model	Actual	Model	Actual	Model	Actual	Model	Actual	Model	Actual	Model	Actual	Model	Actual	Model	Actual	Actual
Bristol (total)	764	632	564	777	43	38	2,039	2,286	1,307	1,537	424	541	883	996	4,717	5,269	402
Exeter	409	143	418	516			1,435	1,827	655	846	167	212	488	634	2,917	3,333	23
Plymouth	146	218	441	373	38	43	1,357	1,312	747	726	209	198	538	529	2,729	2,672	213
Cheltenham&Glouc			462	527			1,581	1,657	572	613	53	55	519	558	2,615	2,797	26
Truro	110	61	463	414			1,717	1,460	768	748	228	241	540	507	3,059	2,683	50
Taunton			468	346			1,618	1,512	696	624	180	133	516	491	2,783	2,482	43
Bath			389	315			1,277	1,075	528	445	57	68	472	377	2,195	1,835	125
Swindon			360	346			1,079	918	416	336	39	34	377	302	1,855	1,600	16
Salisbury			128	146			717	808	327	368	25	17	302	351	1,172	1,322	47
Torbay			224	214			734	707	441	394	153	153	288	242	1,399	1,315	15
Yeovil			283	106											283	106	1
Weston																	
Barnstaple																	
Total	**1,429**	**1,054**	**4,201**	**4,080**	**81**	**81**	**13,554**	**13,562**	**6,457**	**6,637**	**1,535**	**1,651**	**4,922**	**4,986**	**25,723**	**25,414**	**961**
Out of region	**197**		**54**		**14**		**632**		**332**		**133**		**199**		**1,229**		
% Out of region if closest centre used*	**14%**		**1%**		**17%**		**5%**		**5%**		**9%**		**4%**		**5%**		

* Assumes current locations of specific activities out of region continues unchanged

Breakdown of PCI (actual)

Emergency primary diag MI	22.9%
Transfer primary diag MI	1.8%
Emergency non primary diag MI	39.7%
Transfer non primary diag MI	3.4%
Elective	32.2%

23% PPCI. Non-PPCI splits 43% elective, 57% emergency

Table 5.13 Modelled and actual catheter laboratory annual activity by procedure and by centre

The maps below show the current travel times and admission numbers if patients attended their closest hospital that currently performs any given procedure.

5.2.3 TAVI

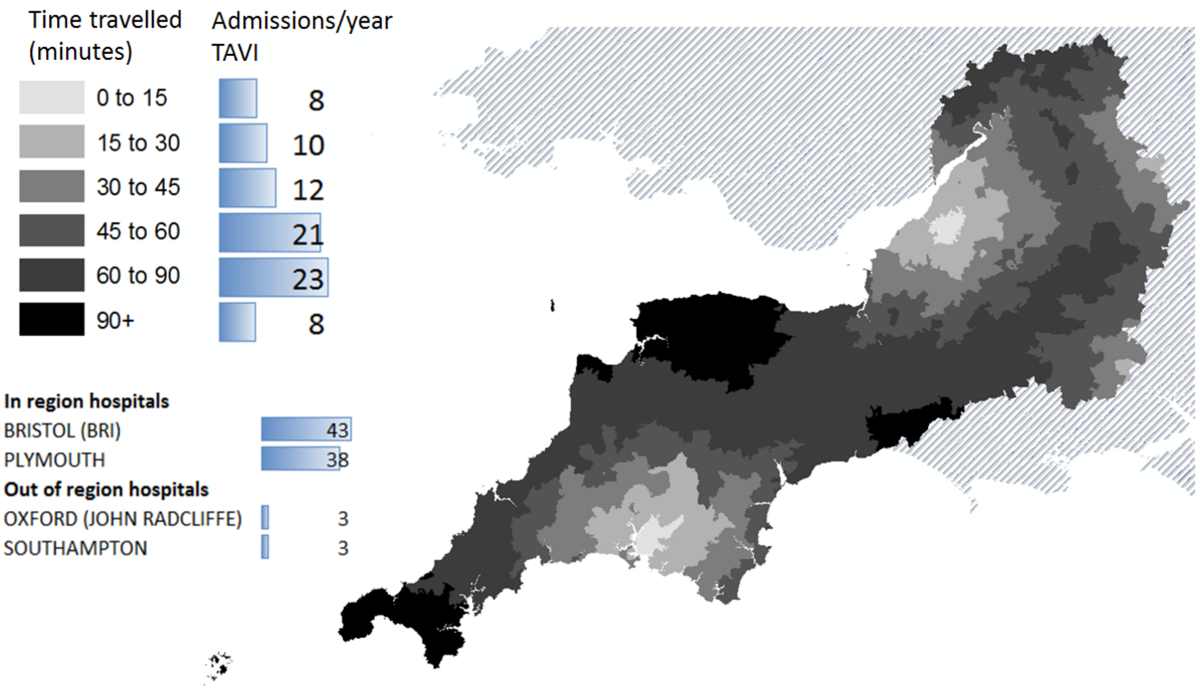


Figure 5.30 Modelled ambulance travel times to centres offering TAVI

5.2.4 Electrophysiology (EP)/Ablation

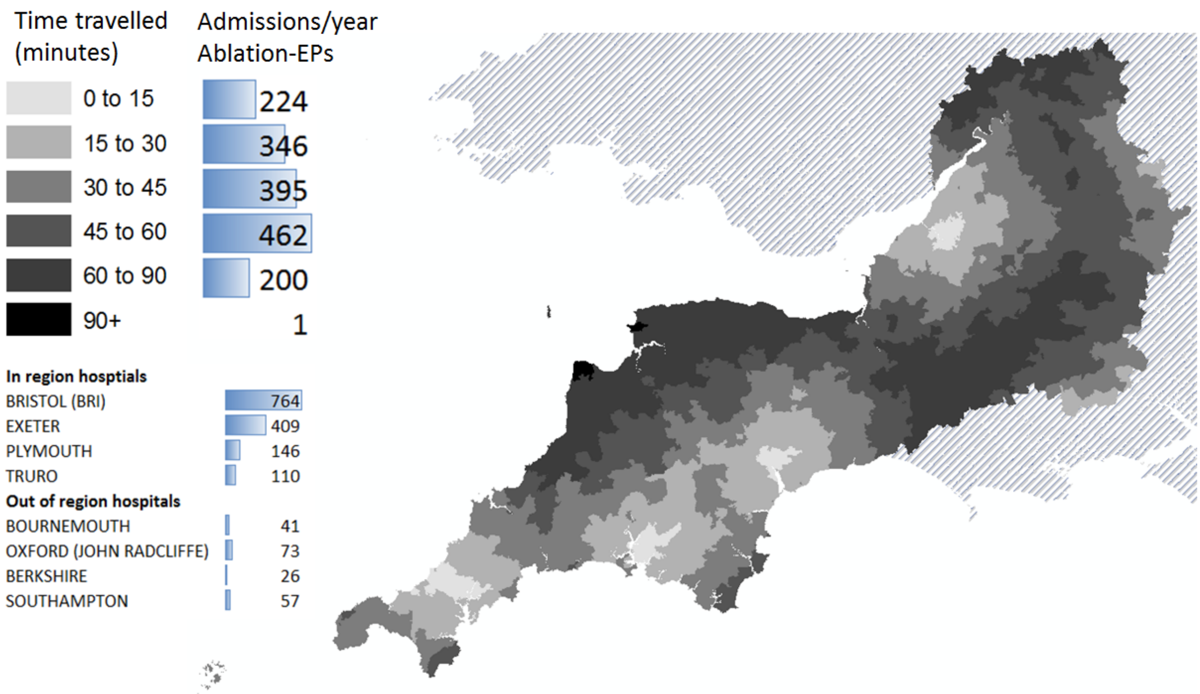


Figure 5.31 Modelled ambulance travel times to centres offering ablation/electrophysiology

5.2.5 Non-emergency PCI

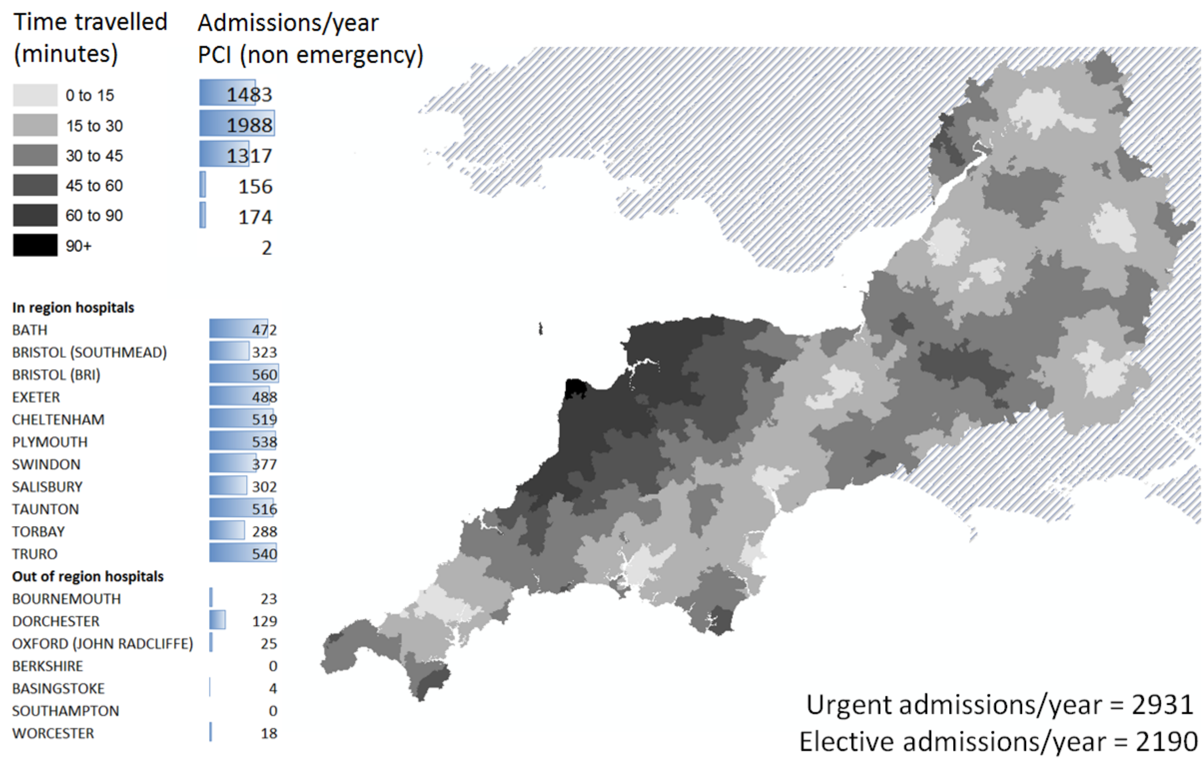


Figure 5.32 Modelled ambulance travel times to centres offering non-emergency PCI

5.2.6 Contrast radiology of the heart (diagnostic coronary angiography)

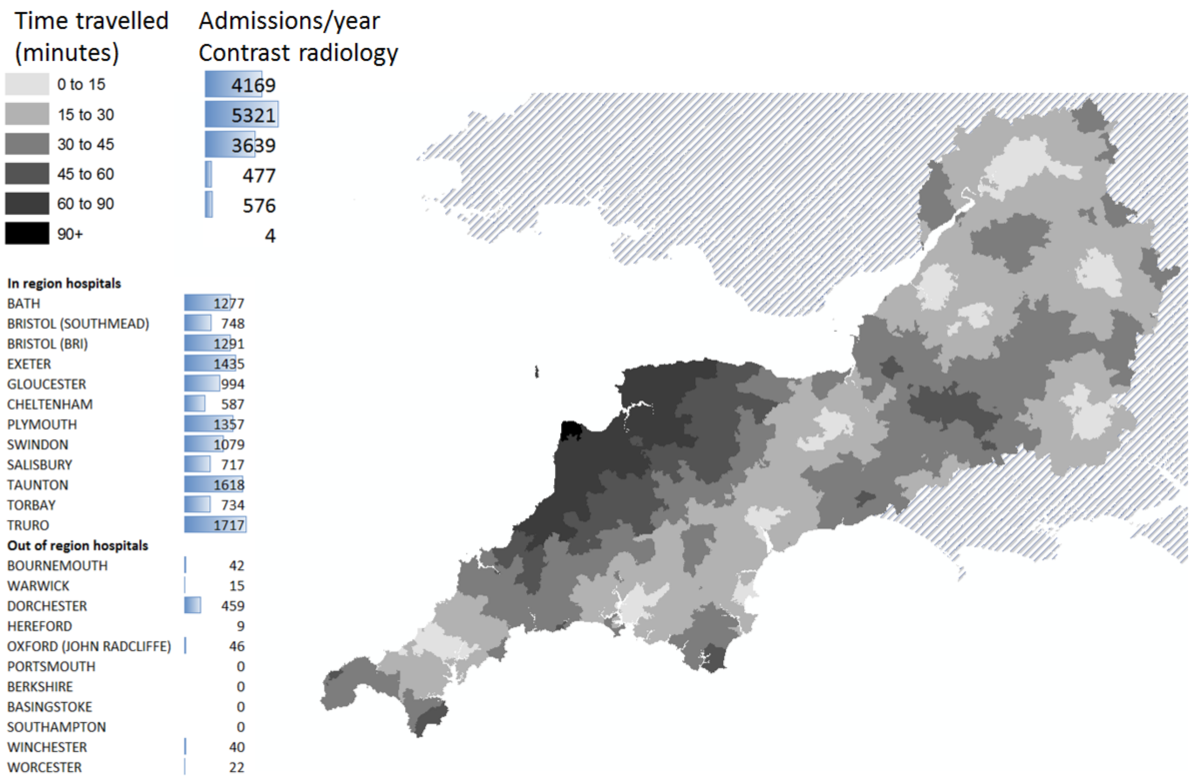


Figure 5.33 Modelled ambulance travel times to centres offering contrast radiology of the heart (diagnostic coronary angiography)

5.2.7 Device implantation

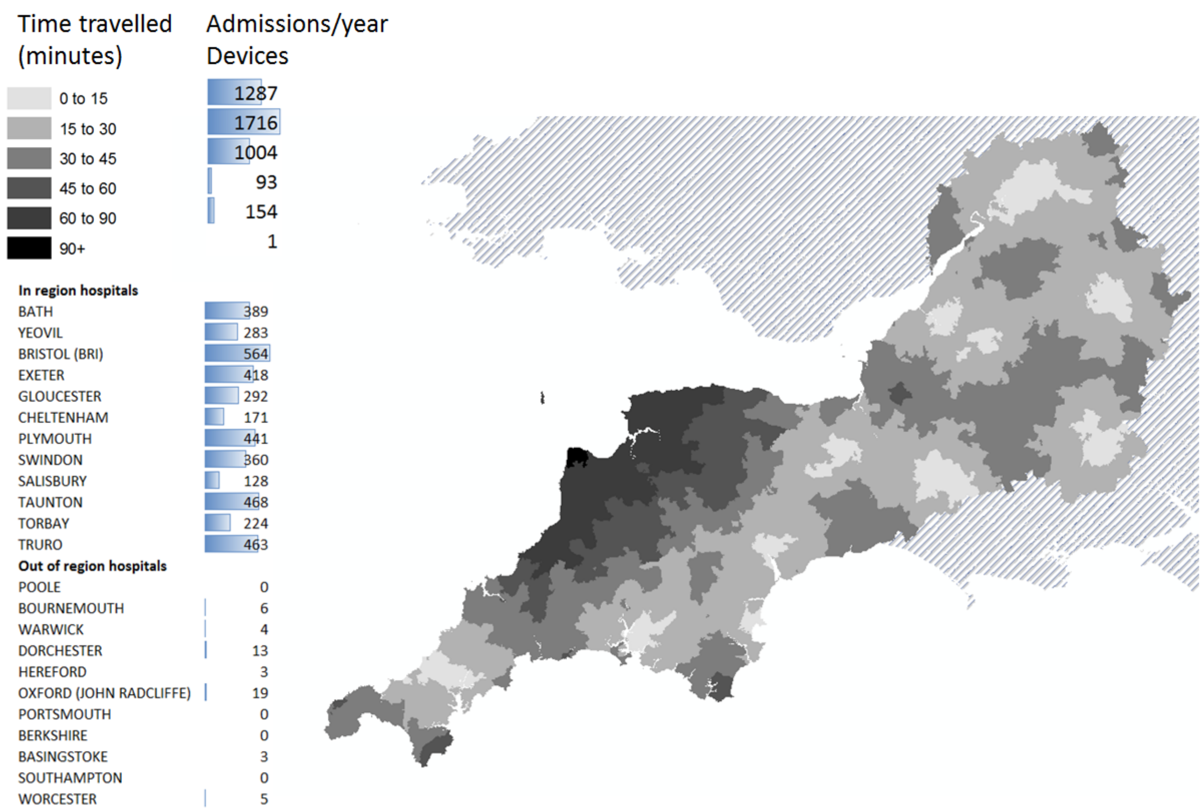


Figure 5.34 Modelled ambulance travel times to centres offering device implantation

5.3 Catheter Laboratory Capacity

5.3.1 Estimating catheter laboratory elective demand and capacity

In one four hour session we assume that the following numbers of procedures may be completed (if the session is used for one procedure type only). These procedure times were as advised by the project steering committee:

- PCI (inc. PPCI) = 3/session = 80min
- Angiography/contrast radiology = 6/session = 40min
- Devices:
    - Permanent pacemaker (PPM: 73.4% devices*) = 3/session = 80min
    - Implantable cardioverter-defibrillator (ICD: 8.6% devices*) = 3/session = 80min
    - Cardiac resynchronisation therapy (CRT: 18.0% devices*) = 1.6/session = 150min
    - Devices weighted average = 93 min
- TAVI = 2/session= 120 min
- Electrophysiological studies/ablation= 1.5/session = 160 min
- Other = 100 min.

**Breakdown of devices comes from NICOR data for all England (2013/2014 report)*

Based on the actual (HES) or modelled (based on geography of patients in HES) number of procedures the estimated catheter lab usage time is as follows:

	EP/Ablation		Devices		TAVI		Contrast Radiology		Non PPCI		Sum of all Cath lab hours minus PPCI		PPCI (STEMI * 0.79)		Other
	Model	Actual	Model	Actual	Model	Actual	Model	Actual	Model	Actual	Model	Actual	Model	Actual	Actual
Bristol (total)	24	20	17	23	2	1	26	29	23	26	92	100	11	14	15
Exeter	13	5	12	15	-	-	18	23	13	16	56	60	4	5	1
Plymouth	5	7	13	11	1	2	17	17	14	14	50	50	5	5	8
Cheltenham&Glouc	-	-	14	16	-	-	20	21	13	14	47	51	1	1	1
Truro	4	2	14	12	-	-	22	19	14	13	53	46	6	6	2
Taunton	-	-	14	10	-	-	21	19	13	13	48	42	5	3	2
Bath	-	-	12	9	-	-	16	14	12	10	40	33	1	2	5
Swindon	-	-	11	10	-	-	14	12	10	8	34	30	1	1	1
Salisbury	-	-	4	4	-	-	9	10	8	9	21	24	1	0	2
Torbay	-	-	7	6	-	-	9	9	7	6	23	22	4	4	1
Yeovil	-	-	8	3	-	-	-	-	-	-	8	3	-	-	0
Weston	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Barnstaple	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	**46**	**34**	**125**	**121**	**3**	**3**	**174**	**174**	**126**	**128**	**474**	**460**	**39**	**42**	**37**

Table 5.14 Hours per week of catheter laboratory usage (based on modelled and actual activity) by procedure and by centre

To estimate cath lab activity during core hours we assume all work other than PPCI is carried out during nine four-hour lab sessions each week. PPCI for patients arriving in core hours (~43% all PPCI) are then also added in to the core hour estimates. With these assumptions we find cath lab utilisation to range from 36% to 92%. These should be seen as general approximations, though it is clear that cath lab utilisation varies significantly between trusts, with Plymouth appearing to be under greatest pressure.

	All modelled Cath lab hours minus PPCI		Other	PPCI in elective times		All elective + other + PPCI in elective hours (inc 10% DNA on elective)		Cath Labs*	Elective hrs per week (9 x 4hr sessions per week)	Estimated actual core hour Cath lab utilisation
	Model	Actual	Actual	Model	Actual	Model	Actual			
Bristol (total)	92	100	15.5	3.3	4.3	121	131	5	180	73%
Exeter	56	60	0.9	1.8	2.3	65	69	3	108	64%
Plymouth	50	50	8.2	2.3	2.2	67	66	2	72	92%
Cheltenham&Glouc	47	51	1.0	1.4	1.4	54	59	2	72	82%
Truro	53	46	1.9	2.5	2.7	63	55	2	72	77%
Taunton	48	42	1.7	1.7	1.3	56	50	2	72	69%
Bath	40	33	4.8	1.5	1.7	51	43	2	72	60%
Swindon	34	30	0.6	1.0	0.9	39	34	2	72	48%
Salisbury	21	24	1.8	0.6	0.4	25	28	2	72	40%
Torbay	23	22	0.6	1.7	1.7	28	26	2	72	36%
Yeovil	8	3	0.0	-	-	9	3			
Weston	-	-	-	-	-	-	-			
Barnstaple	-	-	-	-	-	-	-			
Total	**474**	**460**	**31**			**580**	**565**	**24**	**864**	**65%**

*Taunton, Plymouth, Torbay and North Bristol also have pacing lab, but procedure numbers/times do not include procedures not using approach under image control. Yeovil deliver pacing work in X-Ray

Table 5.15 Modelled and actual catheter laboratory capacity and usage during core hours

5.3.2 STEMI-PCI catheter laboratory time for selected configurations

Cath lab hours are based on modelled STEMI-PCI procedures (based on HES data).

The tables below show predicted STEMI-PCI Cath Lab time, time just during core hours (Monday-Fri 8am-6pm when pressure on Cath labs is at their highest) and changes in Cath lab hours. Following advice from the project steering committee a procedure time of 80 minutes per PCI was adopted.

With centralisation to as few as 6 centres the changes on STEMI-PCI Cath lab time is limited, with a maximum increase in Cath lab usage of less than 2 hours per week during core hours. A two centre solution would have a much larger effect – with 6 extra hours per week, in core hours, required at Plymouth.

CATH LAB TIME (Hours per week)				All hospitals full time					
		Historic mix full/part	Chelt to full time	10	9	7	6	2	15
In-region acute trusts currently offering PPCI	BRISTOL INFIRMARY	10.9	10.0	7.8	7.8	11.6	11.6	15.5	3.6
	DERRIFORD HOSP	5.4	5.4	5.4	5.4	5.4	5.6	19.8	5.3
	CHELTENHAM GENERAL HOSP	1.4	4.1	3.1	3.1	4.8	4.8	-	1.4
	MUSGROVE PARK HOSP	4.6	4.6	4.0	4.0	4.1	4.1	-	2.1
	CORNWALL HOSP	5.8	5.8	5.8	5.8	5.8	5.8	-	5.8
	DEVON & EXETER HOSP	4.3	4.3	4.3	4.3	4.3	7.9	-	3.4
	TORBAY HOSP	3.9	3.9	3.9	3.9	3.9	-	-	3.9
	THE GREAT WESTERN HOSP	1.0	1.0	2.4	2.7	-	-	-	2.3
	UNITED HOSP	1.5	1.5	3.4	3.5	-	-	-	3.1
	SALISBURY DISTRICT HOSP	0.6	0.6	1.5	-	-	-	-	1.1
In-region acute trusts currently not offering PPCI	GLOUCESTERSHIRE HOSP	-	-	-	-	-	-	-	1.8
	N. DEVON DISTRICT HOSP	-	-	-	-	-	-	-	1.7
	SOUTHMEAD HOSP	-	-	-	-	-	-	-	2.9
	WESTON GENERAL HOSP	-	-	-	-	-	-	-	2.1
	YEOVIL DISTRICT HOSP	-	-	-	-	-	-	-	1.7
Out-of-region acute trusts currently offering PPCI (SW patients only)	DORSET COUNTY HOSPITAL	0.4	0.4	0.9	1.1	1.3	1.3	2.6	0.1
	WORCESTERSHIRE HOSPITAL	1.5	0.2	0.2	0.2	0.2	0.2	2.6	0.1
	JOHN RADCLIFFE HOSP	0.7	0.2	0.1	0.1	0.3	0.3	1.1	0.1
	THE BOURNEMOUTH HOSPITAL	0.3	0.3	0.1	0.2	0.2	0.2	0.2	0.1
	SOUTHAMPTON GENERAL HOSP	0.5	0.5	-	0.6	0.9	0.9	0.9	-
Total out of region		3.4	1.6	1.3	2.2	2.9	2.9	7.4	0.4

Model validation suggests that Bristol may attract ~3 hours per week more PPCI time than predicted by geographical modelling.

Cath lab hours are for full week. Hours use in core hours (Mon-Fri 8am-6pm) are ~43% total admissions

Table 5.16 Total catheter laboratory usage for PPCI for the selected configurations

CATH LAB TIME (Hours per week, core time Mon-Fri 8am-6pm)

		Historic mix full/part	Chelt to full time	All hospitals full time					
				10	9	7	6	2	15
In-region acute trusts currently offering PPCI	BRISTOL INFIRMARY	3.3	3.3	3.3	3.3	5.0	5.0	6.7	1.5
	DERRIFORD HOSP	2.3	2.3	2.3	2.3	2.3	2.4	8.6	2.3
	CHELTENHAM GENERAL HOSP	1.4	1.4	1.3	1.3	2.1	2.1	-	0.6
	MUSGROVE PARK HOSP	1.7	1.7	1.7	1.7	1.7	1.7	-	0.9
	CORNWALL HOSP	2.5	2.5	2.5	2.5	2.5	2.5	-	2.5
	DEVON & EXETER HOSP	1.8	1.8	1.8	1.8	1.8	3.4	-	1.5
	TORBAY HOSP	1.7	1.7	1.7	1.7	1.7	-	-	1.7
	THE GREAT WESTERN HOSP	1.0	1.0	1.0	1.2	-	-	-	1.0
	UNITED HOSP	1.5	1.5	1.5	1.5	-	-	-	1.3
	SALISBURY DISTRICT HOSP	0.6	0.6	0.6	-	-	-	-	0.5
In-region acute trusts currently not offering PPCI	GLOUCESTERSHIRE HOSP	-	-	-	-	-	-	-	0.8
	N. DEVON DISTRICT HOSP	-	-	-	-	-	-	-	0.7
	SOUTHMEAD HOSP	-	-	-	-	-	-	-	1.2
	WESTON GENERAL HOSP	-	-	-	-	-	-	-	0.9
	YEOVIL DISTRICT HOSP	-	-	-	-	-	-	-	0.7
Out-of-region acute trusts currently offering PPCI (SW patients only)	DORSET COUNTY HOSPITAL	0.4	0.4	0.4	0.5	0.6	0.6	1.1	0.0
	WORCESTERSHIRE HOSPITAL	0.1	0.1	0.1	0.1	0.1	0.1	1.1	0.1
	JOHN RADCLIFFE HOSP	0.0	0.0	0.0	0.0	0.1	0.1	0.5	0.0
	THE BOURNEMOUTH HOSPITAL	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0
	SOUTHAMPTON GENERAL HOSP	-	-	-	0.3	0.4	0.4	0.4	-
Total out of region		-	-	0.5	1.0	1.3	1.3	3.2	0.2

Model validation suggests that Bristol may attract ~3 hours per week more PPCI time than predicted by geographical modelling.

Table 5.17 Catheter laboratory usage for PPCI during core hours for the selected configurations

CATH LAB TIME (Change in hours per week in core hours. Mon-Fri 8am-6pm)

		Historic mix full/part	Chelt to full time	All hospitals full time					
				10	9	7	6	2	15
In-region acute trusts currently offering PPCI	BRISTOL INFIRMARY	-	-	-	-	1.7	1.7	3.3	- 1.8
	DERRIFORD HOSP	-	-	-	-	-	0.1	6.2	-
	CHELTENHAM GENERAL HOSP	-	-	-	-	0.7	0.7	- 1.4	- 0.8
	MUSGROVE PARK HOSP	-	-	-	-	-	-	- 1.7	- 0.9
	CORNWALL HOSP	-	-	-	-	-	-	- 2.5	-
	DEVON & EXETER HOSP	-	-	-	-	-	1.6	- 1.8	- 0.4
	TORBAY HOSP	-	-	-	-	-	- 1.7	- 1.7	-
	THE GREAT WESTERN HOSP	-	-	-	0.2	- 1.0	- 1.0	- 1.0	-
	UNITED HOSP	-	-	-	0.1	- 1.5	- 1.5	- 1.5	- 0.1
	SALISBURY DISTRICT HOSP	-	-	-	- 0.6	- 0.6	- 0.6	- 0.6	- 0.2
In-region acute trusts currently not offering PPCI	GLOUCESTERSHIRE HOSP	-	-	-	-	-	-	-	0.8
	N. DEVON DISTRICT HOSP	-	-	-	-	-	-	-	0.7
	SOUTHMEAD HOSP	-	-	-	-	-	-	-	1.2
	WESTON GENERAL HOSP	-	-	-	-	-	-	-	0.9
	YEOVIL DISTRICT HOSP	-	-	-	-	-	-	-	0.7
Out-of-region acute trusts currently offering PPCI (SW patients only)	DORSET COUNTY HOSPITAL	-	-	-	0.1	0.2	0.2	0.7	- 0.3
	WORCESTERSHIRE HOSPITAL	-	-	-	-	-	-	1.0	-
	JOHN RADCLIFFE HOSP	-	-	-	-	0.1	0.1	0.4	-
	THE BOURNEMOUTH HOSPITAL	-	-	-	-	-	-	-	-
	SOUTHAMPTON GENERAL HOSP	-	-	-	0.3	0.4	0.4	0.4	-
Total out of region		-	-	0.5	1.0	1.3	1.3	3.2	0.2

Table 5.18 Net catheter laboratory usage for PPCI during core hours for the selected configurations

5.4 Forecast demographic growth in STEMI

The table below uses regional population forecasts from the Office of National Statistics, coupled with the age breakdown of patients with a primary diagnosis of STEMI (from HES). If there are no other changes (such as improvements in prevention or lifestyle) the forecast demographic shift in the South West population would be expected to increase STEMI rates by ~18% over 10 years.

Age Band	Rate of STEMI (per '000)	Forecast Regional Population (SW)						Forecast Incidence of STEMI					
		2012	2015	2020	2025	2030	2035	2012	2015	2020	2025	2030	2035
0 - 4 years	0.00	265	270	274	273	271	271	0	0	0	0	0	0
5 - 9 years	0.00	246	265	281	283	283	281	0	0	0	0	0	0
10 - 14 years	0.00	250	244	274	290	292	292	0	0	0	0	0	0
15 - 19 years	0.00	281	274	255	287	302	305	0	0	0	0	0	0
20 - 24 years	0.00	294	296	287	270	303	318	0	0	0	0	0	0
25 - 29 years	0.00	269	281	289	279	265	295	0	0	0	0	0	0
30 - 34 years	0.00	264	272	286	293	283	269	0	0	0	0	0	0
35 - 39 years	0.06	266	261	281	294	301	291	17	17	18	19	19	19
40 - 44 years	0.17	319	294	268	288	301	308	54	50	45	49	51	52
45 - 49 years	0.36	341	333	298	272	293	306	122	119	107	97	105	109
50 - 54 years	0.59	313	336	337	302	277	298	185	199	199	179	164	176
55 - 59 years	0.71	281	298	338	340	307	282	200	212	240	241	218	200
60 - 64 years	0.87	293	278	299	341	343	311	255	242	261	297	299	271
65 - 69 years	0.88	282	302	274	296	339	342	247	264	240	260	297	300
70 - 74 years	1.10	203	232	288	263	285	327	224	256	318	290	315	362
75 - 79 years	1.15	167	178	212	265	243	266	192	204	243	303	279	305
80 - 84 years	1.70	130	134	151	182	230	214	221	229	257	310	392	364
85 - 89 years	1.84	83	87	99	115	143	182	152	160	181	212	262	335
90+ years	2.11	48	54	66	83	106	138	101	114	138	174	223	290
All ages		4,595	4,688	4,853	5,016	5,166	5,294	1,970	2,065	2,247	2,432	2,623	2,783
								Projected growth from 2012:	5%	14%	23%	33%	41%

Table 5.19 Forecast growth in emergency STEMI admissions, 2012-2035

5.5 Hyperacute Stroke

5.5.1 Emergency stroke admissions by home location and hospital

95% of patients attend either their closest hospital or a hospital that is no more than 5 miles further than their closest hospital (treating the two Bristol hospitals as a combined Bristol location). It is therefore a reasonable assumption in the modelling that people will attend a hospital local to their home address (this assumption is further tested in model validation below).

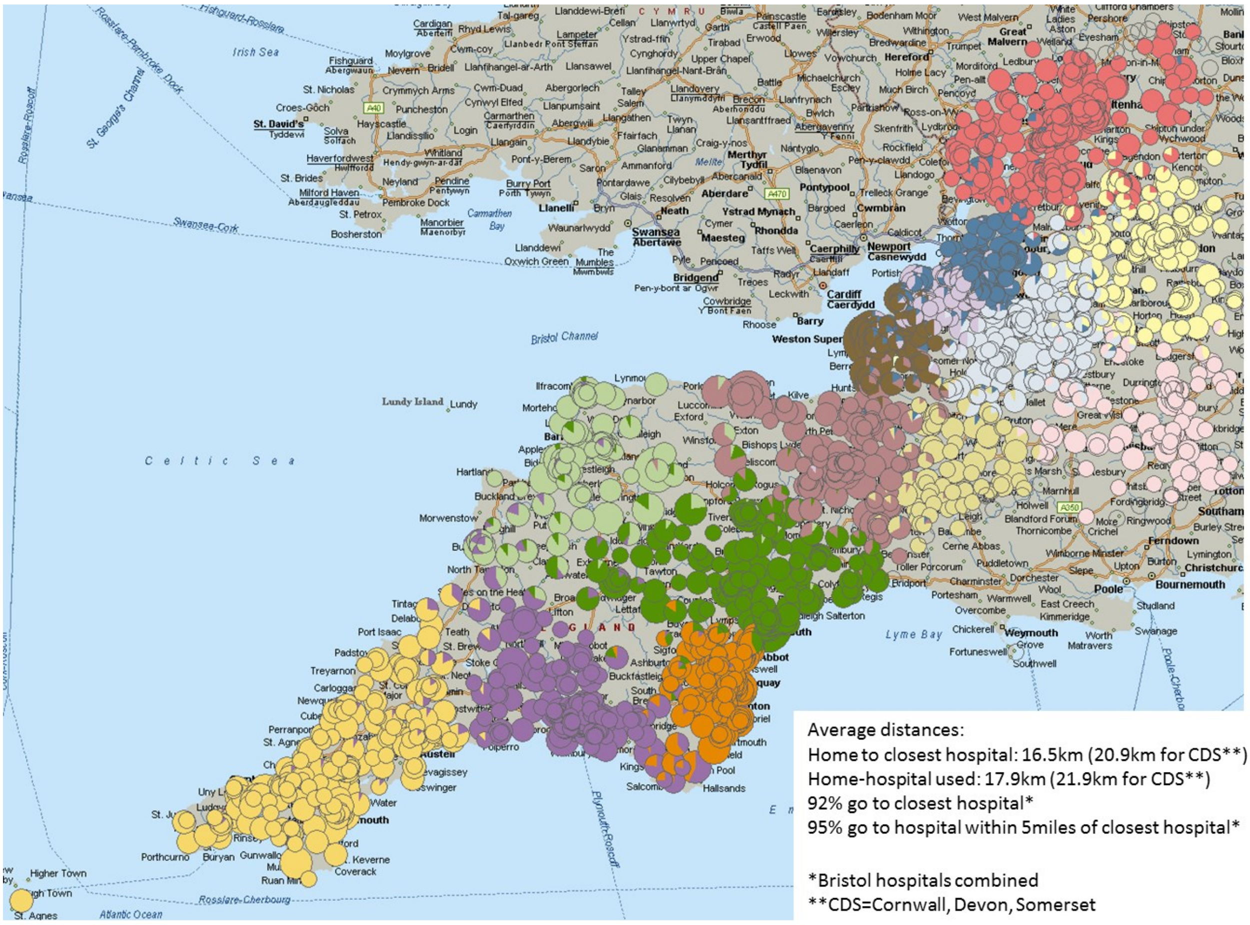


Figure 5.35 Emergency stroke admissions by patient home location and hospital attended

The closest (shortest travel time) hospital estimated by MapPoint travel times is shown below.

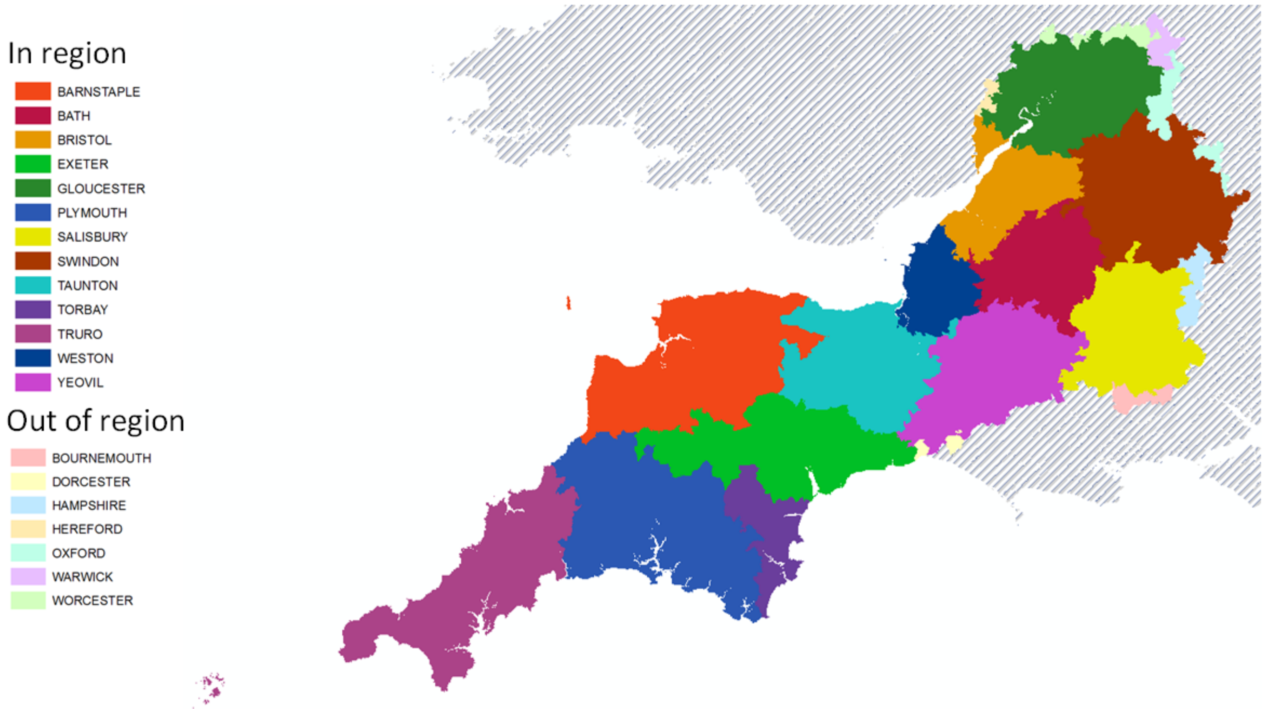


Figure 5.36 Nearest acute stroke hospital by road travel time

5.5.2 Stroke admissions from outside the region

Overall 6.3% of stroke admissions come from patients registered to a GP not in the South West region. Similarly to STEMI admissions, Salisbury and Yeovil take the highest proportion of out of region patients (25% and 24%) respectively. The model has been set-up to include all those patients who live closest to a hospital within region, rather than just the patients registered to a GP within the region.

	All patients	Regional patients	% Out of region
BRISTOL (TOTAL)	1,149	1,098	4.5%
GLOUCESTERSHIRE HOSPS NHSFT	784	741	5.5%
PLYMOUTH HOSPS NHST	784	759	3.2%
ROYAL CORNWALL HOSPS NHST	742	708	4.6%
ROYAL DEVON & EXETER NHSFT	660	634	3.9%
ROYAL UNITED HOSPS BATH NHSFT	624	595	4.6%
S. DEVON H.C. NHSFT	569	540	5.2%
TAUNTON & SOMERSET NHSFT	554	538	2.9%
GREAT WESTERN HOSPS NHSFT	488	448	8.3%
NORTHERN DEVON H.C. NHST	374	360	3.8%
SALISBURY NHSFT	327	245	25.0%
YEOVIL DISTRICT HOSP NHSFT	321	243	24.3%
WESTON AREA HEALTH NHST*	270	252	6.6%

Table 5.20 Out-of-region emergency stroke admissions by centre

*Weston-super-Mare open 24/7 in the model, but part-time in reality

5.5.3 Comparison of HES and SSNAP data

HES data was cross-checked against data from SSNAP. There is a close agreement on the total regional number of incident strokes: 7,647 and 7,624 per year, but small individual differences between HES and SSNAP exist. Taunton, for example, has 13% fewer stroke admissions in HES than are recorded in SSNAP, whereas Weston General Hospital has 18% more admissions in HES than in SSNAP.

The results in this report use the results directly output from the model (based on HES data for patients with stroke as the primary diagnosis/procedure) and based on the comparison, no adjustment in the number of incident cases is required to calibrate the HES results to SSNAP.

	HES[1]	SSNAP[2]
BRISTOL (TOTAL)	1,149	1,083
GLOUCESTERSHIRE HOSPS NHSFT	784	831
PLYMOUTH HOSPS NHST	784	751
ROYAL CORNWALL HOSPS NHST	742	735
ROYAL DEVON & EXETER NHSFT	660	624
ROYAL UNITED HOSPS BATH NHSFT	624	602
S. DEVON H.C. NHSFT	569	614
TAUNTON & SOMERSET NHSFT	554	634
GREAT WESTERN HOSPS NHSFT	488	450
NORTHERN DEVON H.C. NHST	374	387
SALISBURY NHSFT	327	351
YEOVIL DISTRICT HOSP NHSFT	321	337
WESTON AREA HEALTH NHST*	270	229
TOTAL	7,647	7,624

[1]HES: Emergency admissions per year 2012-2014
[2]SSNAP Admissions per year April 2013 to March 2015
*Weston-Super-Mare open 24/7 in the model, but part-time in reality

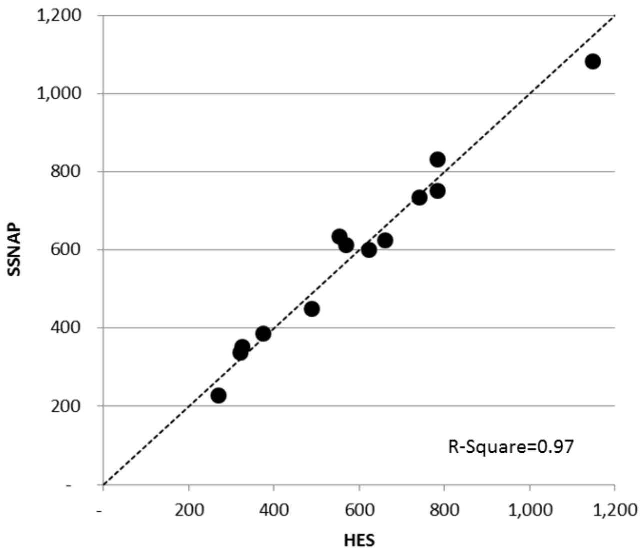


Figure 5.37 Comparison of emergency stroke admissions data from HES and SSNAP

5.5.4 Model validation

For validation of the model all current acute stroke hospitals were taken as open in the model and treated as though they all operate 24/7 (not presently the case for Weston-super-Mare).

There is an very high correlation (R^2=0.89) between predicted and actual admissions. We note that both Weston and Yeovil receive ~150 fewer patients per year than modelled. For Weston, this is due to it operating part-time. Out of hours these patients are taken to Bristol by prior arrangement. Bristol and Exeter both receive ~100 more patients per year than modelled. This may be due to these centres attracting more patients or due to commuting into the city for work, or other considerations. The under-prediction should be borne in mind when predicting likely outcomes of any service reconfiguration.

	Model	Actual
BRISTOL (TOTAL)	1,045	1,149
GLOUCESTERSHIRE HOSPS NHSFT	717	784
PLYMOUTH HOSPS NHST	750	784
ROYAL CORNWALL HOSPS NHST	729	742
ROYAL DEVON & EXETER NHSFT	548	660
ROYAL UNITED HOSPS BATH NHSFT	680	624
S. DEVON H.C. NHSFT	550	569
TAUNTON & SOMERSET NHSFT	528	554
GREAT WESTERN HOSPS NHSFT	532	488
NORTHERN DEVON H.C. NHST	406	374
SALISBURY NHSFT	246	327
YEOVIL DISTRICT HOSP NHSFT	465	321
WESTON AREA HEALTH NHST*	426	270

*Weston open 24/7 in model, but part time in reality.

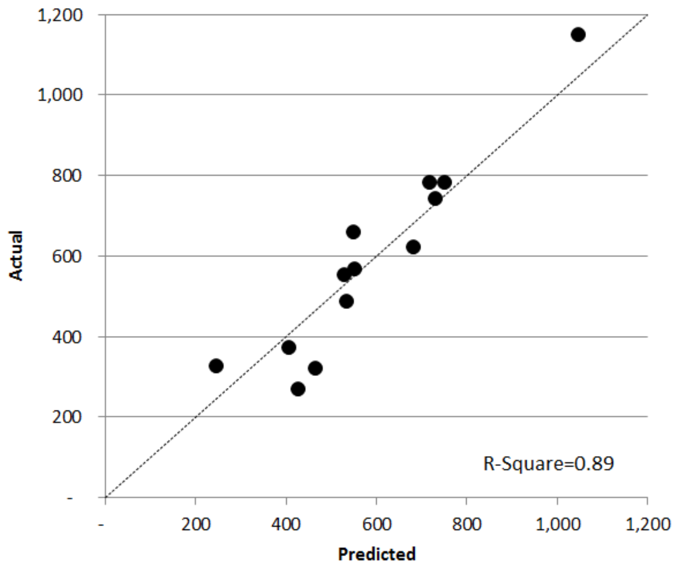


Figure 5.38 Model validation: predicted versus actual emergency stroke admissions

5.5.5 Relationship between the number of HASUs and average travel time

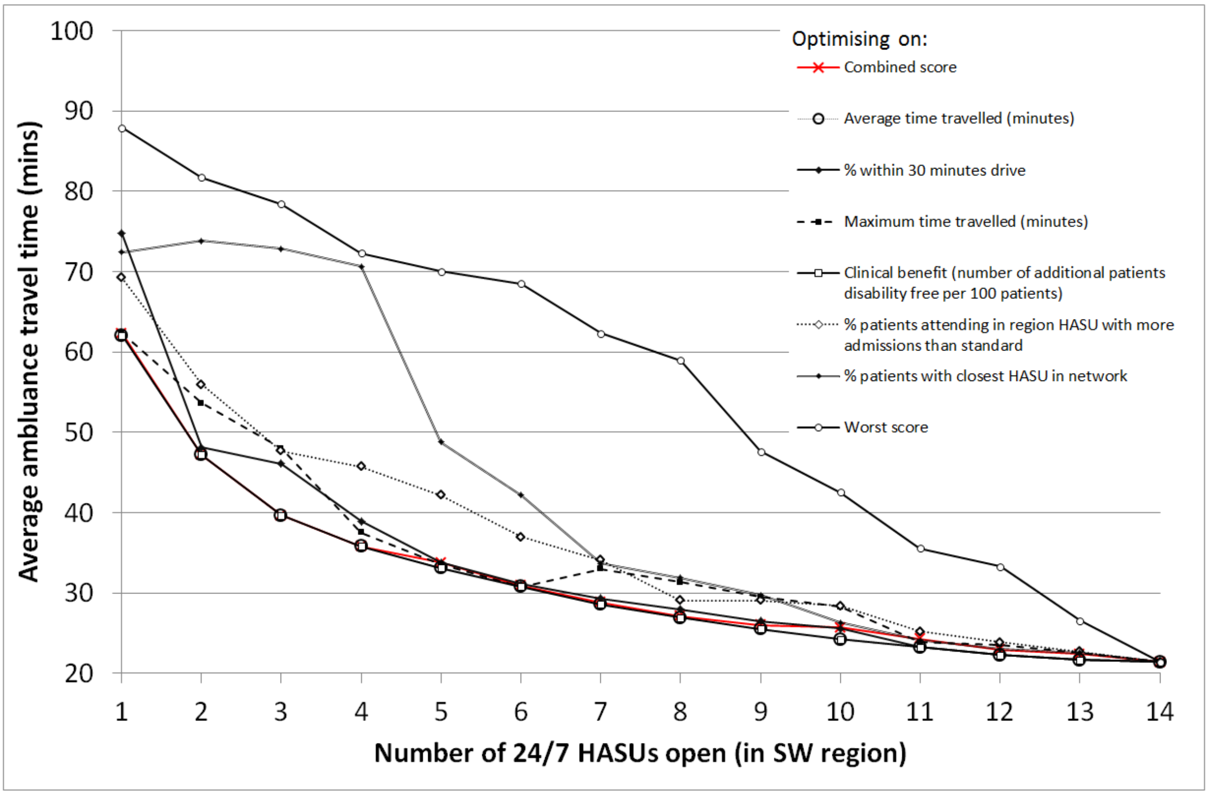


Figure 5.39 Average ambulance travel time by number of HASUs

With one HASU in the region the best average travel time possible is ~62 minutes. There are diminishing returns as more HASUs are added, with the optimal average travel time being ~33 minutes with 5 HASUs and ~21 minutes with 14 HASUs.

The model allows for the average travel time to be estimated if the selection of HASUs is based on alternative parameters. Of note is the effect of optimising the model solely on maximising the number of patients treated within the SW region. When the choice of hospitals is based just this parameter the average travel time to hospital with 5 HASUs open is ~49 minutes compared to ~33 minutes when the choice is based solely on average travel time. The model preferentially selects HASUs towards the eastern boundary in order to prevent patients being displaced outside the region, but causes significant disadvantage to those further west in the region. As the proportion of patients being treated within network is not a patient –centred parameter this was removed from the ‘combined score’ which seeks to find solutions that maximise a variety of parameters. The number or proportion of patients being treated out of region is reported, but is used as a secondary consideration.

The combined score (optimising on average travel time, the proportion of patients within 30 minutes of a HASU, the predicted clinical benefit, the maximum distance any one patient has to travel and the proportion of patients attending a HASU admitting at least 600 strokes per year) produced very similar average travel distances to configurations optimising on average travel distance alone.

The notation scheme for the following graphs is the same as for the earlier PPCI graphs. As an example solution the effect of selecting the 6 planned vascular surgical centres (Bristol, Plymouth, Exeter, Taunton, Cheltenham, Truro) is also shown.

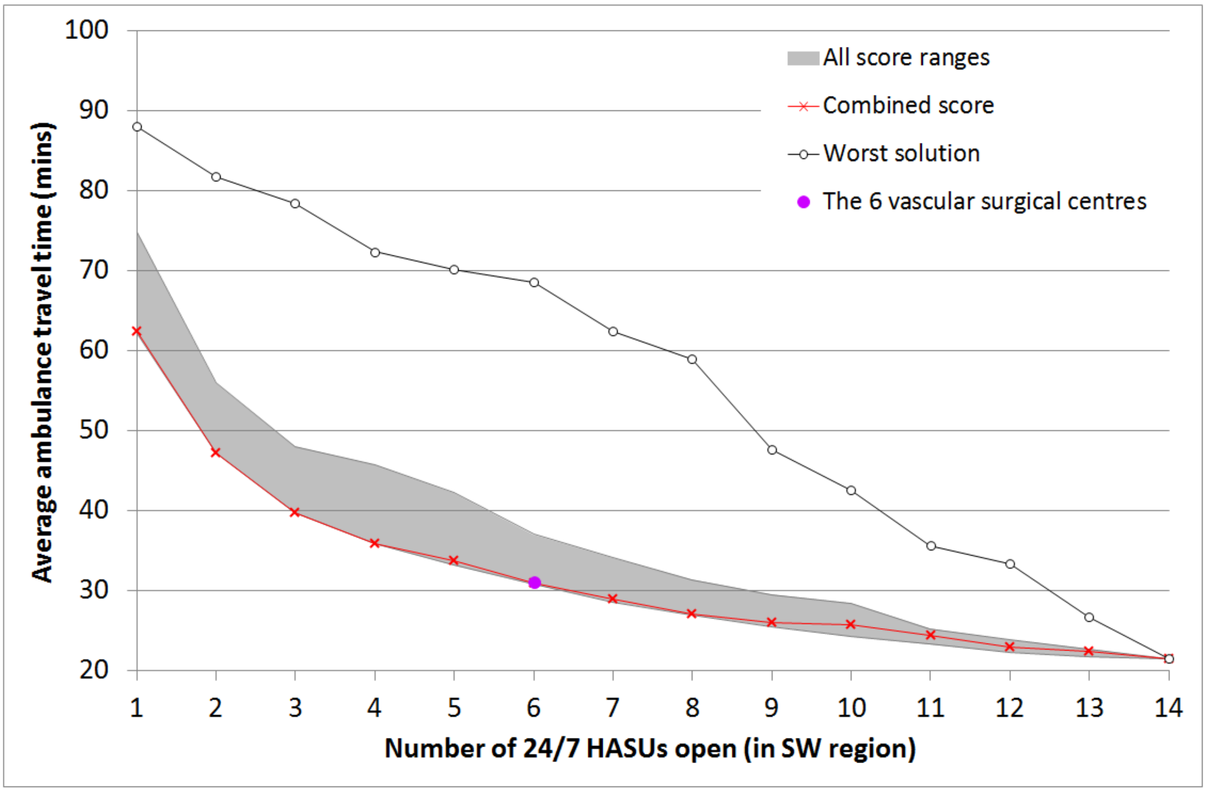


Figure 5.40 **Average ambulance travel time by number of HASUs (simplified)**

5.5.6 Relationship between the number of HASUs and the maximum travel time

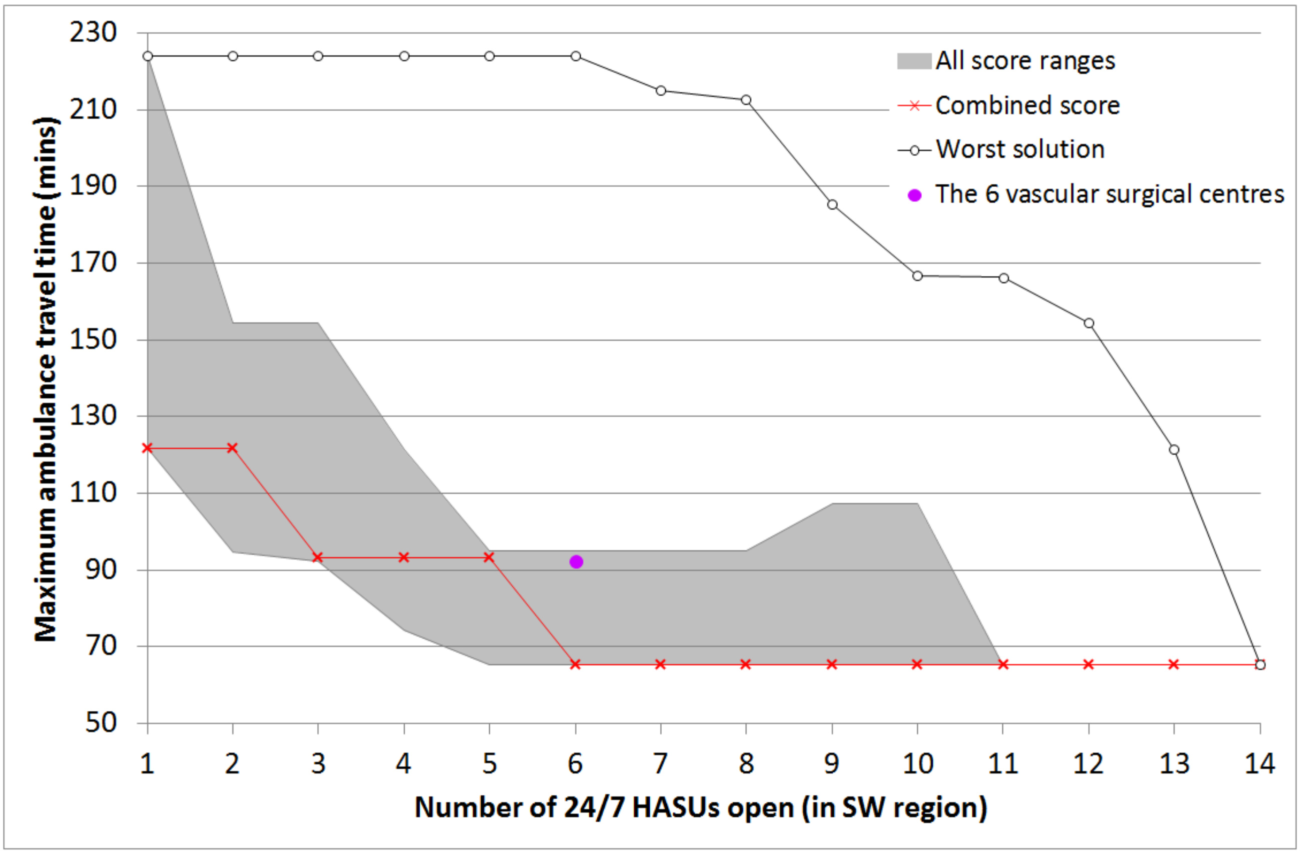


Figure 5.41 Maximum ambulance travel time by number of HASUs

The shortest possible maximum travel time for 6-14 HASUs is ~65 minutes. The patients with longest travel times are those on the North Cornish coast between Bude and Boscastle. The combined score produces results very similar to the best possible score on this parameter, apart from the 5 HASU configuration.

5.5.7 Relationship between the number of HASUs and the proportion of patients living within 30 minutes ambulance travel time

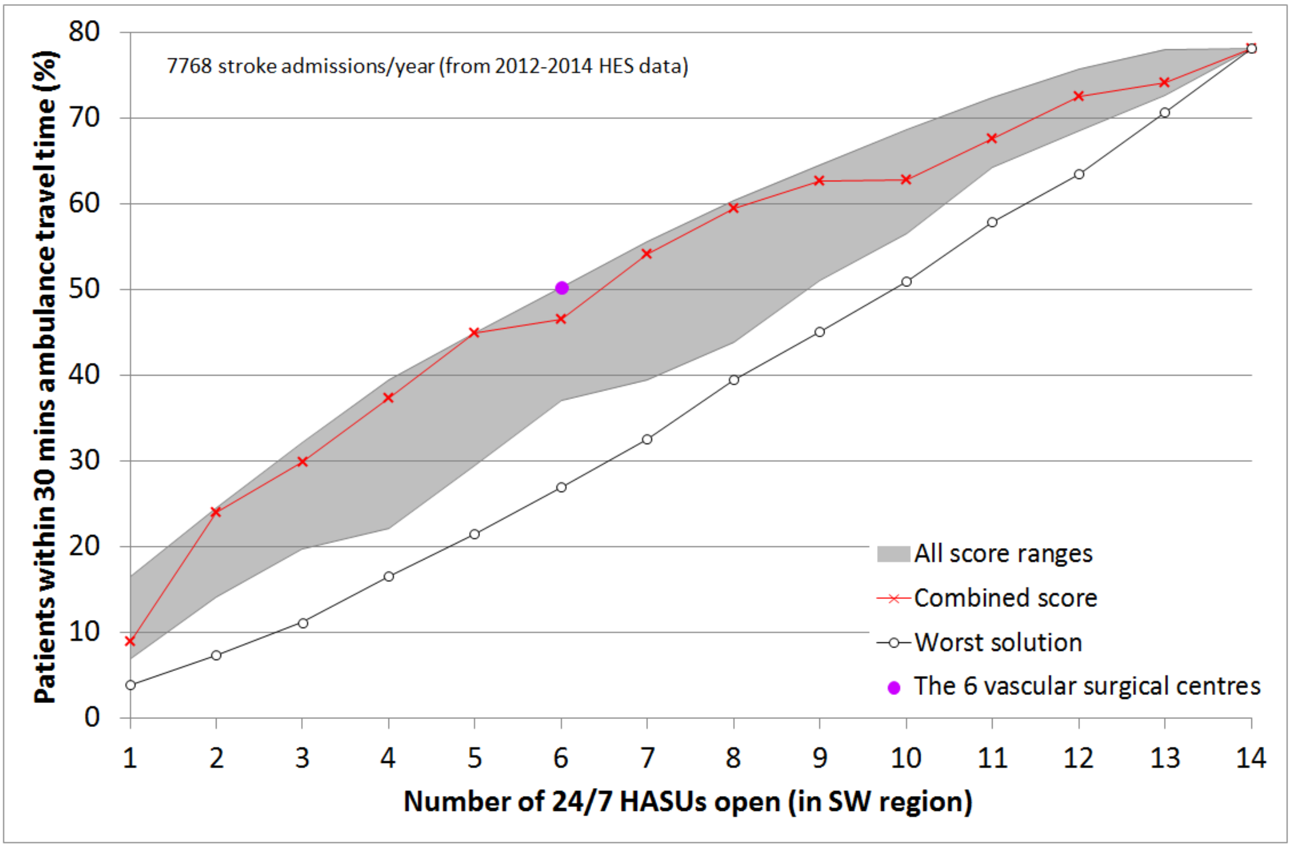
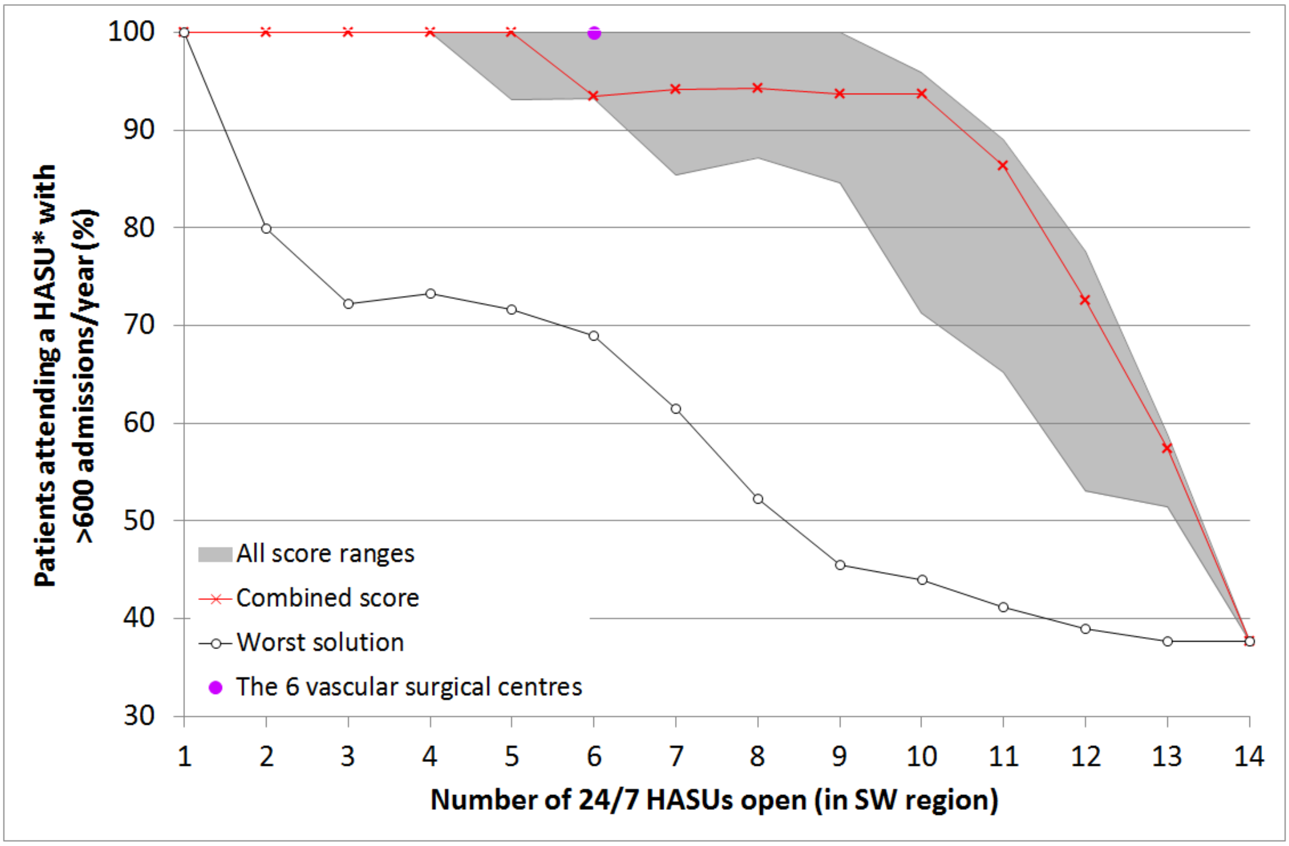


Figure 5.42 Proportion of patients within 30 mins ambulance travel time by number of HASUs

As HASUs are added, there is a steady rise in the proportion of patients within 30 minutes ambulance travel time. This is as expected as hospitals are built close to population centres. The combined score overall produces results similar to the best possible score, for example, ~55% and 78% of population being within a 30 min ambulance drive with 5 and 14 HASUs respectively.

5.5.8 Relationship between the number of HASUs and the proportion of patients attending a HASU admitting at least 600 acute stroke patients per year



**These results count in-region patients only*

Figure 5.43 Proportion of patients attending a HASU treating >600 patients/year by number of HASUs

The model predicts that it is not possible to have more than 9 centres that all admit more than 600 stroke patients per year. When using the combined score, all configurations with 5 centres or fewer have all patients being admitted to a centre admitting more than 600 stroke patients/year. With 6-9 units there is a trade-off such that the optimisation method selects combinations that do not have all patients attending a unit receiving >600 patients per year. This trade-off is primarily between distances travelled and the ability to have all units receiving >600 patients per year.

5.5.9 Relationship between the number of HASUs and the clinical benefit

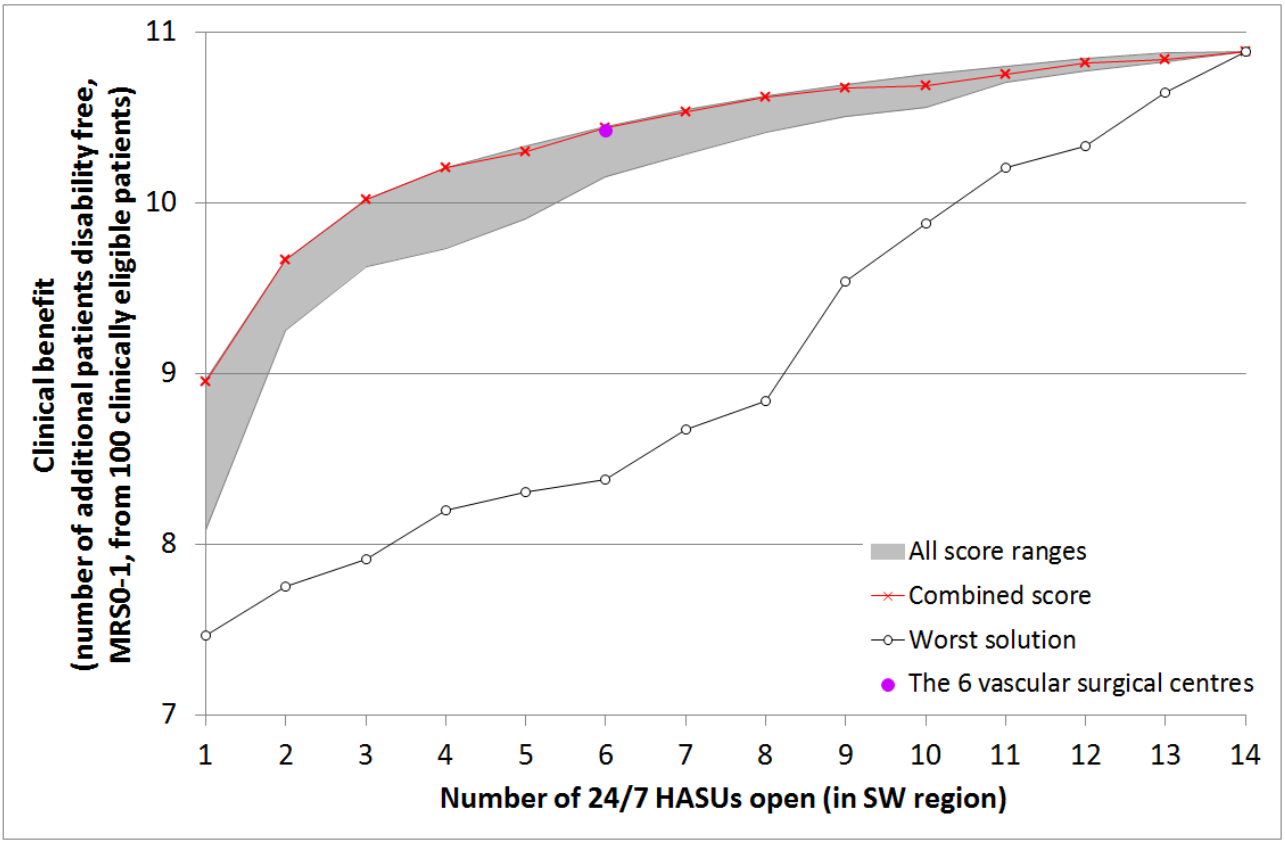


Figure 5.44 Clinical benefit (additional disability-free patients) by number of HASUs

The greatest number of additional patients disability free (mRS0-1) from 100 clinically eligible patients is predicted to be ~11 per year; this decreases to below 9 per year with a single HASU. The combined score produces results very similar to the best possible score; the predicted number of additional patients disability free decreases from ~11 to ~10.5 when moving from 14 to 7 HASUs. The minor effect of centralisation is due to (1) a relatively shallow relationship between time to thrombolysis and number of additional patients disability free, and (2) average travel times being increased by just 7 minutes between 14 and 7 HASUs. These results do not take into account the potential advantage to door-to-needle time of having fewer, larger centres (Bray et al, 2013).

5.5.10 Relationship between the number of HASUs and the number of patients treated within the SW region

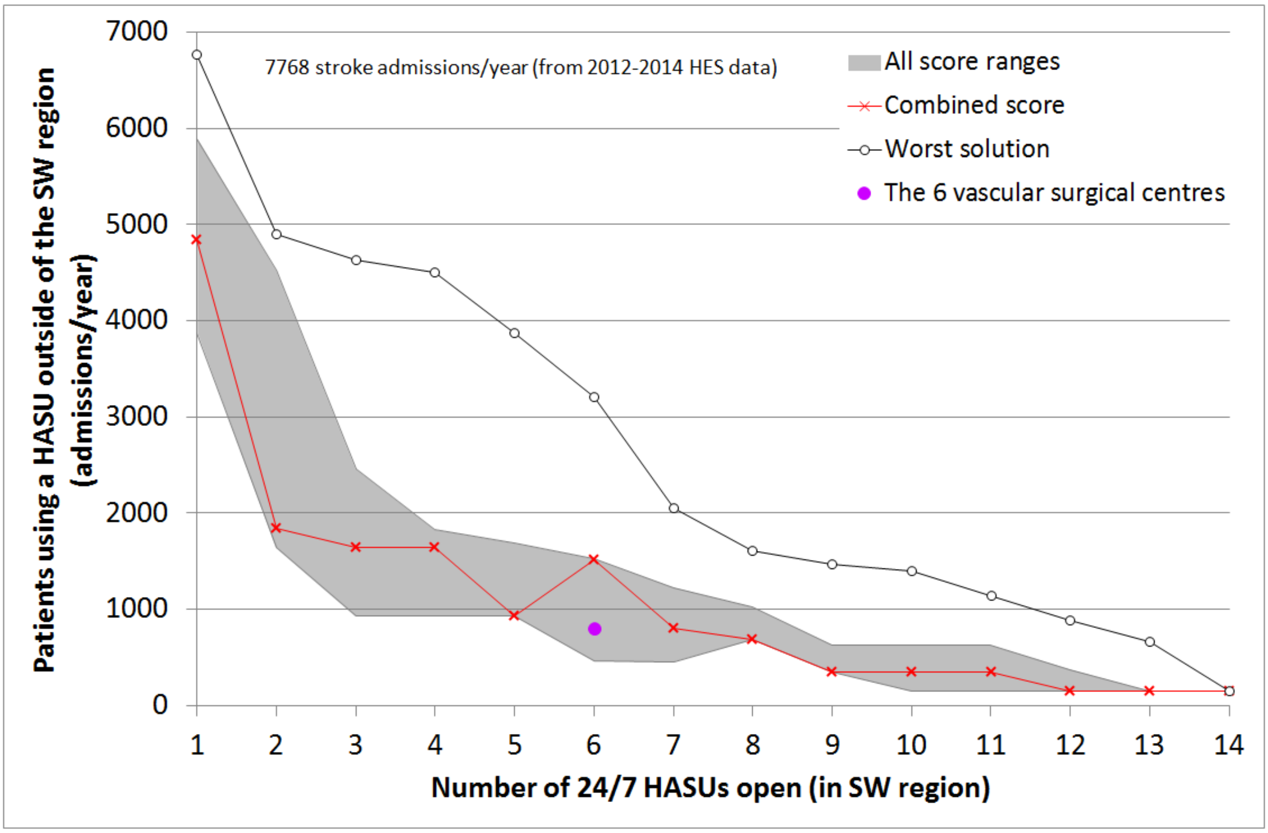


Figure 5.45 Number of patients admitted to HASUs outside the region by number of HASUs

The proportion of patients treated within region is not a patient-centred parameter and is not included in the primary scoring to identify optimal solutions. It is reported for all combinations. When this measure is a priority the model will be biased towards opening hospitals on the Eastern edge of the region in order to prevent movement of patients to HASUs to the East. This will disadvantage the average and maximum travel times as well as the overall clinical impact. The combined score does track reasonably close to the best value attainable for the combinations that are identified by the primary scoring for some of the combinations (between 8-14 HASUs). With fewer than eight HASUs there is an increasing compromise between optimising the proportion of patients treated in region and the patient-centred parameters in the model. More information on where patients go when they are treated outside the region is given with the maps below.

5.5.11 Relationship between the number of HASUs and the emergency ambulance time

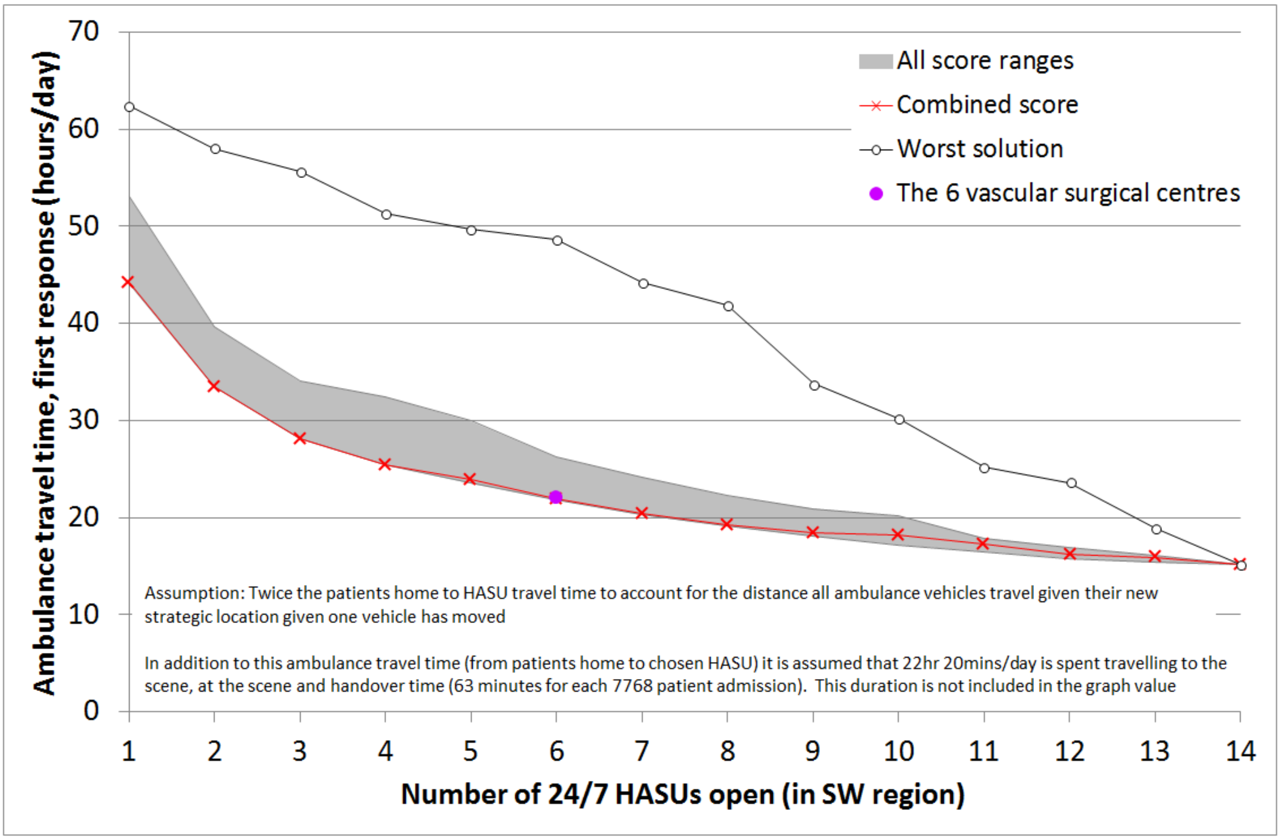


Figure 5.46 Total emergency ambulance travel time by number of HASUs

We estimate that there is an average ~22 hours per day fixed ambulance time (irrespective of travel time to hospitals) for time spent travelling to the scene, at the scene and handover time (63 minutes for each of the 7768 stroke admissions). In addition to this fixed time there is the travel time to the nearest HASU and a similar travel time back to the ambulance starting location. The amount of travel time is estimated to be ~15 hours per day at present. This would increase by about 7 hour per day with centralisation in 6 HASUs. Further centralisation brings significantly increased ambulance time, up to 11 additional hours/day with centralisation to two HASUs.

Similar to STEMI, the diagnostic false-positive rate for the use of the FAST test for suspected stroke increases the number of emergency responses by approximately 19% (McMeekin et al, 2013).

5.5.12 Relationship between the number of HASUs and ambulance repatriation time

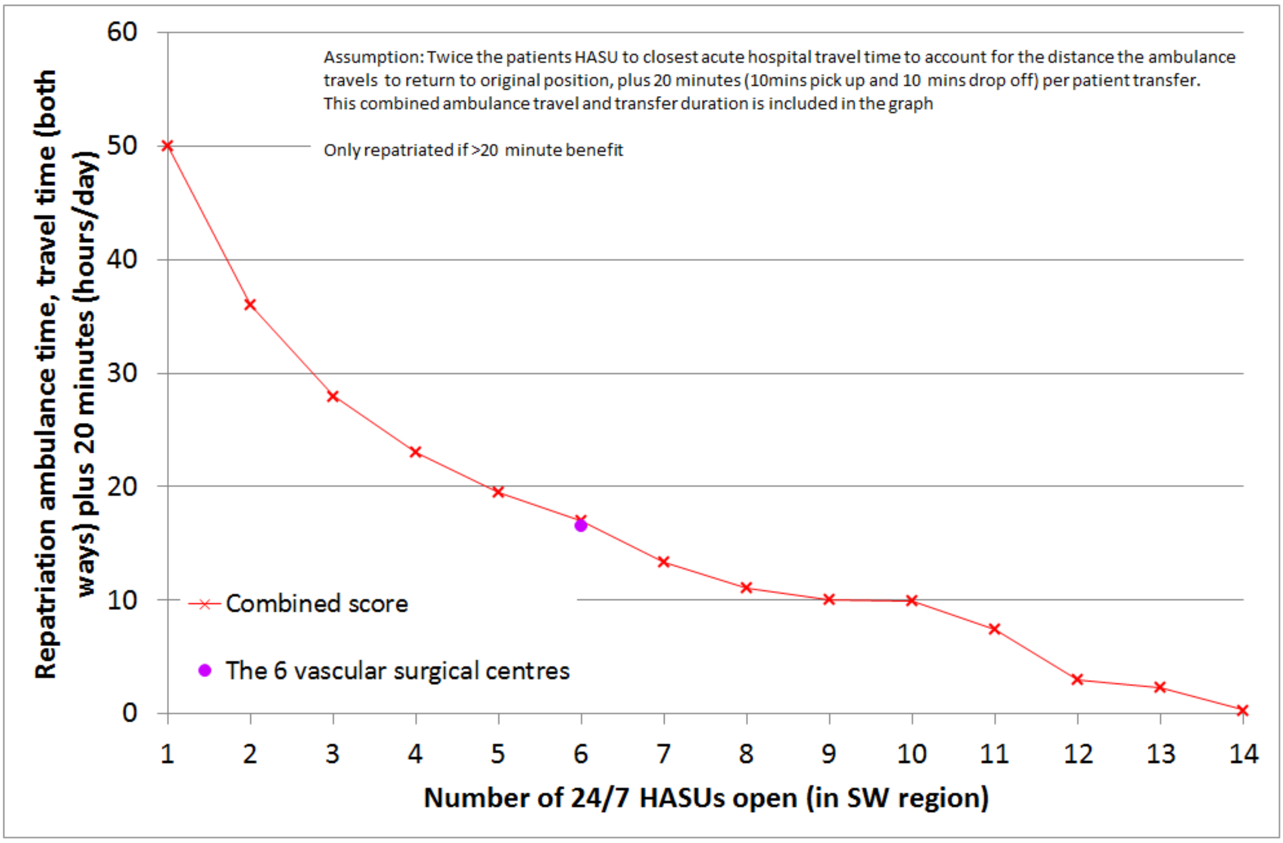


Figure 5.47 Total ambulance repatriation travel time by number of HASUs

In the above graph we have taken a ‘worst case’ example of where all patients require repatriation back to their closest acute hospitals after an initial stay in a HASU. In reality, based on the London reconfiguration experience, about a third of patients will go straight home after acute stroke care rather than return to their local acute hospital.

With 6 HASUs we would expect an average of 17 hours ambulance time to be taken per day in repatriating all patients back to their local hospital. Reducing the number of centres below 6 leads to a sharply increasing requirement for repatriation (estimated at 36 hours per day with a two-HASU solution).

5.5.13 Relationship between the number of HASUs and the clinical benefit to patients when using current hospital door-to-needle times

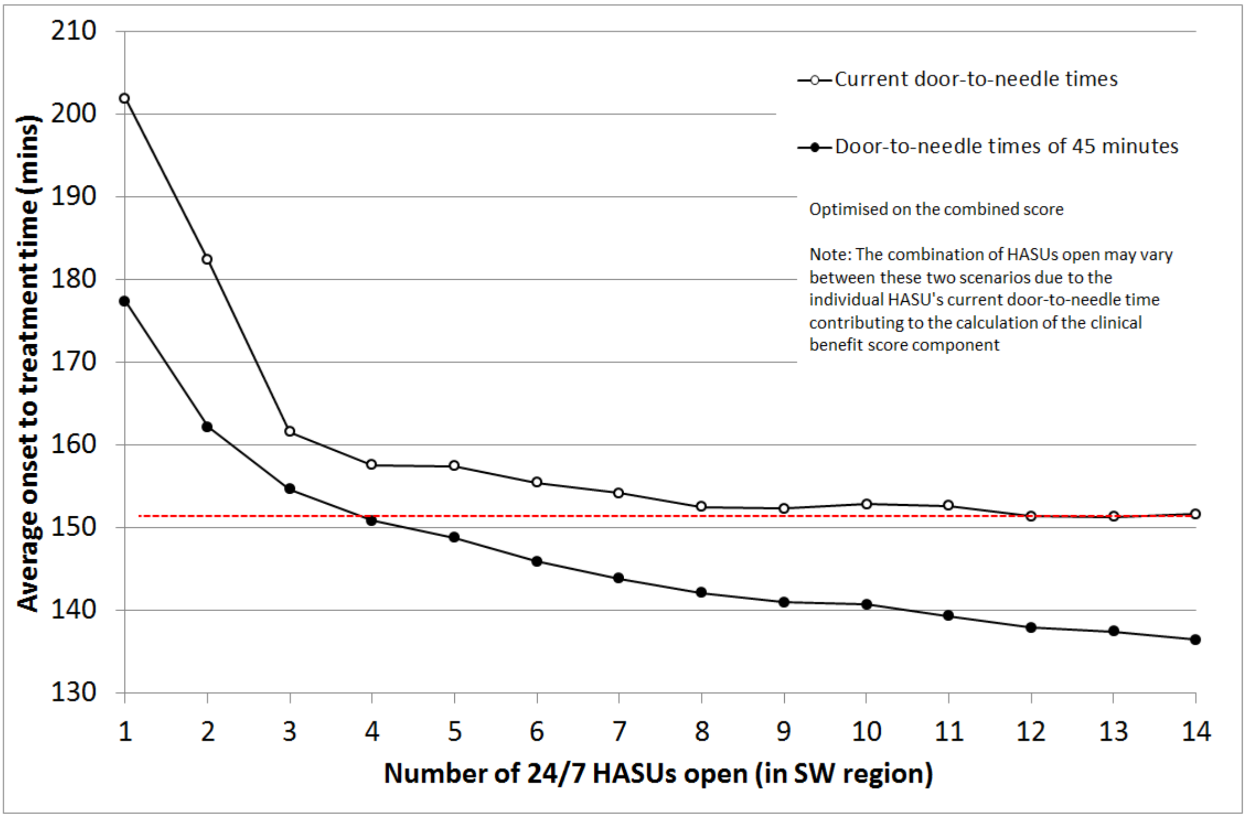


Figure 5.48 **Average onset-to-treatment times by number of HASUs and by average door-to-needle time**

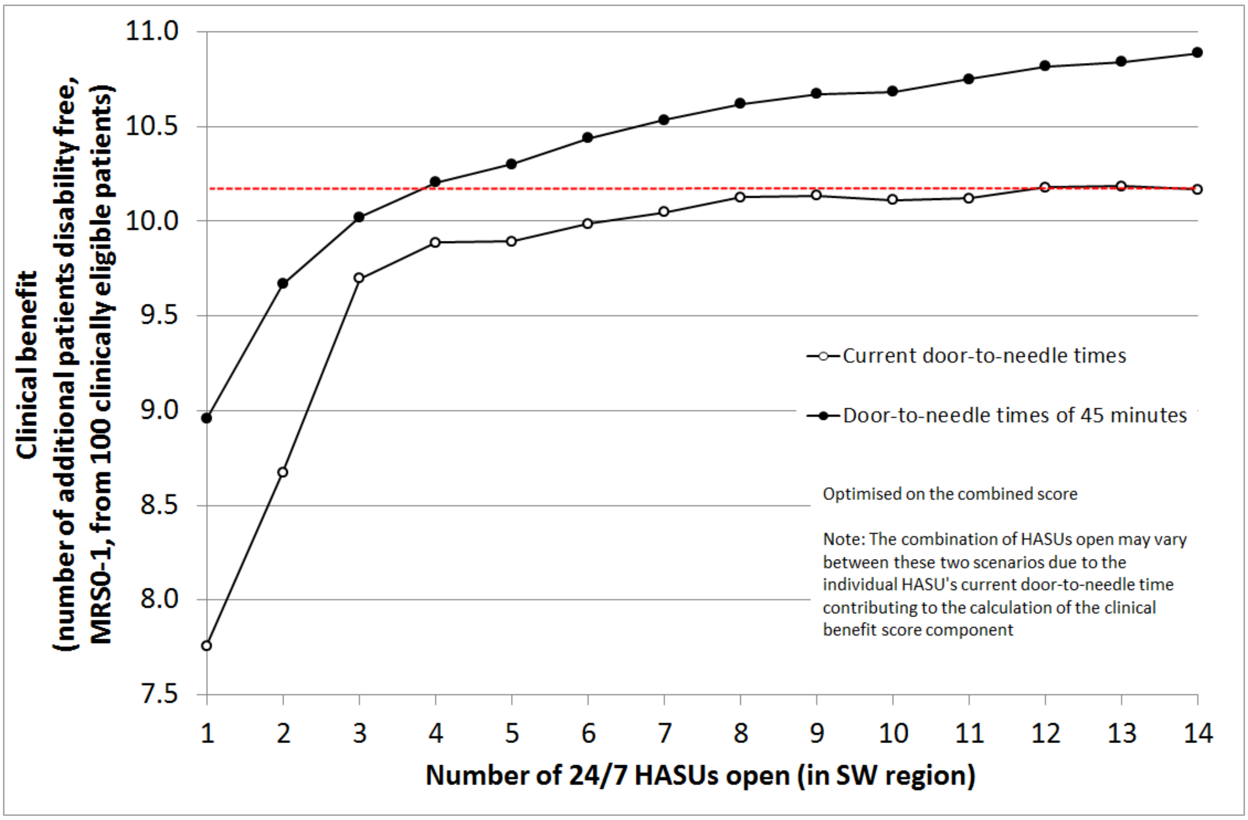


Figure 5.49 Clinical benefit (additional disability-free patients) by number of HASUs and by average door-to-needle time

When modelling the future configuration of HASUs, a 45 minute door-to-needle time for all HASUs is used. If current door to needle times are used per hospital and patients still attend their closest hospital the impact of opening an additional HASU may not give a net benefit if that centre has a longer door-to-needle time, thus negating the benefit from the shorter travel time.

It is worthy of note that 4 HASUs each operating a 45 minute door-to-needle time delivers the same predicted clinical benefit presently delivered by 14 hospitals with their individual door-to-needle times.

5.5.14 Relationship between the number of HASUs and the clinical benefit to patients when hospital door-to-needle time is reduced

As was seen previously reducing the number of HASUs from 14 to 7 would be expected to lead to ~0.5 fewer patients leaving disability free per year (per 100 clinically eligible patients) if performance elsewhere in the system was unchanged.

A reduction of other times in the system could be expected to help mitigate longer travel times. A 15 minutes average reduction in door-to-needle time would be expected to lead to an increased number of patients leaving hospital disability free by ~1 patient per year (per 100 clinically eligible patients).

It should be noted that the benefit of reduced times other than travel time will be spread across all patients whereas the increase in average travel time is focussed on those areas around any emergency centre without a HASU service. Though there may be a net reduction in disability this will be unevenly distributed geographically, with some areas having lower and other areas higher numbers of additional patients disability free. These geographical variations are discussed below.

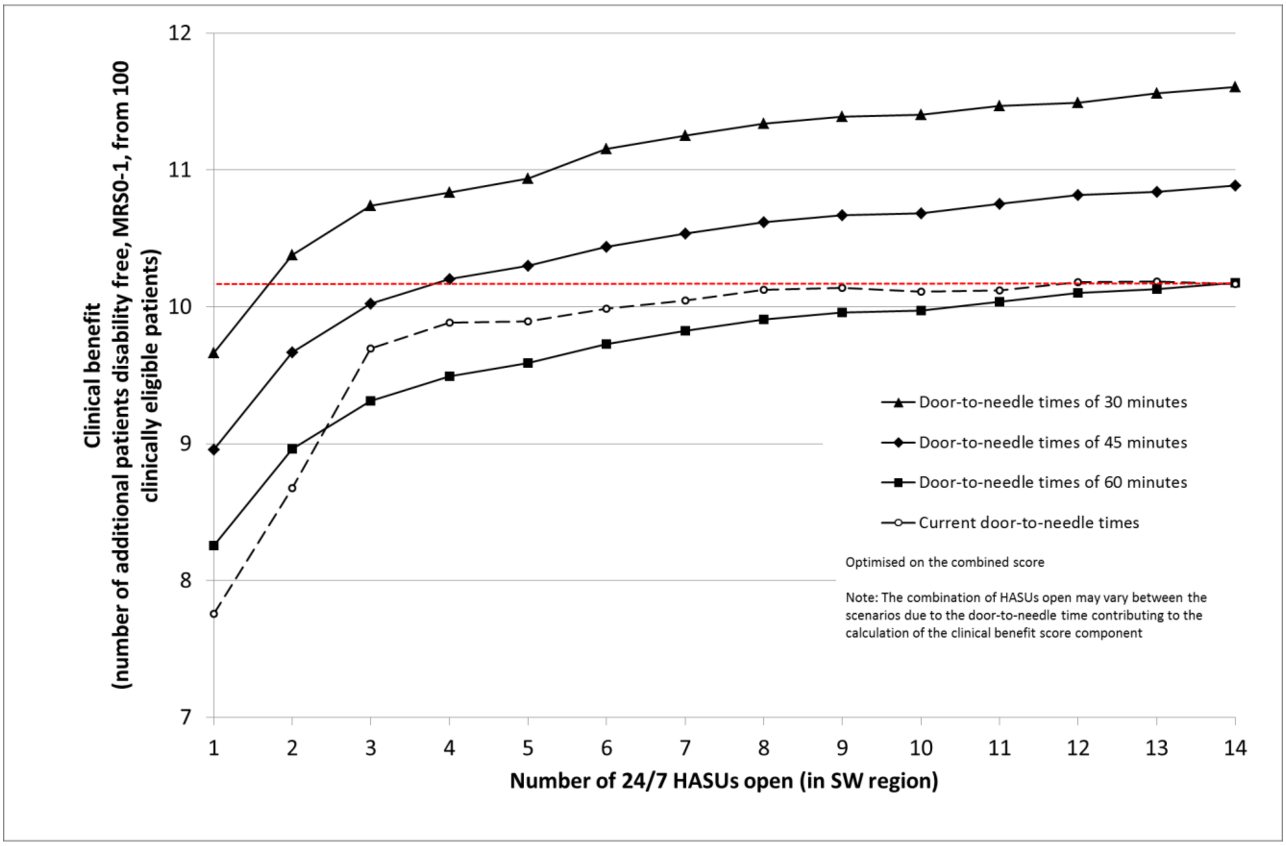


Figure 5.50 Clinical benefit (additional disability-free patients) by number of HASUs and by door-to-needle time

5.5.15 Optimal and near-optimal solutions

Previous plots have shown ‘optimal’ solutions based on either single parameters (such as optimising solely on average ambulance travel time) or optimising the combined score of multiple parameters.

It should be stressed that though there may be one calculated ‘optimal’ combinations of HASUs, there may also be many similar scoring combinations that are ‘near optimal’. There may be reasons, not included in the model, for selecting a configuration from this near-optimal selection. For example in the table below the solution for designating 6 HASUs is shown. The highlighted line shows what are expected to be the six regional vascular surgical centres. This selection of HASUs is a near-optimal solution in the model and it may be preferable (due to co-localising PPCI and vascular surgery) to the mathematically optimal solution. The model shows that in selecting such a ‘near optimal’ configuration there would be very little compromise compared with selecting the modelled optimal solution.

When selecting six HASUs from 14 we find 92 near-optimal solutions with negligible compromise compared with the optimal solution.

92 near optimal solutions (within 3 percentage points)

16 near optimal solutions (within 1 percentage point)

		The score definition												
	Scores (%max)	Average Time Travelled (mins)	Max Time Travelled (mins)	Patients Within 30 Mins Travel (%)	Clinical Benefit (per 100 clinically suitable patients)	Patients Attending Hospital With >600 Admissions (%)	Patients Using Hospital In Network (%)	In region hospitals open (all out of region hospitals are open)					
The optimal solution	**82.3**	**31**	**65**	**47**	**10.4**	**94**	**80**	**Bristol1**	**Exeter**	**Barnstaple**	**Plymouth**	**Taunton**	**Truro**
	82.1	31	65	46	10.4	93	80	Bristol1	Barnstaple	Plymouth	Taunton	Torbay	Truro
	82.0	31	65	46	10.4	94	81	Bristol2	Exeter	Barnstaple	Plymouth	Taunton	Truro
	82.0	32	65	46	10.4	94	90	Bristol1	Barnstaple	Gloucester	Plymouth	Taunton	Truro
	81.9	31	70	49	10.4	93	88	Bristol1	Exeter	Barnstaple	Gloucester	Plymouth	Truro
	81.9	31	65	45	10.4	93	81	Bristol2	Barnstaple	Plymouth	Taunton	Torbay	Truro
	81.9	31	92	50	10.4	100	90	Bristol1	Exeter	Gloucester	Plymouth	Taunton	Truro
	81.7	31	65	46	10.4	92	80	Bristol1	Weston	Exeter	Barnstaple	Plymouth	Truro
	81.6	31	65	46	10.4	93	80	Bristol2	Weston	Exeter	Barnstaple	Plymouth	Truro
	81.6	32	65	46	10.4	94	89	Bristol2	Barnstaple	Gloucester	Plymouth	Taunton	Truro
	81.5	31	92	49	10.4	100	90	Bristol2	Exeter	Gloucester	Plymouth	Taunton	Truro
	81.5	31	92	48	10.4	100	84	Bristol1	Exeter	Plymouth	Swindon	Taunton	Truro
	81.4	31	71	48	10.4	93	88	Bristol2	Exeter	Barnstaple	Gloucester	Plymouth	Truro
	81.4	31	95	50	10.4	100	90	Bristol1	Gloucester	Plymouth	Taunton	Torbay	Truro
	81.4	31	65	45	10.4	93	84	Bristol1	Barnstaple	Plymouth	Swindon	Taunton	Truro
	81.4	31	70	47	10.4	92	83	Bristol1	Exeter	Barnstaple	Plymouth	Swindon	Truro
	81.3	32	93	50	10.4	100	89	Bristol1	Weston	Exeter	Gloucester	Plymouth	Truro
	81.1	32	93	50	10.4	100	89	Bristol2	Weston	Exeter	Gloucester	Plymouth	Truro
	81.1	32	93	50	10.4	100	90	Bristol1	Exeter	Gloucester	Plymouth	Swindon	Truro
	81.1	34	74	46	10.3	100	87	Bristol1	Barnstaple	Gloucester	Plymouth	Swindon	Truro
	81.1	31	92	48	10.4	100	84	Bristol2	Exeter	Plymouth	Swindon	Taunton	Truro
	81.0	31	65	45	10.4	93	85	Yeovil	Bristol1	Exeter	Barnstaple	Plymouth	Truro

Red highlights the six vascular surgical centres.

Table 5.21 Optimal and near-optimal solutions for hyperacute stroke

5.5.16 Specific configurations: two, six, seven, nine, ten and fifteen HASUs

As described in Methods, the following specific configurations were chosen for more detailed analysis:

Scenario	1	2	3	4	5	Current stroke	6
# Hospitals	2	6	7	9	10	hosp 24/7	15
In region hospitals	Bristol 1	Bristol 1	Bristol 1	Bristol 1	Bristol 1	Bristol 1	Bristol 1
	Plymouth	Plymouth	Plymouth	Plymouth	Plymouth	Plymouth	Plymouth
		Gloucester	Gloucester	Gloucester	Gloucester	Gloucester	Gloucester
		Taunton	Taunton	Taunton	Taunton	Taunton	Taunton
		Truro	Truro	Truro	Truro	Truro	Truro
		Exeter	Exeter	Exeter	Exeter	Exeter	Exeter
			Torbay	Torbay	Torbay	Torbay	Torbay
				Swindon	Swindon	Swindon	Swindon
				Bath	Bath	Bath	Bath
					Salisbury	Salisbury	Salisbury
						Bristol 2	Bristol 2
						Barnstaple	Barnstaple
						Weston	Weston
						Yeovil	Yeovil
							Cheltenham
Out of region hospitals	Poole	Poole	Poole	Poole	Poole	Poole	Poole
	Bournmouth	Bournmouth	Bournmouth	Bournmouth	Bournmouth	Bournmouth	Bournmouth
	Warwick	Warwick	Warwick	Warwick	Warwick	Warwick	Warwick
	Dorchester	Dorchester	Dorchester	Dorchester	Dorchester	Dorchester	Dorchester
	Hereford	Hereford	Hereford	Hereford	Hereford	Hereford	Hereford
	Banbury	Banbury	Banbury	Banbury	Banbury	Banbury	Banbury
	Oxford (JR)	Oxford (JR)	Oxford (JR)	Oxford (JR)	Oxford (JR)	Oxford (JR)	Oxford (JR)
	Portsmouth	Portsmouth	Portsmouth	Portsmouth	Portsmouth	Portsmouth	Portsmouth
	Reading	Reading	Reading	Reading	Reading	Reading	Reading
	Basingstoke	Basingstoke	Basingstoke	Basingstoke	Basingstoke	Basingstoke	Basingstoke
	Southampton	Southampton	Southampton	Southampton	Southampton	Southampton	Southampton
	Winchester	Winchester	Winchester	Winchester	Winchester	Winchester	Winchester
	Worcester	Worcester	Worcester	Worcester	Worcester	Worcester	Worcester

Table 5.22 HASU configurations selected for detailed analysis

A summary of key performance indicators is shown in the table below.

Scenario	1	2	3	4	5	Current stroke	6
# Hospitals	2	6	7	9	10	hosp 24/7	15
In region hospitals	Bristol 1	Bristol 1	Bristol 1	Bristol 1	Bristol 1	Bristol 1	Bristol 1
	Plymouth	Plymouth	Plymouth	Plymouth	Plymouth	Plymouth	Plymouth
		Gloucester	Gloucester	Gloucester	Gloucester	Gloucester	Gloucester
		Taunton	Taunton	Taunton	Taunton	Taunton	Taunton
		Truro	Truro	Truro	Truro	Truro	Truro
		Exeter	Exeter	Exeter	Exeter	Exeter	Exeter
			Torbay	Torbay	Torbay	Torbay	Torbay
				Swindon	Swindon	Swindon	Swindon
				Bath	Bath	Bath	Bath
					Salisbury	Salisbury	Salisbury
						Bristol 2	Bristol 2
						Barnstaple	Barnstaple
						Weston	Weston
						Yeovil	Yeovil
							Cheltenham
Average travel (mins)	47	31	30	26	26	21	21
Maximum travel (mins)	122	92	92	92	92	65	65
Patients within 30 mins (%)	24	50	55	65	67	78	79
Patients using hospital in network (%)	76	90	90	92	95	98	99
Clinical benefit*	9.7	10.4	10.5	10.6	10.7	10.9	10.9
Patients attending hopsital with >600 admissions (%)	100	100	92	85	81	38	28
First response, ambulance travel time (hours/day)**	33	22	21	19	18	15	15
Repatriation, ambulance time (hours/day)***	36	17	14	9	8	0	0

*Clinical benefit = # patients MRS0-1 for every 100 patients clinically suitable for thrombolysis

** Twice time/distance from home to hospital. In addition there are 22 hours 21 mins per day travelling to scene, on scene and handover (63 min per patient)

*** Twice inter-hopsital travel time + 20 mins per patient

Table 5.23 Key parameter outputs for the selected HASU configurations

The spread of ambulance travel times is shown in the following box and whiskers plot.

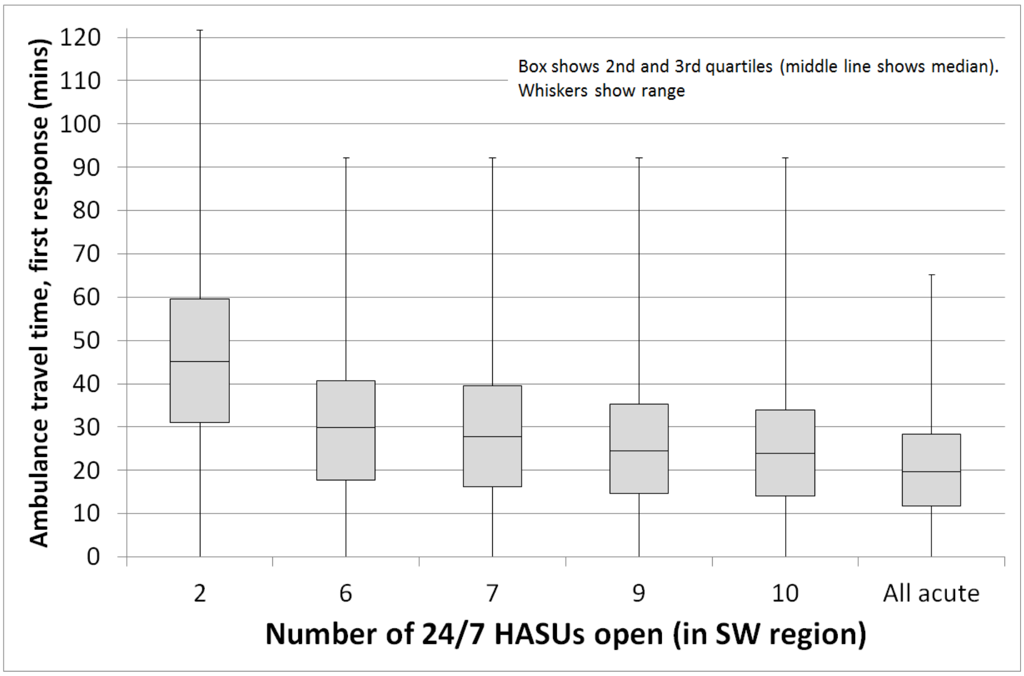


Figure 5.51 Ambulance travel times by number of HASUs

A further breakdown of travel times is shown below. The *changes* in travel times (from the present 14 hospital configuration) are also shown.

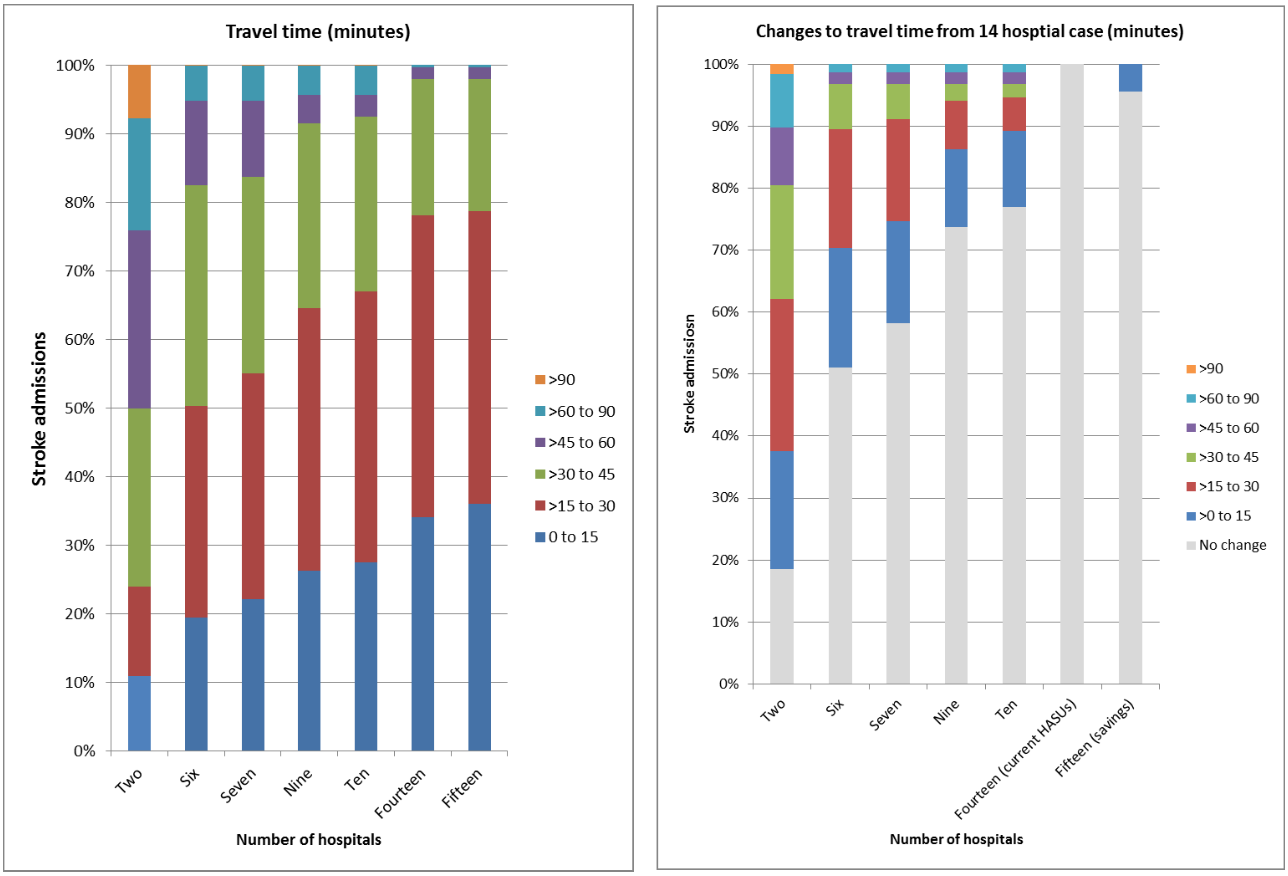


Figure 5.52 Ambulance travel times and change in travel times by number of HASUs

When reducing the number of centres to six or seven HASUs there are a small proportion of patients who are significantly affected, with travel time increased by more than 30 minute for ~10% of patients (this is a higher figure than with STEMI admissions as stroke patients start with more hospitals presently available). With a two HASU solution more than 35% of patients would have their travel time extended by more than 30 minutes and 10% would have travel time extended by more than 60 minutes (with ~8% of patients having an ambulance travel time of more than 90 minutes to their closest HASU).

The table below shows the number of stroke admissions to each HASU.

		Status Quo	10	9	7	6	2	15
In-region acute trusts currently offering stroke	BRISTOL INFIRMARY	548	1,272	1,272	2,126	2,126	2,999	548
	DERRIFORD HOSP	750	762	762	762	813	2,929	750
	GLOUCESTERSHIRE HOSP	717	732	732	1,038	1,038	-	**431**
	MUSGROVE PARK HOSP	528	1,033	1,033	1,037	1,037	-	528
	CORNWALL HOSP	729	729	729	729	729	-	729
	DEVON & EXETER HOSP	548	717	717	717	1,216	-	548
	TORBAY HOSP	550	550	550	550	-	-	550
	THE GREAT WESTERN HOSP	532	532	548	-	-	-	511
	UNITED HOSP	680	759	796	-	-	-	680
	SALISBURY DISTRICT HOSP	**246**	**317**	-	-	-	-	**246**
	N. DEVON DISTRICT HOSP	**406**	-	-	-	-	-	**406**
	SOUTHMEAD HOSP	**497**	-	-	-	-	-	**497**
	WESTON GENERAL HOSP	**426**	-	-	-	-	-	**426**
	YEOVIL DISTRICT HOSP	**465**	-	-	-	-	-	**465**
In-region acute trusts currently not offering stroke	CHELTENHAM GENERAL HOSP	-	-	-	-	-	-	**342**
Out-of-region acute trusts currently offering PPCI (SW patients only)	DORSET COUNTY HOSPITAL	17	234	293	328	328	648	17
	WORCESTERSHIRE HOSPITAL	23	23	23	23	23	529	9
	JOHN RADCLIFFE HOSP	37	37	37	76	76	152	33
	THE BOURNEMOUTH HOSPITAL	16	16	30	30	30	30	16
	SOUTHAMPTON GENERAL HOSP	-	-	14	14	14	14	-
	WARWICK HOSPITAL	24	24	24	24	24	24	14
	HORTON GENERAL HOSPITAL	7	7	7	7	7	20	-
	HAMPSHIRE COUNTY HOSPITAL	17	17	184	239	239	239	17
	HEREFORD COUNTY HOSPITAL	5	6	6	6	6	76	5
	POOLE HOSPITAL NHS FOUNDATI	-	-	9	9	9	9	-
	BERKSHIRE HOSPITAL	-	-	-	53	53	99	-
Total out of region		146	364	628	809	809	1,840	111

Bold red shows when less than 500 stroke per year anticipated.

Table 5.24 Numbers of stroke admissions for the selected configurations

5.5.17 Specific configurations: two, six, seven, nine, ten and fifteen HASUs - maps of travel times and change in travel times

Shown below are maps on expected travel time and changes in travel time (compared with 14 centres offering acute stroke care 24/7). The maps show modelled ambulance travel times, and the numbers of patients in each travel-time category, by geography.

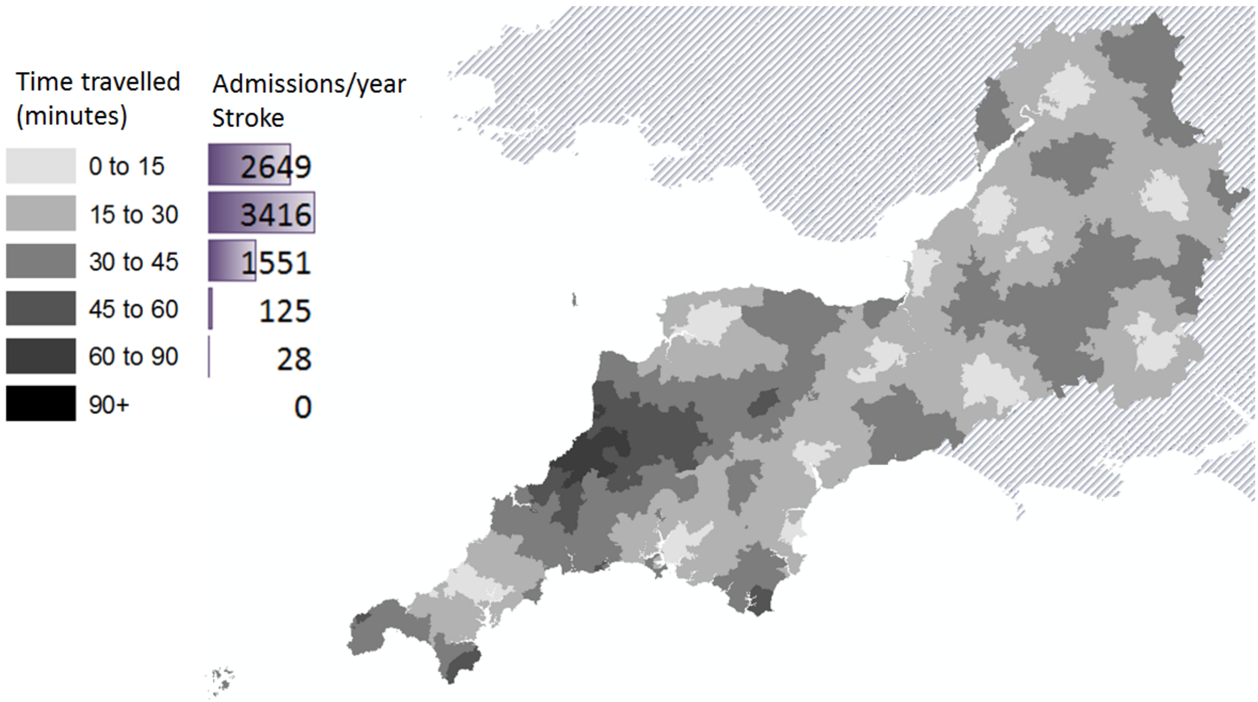


Figure 5.53 Modelled ambulance travel times: 14 HASUs operating 24/7 (two in Bristol)

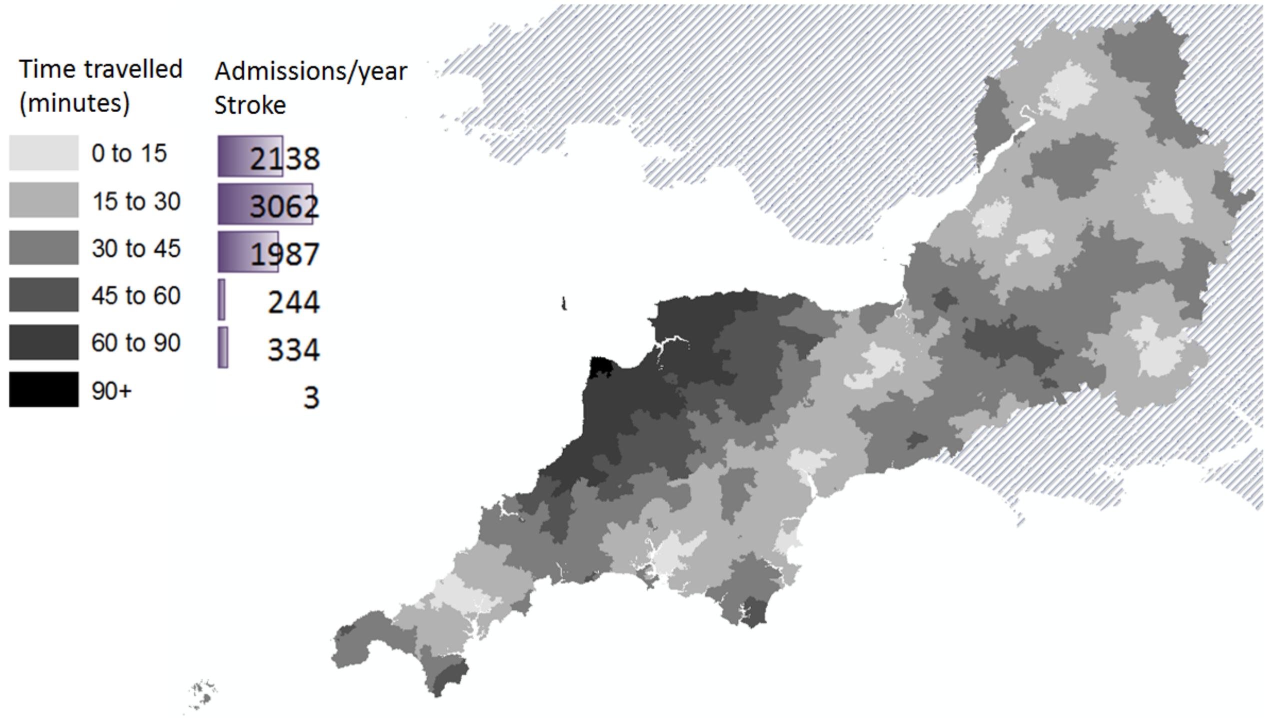


Figure 5.54 **Modelled ambulance travel times: 10 HASUs**

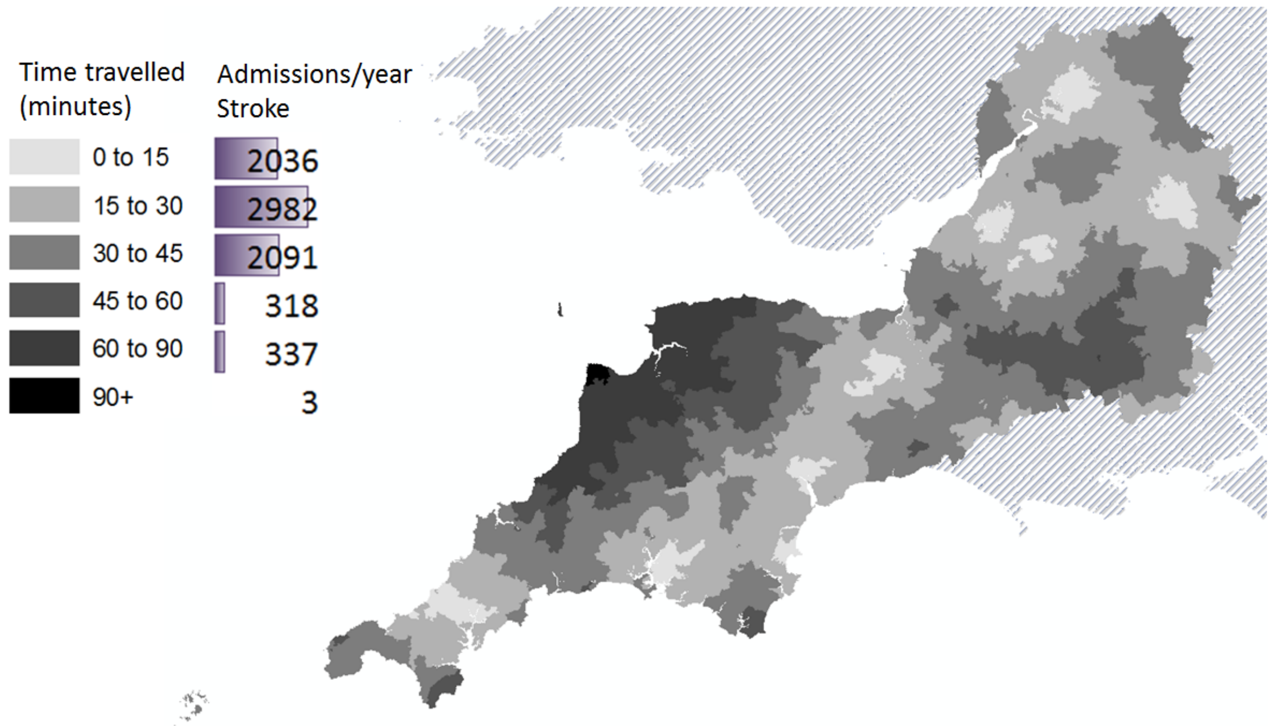


Figure 5.55 **Modelled ambulance travel times: 9 HASUs**

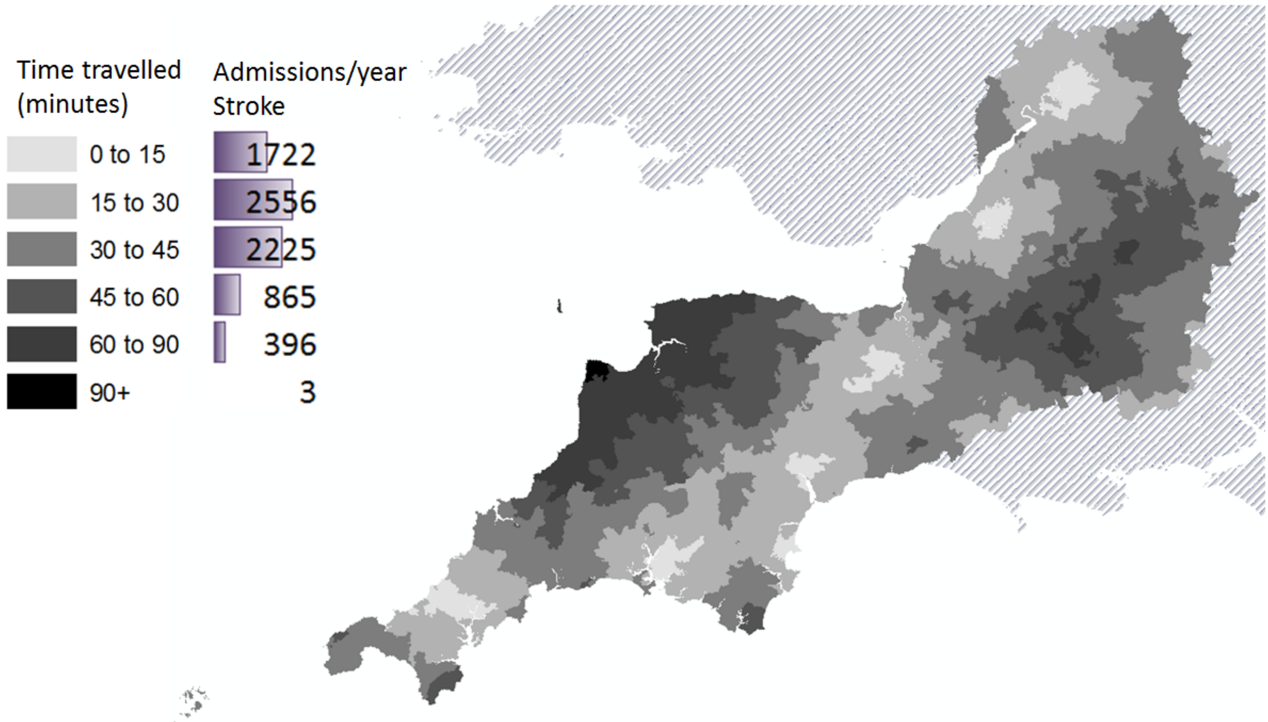


Figure 5.56 **Modelled ambulance travel times: 7 HASUs**

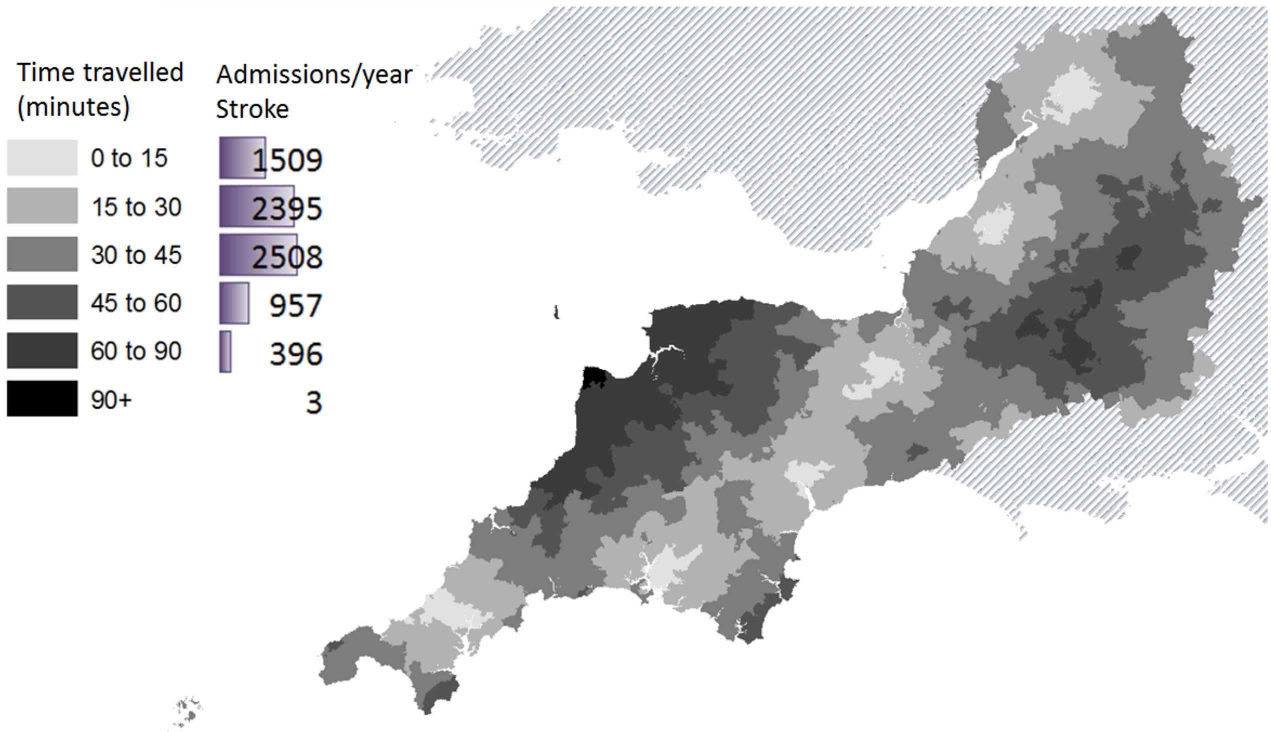


Figure 5.57 **Modelled ambulance travel times: 6 HASUs based in the Vascular Centres**

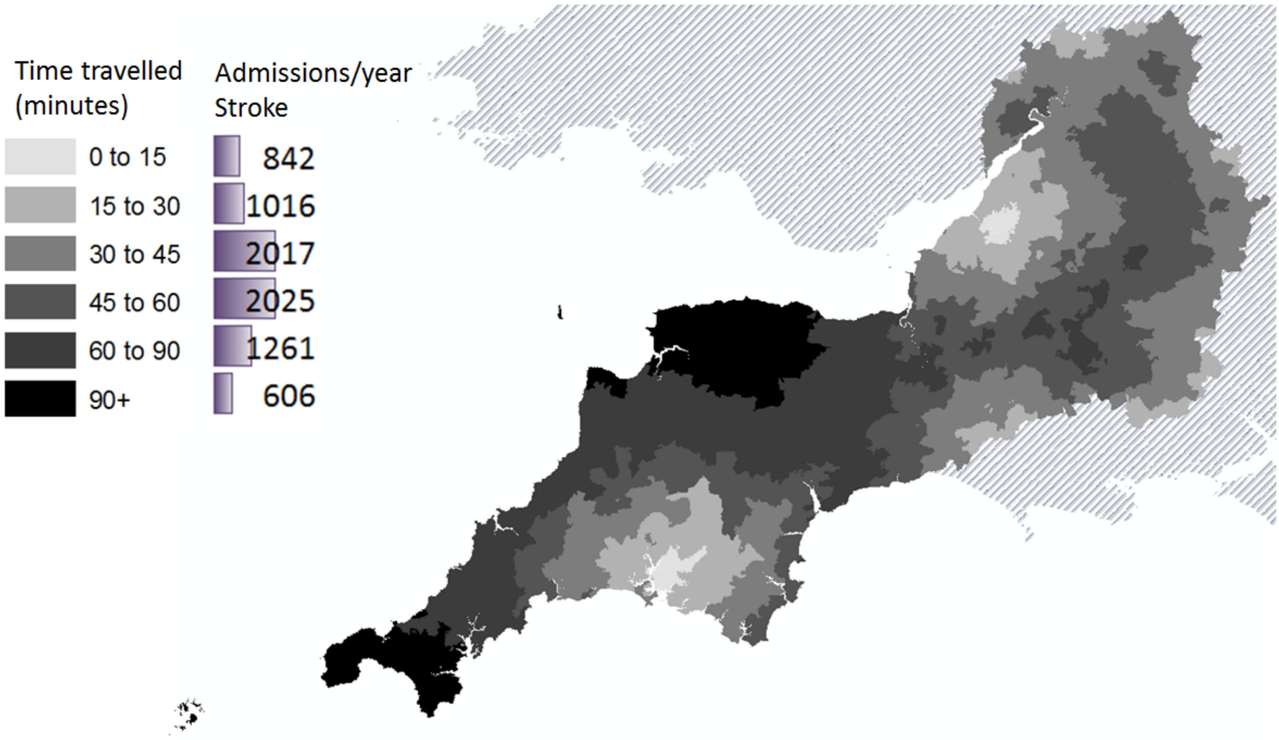


Figure 5.58 Modelled ambulance travel times: 2 HASUs based in the Neurointerventional Centres

The following maps show modelled changes in ambulance travel times (compared with the present 14 centres), and the numbers of patients in each travel-time category, by geography.

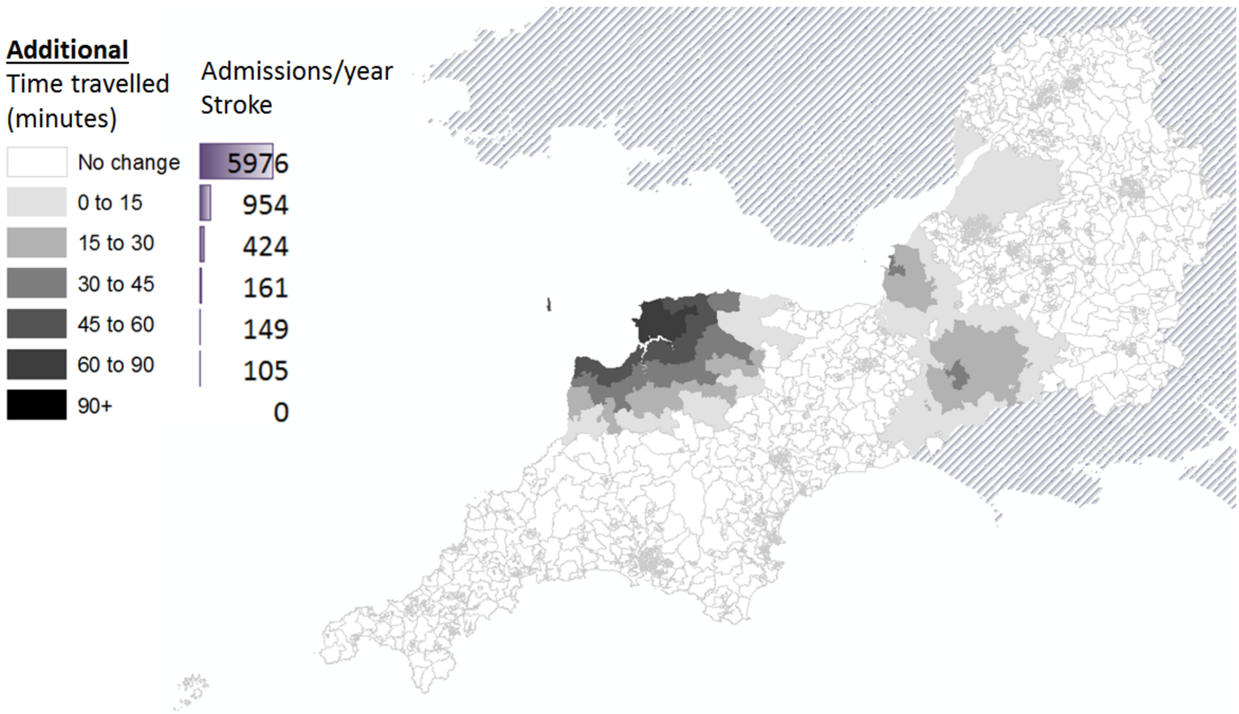


Figure 5.59 Changes in modelled ambulance travel times: 10 HASUs

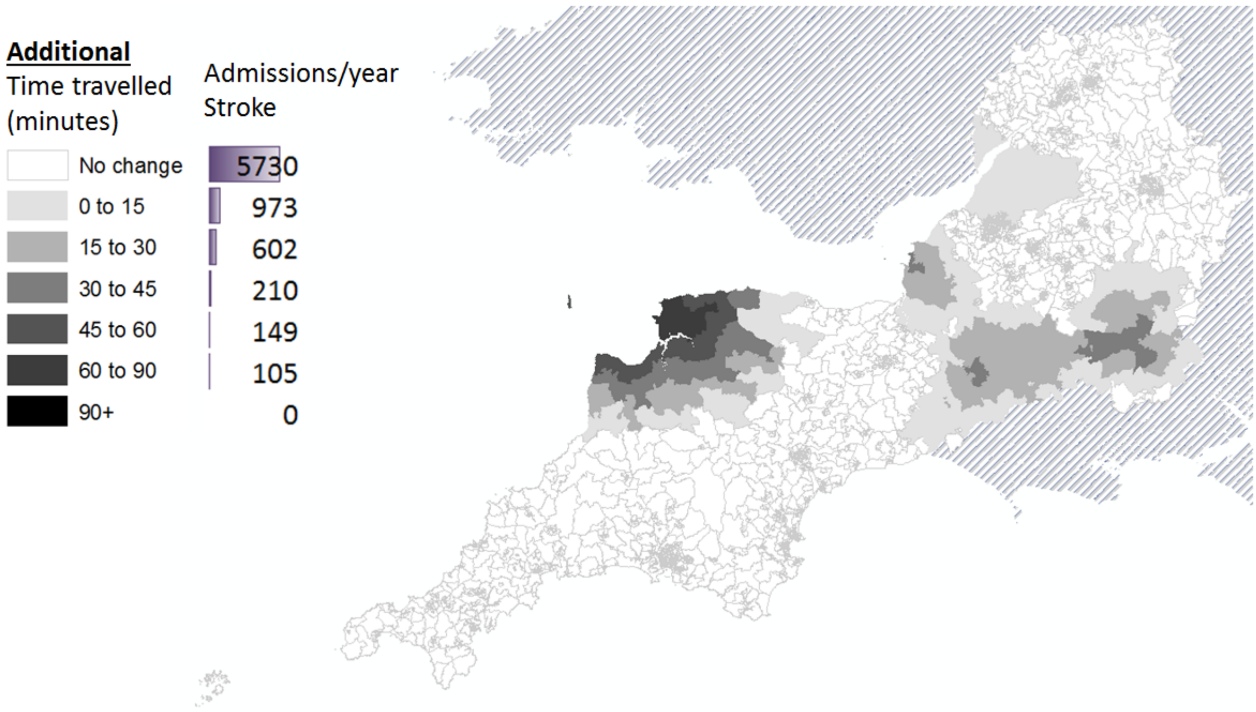


Figure 5.60 Changes in modelled ambulance travel times: 9 HASUs

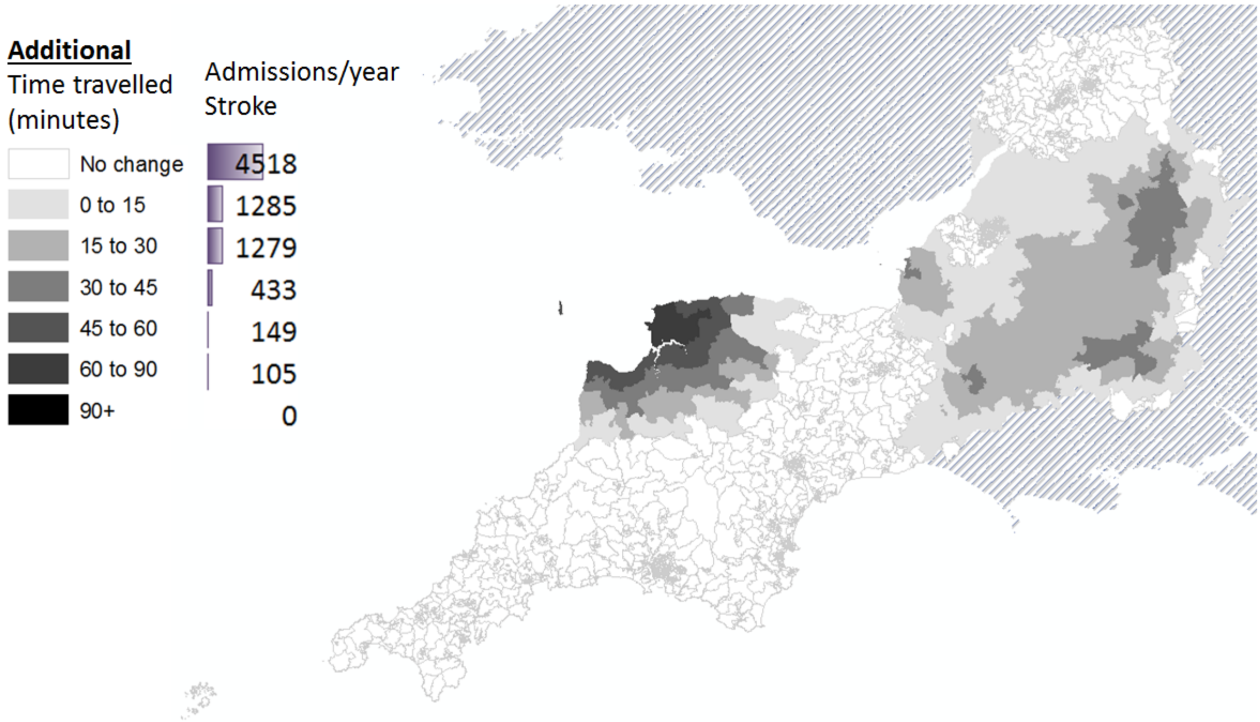


Figure 5.61 Changes in modelled ambulance travel times: 7 HASUs

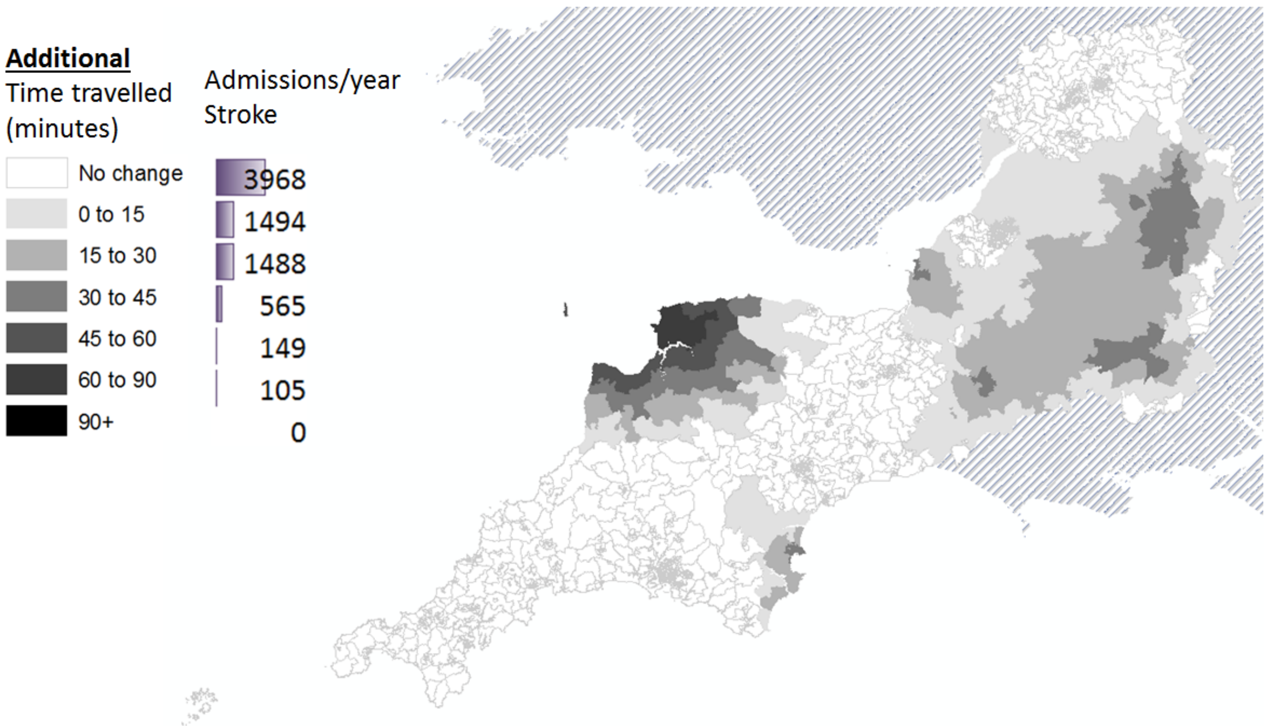


Figure 5.62 Changes in modelled ambulance travel times: 6 HASUs based in the Vascular Centres

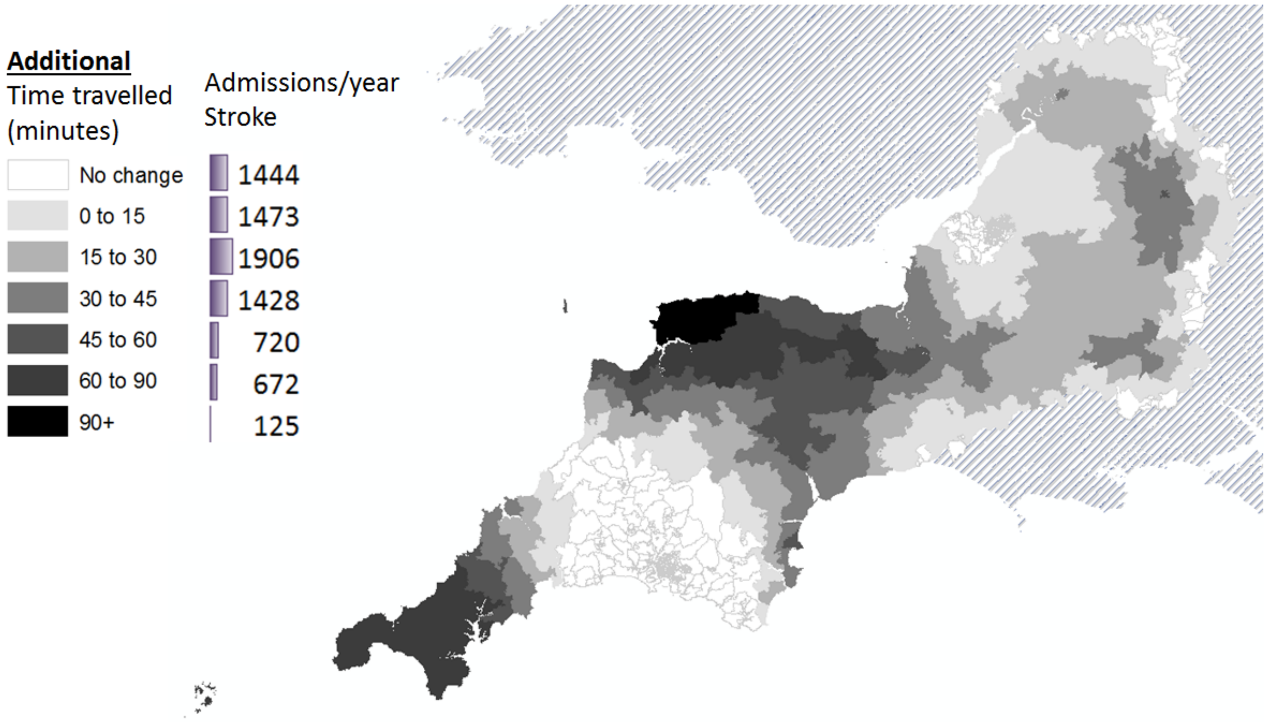


Figure 5.63 **Changes in modelled ambulance travel times: 2 HASUs based in the Neurointerventional Centres**

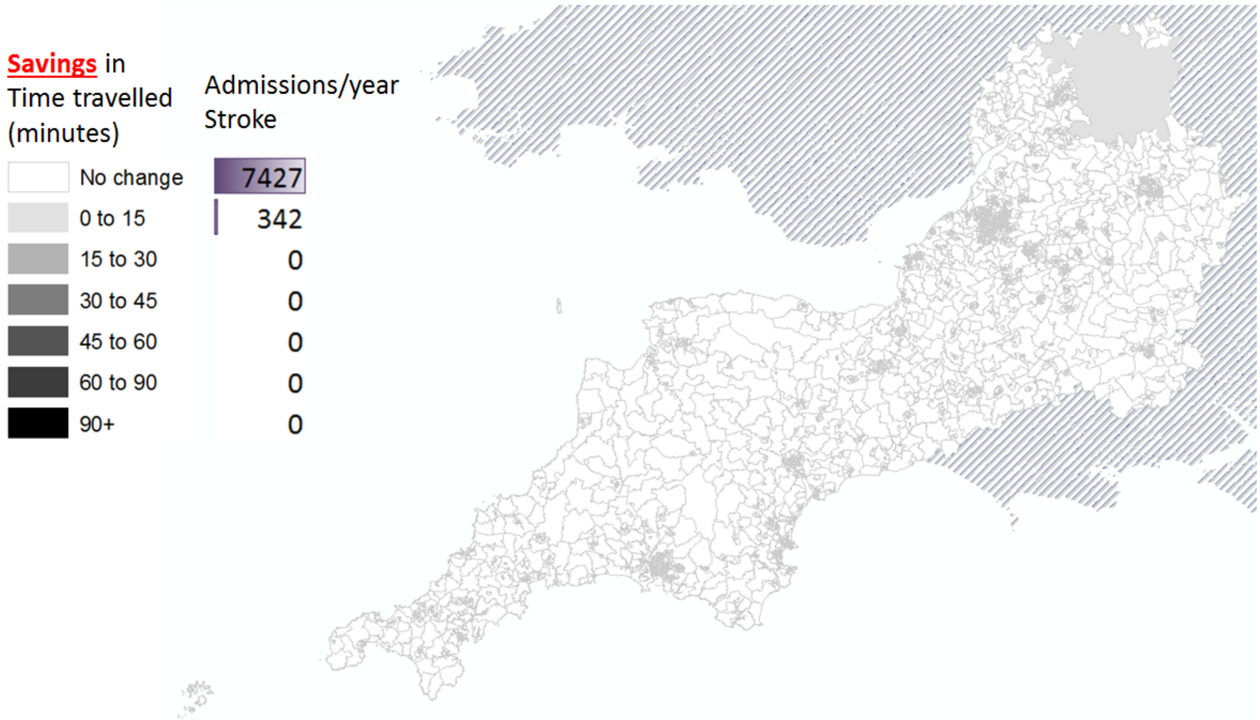


Figure 5.64 **Changes in modelled ambulance travel times: 15 HASUs to minimise travel times**

5.6 Heart Attack Centres and HASUs: other considerations

The range of possible configurations for HACs and HASUs is further constrained by considerations of institutional size and co-dependency. If the six proposed vascular surgical centres are to be designated as Specialist Emergency Centres offering both PPCI and HASU care, and if all HASUs are also required to have a stroke admission rate of between 500-1300/year (see Section 4.1.4), there are 16 possible configurations. Eight of these 16 configurations align with the seven current 24/7 PPCI centres - the six vascular surgical centres plus Torbay. Of these 8 configurations, the number of additional stroke patients displaced outside the region varies between 199 and 661 (see table below). Of note is that all the options with the smallest increase in patients displaced to out-of-region HASUs include Yeovil, given its boundary position in relation to Dorset. Thus if selecting from among otherwise very similar configurations (in terms of the primary parameters) on the secondary consideration of the number of patients displaced to HASUs outside the region, retaining a HASU at Yeovil is consistently favoured.

				Admissions/year														
				Six vascular surgical centres (fixed open)						Eight potential HASUs								
Scenario	Number of HASUs	Min admissions	Max admissions	BRISTOL 1	DEVON & EXETER HOSP	GLOUCESTER SHIRE HOSP	DERRIFORD HOSP	MUSGROVE PARK HOSP	CORNWALL HOSP	BATH	YEOVIL	BRISTOL 2	WESTON GENERAL HOSP	N. DEVON DISTRICT HOSP	THE GREAT WESTERN HOSP	SALISBURY DISTRICT HOSP	TORBAY HOSP	Out of region
Current	*14*	*246*	*750*	*523*	*548*	*717*	*750*	*530*	*729*	*680*	*465*	*523*	*425*	*406*	*532*	*246*	*550*	*146*
1	7	729	1,272	1,272	1,216	1,019	813	1,033	729	950	-	-	-	-	-	-	-	736
2	7	729	1,216	1,092	1,216	982	813	1,037	729	-	-	1,092	-	-	-	-	-	807
3	8	704	1,216	704	1,216	982	813	1,033	729	852	-	704	-	-	-	-	-	735
4	8	548	1,272	1,272	1,216	732	813	1,033	729	796	-	-	-	-	548	-	-	628
5	8	550	1,272	1,272	717	1,019	762	1,033	729	950	-	-	-	-	-	-	550	736
6	8	598	1,216	1,030	1,216	982	813	901	729	-	598	1,030	-	-	-	-	-	470
7	8	660	1,216	957	1,216	717	813	1,037	729	-	-	957	-	-	660	-	-	682
8	8	550	1,092	1,092	717	982	762	1,037	729	-	-	1,092	-	-	-	-	550	807
9	9	548	1,216	653	1,216	717	813	1,033	729	780	-	653	-	-	548	-	-	627
10	9	550	1,033	704	717	982	762	1,033	729	852	-	704	-	-	-	-	550	735
11	9	548	1,272	1,272	717	732	762	1,033	729	796	-	-	-	-	548	-	550	628
12	9	598	1,216	894	1,216	717	813	901	729	-	598	894	-	-	660	-	-	345
13	9	550	1,030	1,030	717	982	762	901	729	-	598	1,030	-	-	-	-	550	470
14	9	550	1,037	957	717	717	762	1,037	729	-	-	957	-	-	660	-	550	682
15	10	548	1,033	653	717	717	762	1,033	729	780	-	653	-	-	548	-	550	627
16	10	550	901	894	717	717	762	901	729	-	598	894	-	-	660	-	550	345

In scenarios that include two Bristol centres, the admissions are divided equally between them

Table 5.25 Potential HASU configurations once secondary considerations are applied regarding (i) co-dependency with vascular surgery and PPCI and (ii) 500-1,300 stroke admissions/year

The spread of travel times for each scenario in Table 5.25 is shown in the box and whiskers plot below, broadly corresponding with a fall in total ambulance travel time with an increasing number of HASUs.

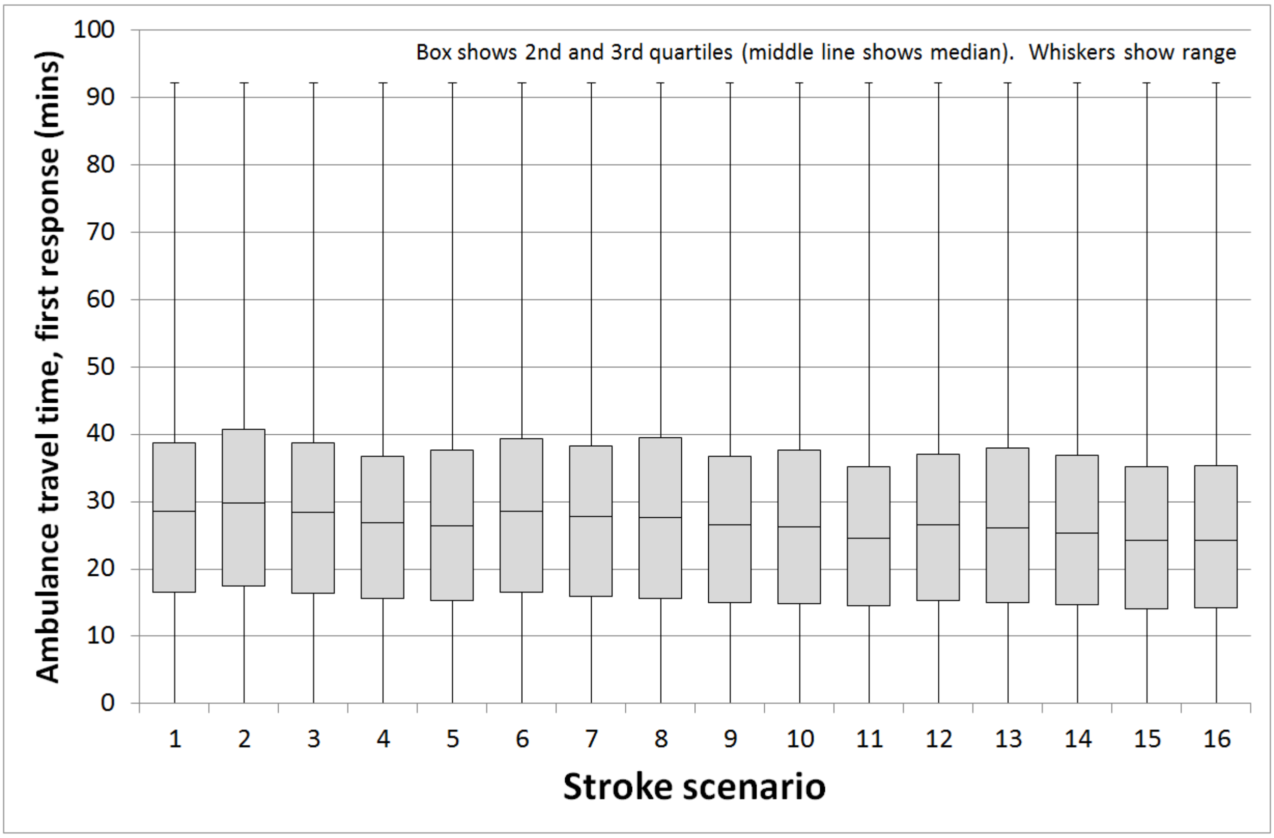


Figure 5.65 Total ambulance travel time according to different HASU configurations ('Stroke scenario' numbers correspond to Table 5.25)

From the 16 configurations that meet the minimum and maximum admissions criteria for a HASU, three scenarios with 8, 9 & 10 HASUs were identified based on the secondary consideration of the number of patients displaced to HASUs outside the region, and these are mapped in more detail below (scenarios 5, 13 and 16 in Table 5.25). All are based on a 7 HAC configuration which constrains the inclusion of Torbay as a HASU, which is not the case in all equivalently-scoring HASU configurations that include only 6 HACs.

To illustrate the issue of trade-offs, a second 7 HAC/9 HASU configuration (Table 5.25, scenario 11) is also mapped in more detail. This configuration has an improved average travel time compared to scenario 13 at 26 minutes compared to 28 minutes, and with 65% of patients living within 30 minutes of a HASU against 58%. Nonetheless the modelled overall clinical benefit between the two 9-HASU configurations is identical, and scenario 11 involves an additional 482 patients travelling to HASUs outside the region compared to an additional 224 in scenario 13.

	Scenario	5	11	13	16	
	# Hospitals	8	9	9	10	
	In region hospitals	Bristol 1	Bristol 1	Bristol 1	Bristol 1	Cardiac & HASU
		Plymouth	Plymouth	Plymouth	Plymouth	
		Glouc/Chelt	Glouc/Chelt	Glouc/Chelt	Glouc/Chelt	
		Taunton	Taunton	Taunton	Taunton	
		Truro	Truro	Truro	Truro	
		Exeter	Exeter	Exeter	Exeter	
		Torbay	Torbay	Torbay	Torbay	
		Bath	Bath			HASU
			Swindon		Swindon	
				Bristol 2	Bristol 2	
				Yeovil	Yeovil	
Cardiac admissions	Average travel (mins)	28	28	28	28	
	Maximum travel (mins)	92	92	92	92	
	Patients within 30 mins (%)	61	61	61	61	
	Patients using hospital in network (%)	93	93	93	93	
	Clinical benefit*	95.0	95.0	95.0	95.0	
	Patients attending hopsital with >standard admissions (%) **	100	100	100	100	
	Patients with call-to-treatment time of 120 min (%)	64	64	64	64	
	Patients with call-to-treatment time of 150 min (%)	96	96	96	96	
	First response, ambulance travel time (hours/day) ***	5	5	5	5	
	Repatriation, ambulance time (hours/day) ****	3	3	3	3	
Stroke admissions	Average travel (mins)	28	26	28	27	
	Maximum travel (mins)	92	92	92	92	
	Patients within 30 mins (%)	59	65	58	64	
	Patients using hospital in network (%)	91	92	94	96	
	Clinical benefit*	10.6	10.6	10.6	10.6	
	Patients attending hopsital with >standard admissions (%) **	92	85	84	85	
	First response, ambulance travel time (hours/day) ***	20	19	20	19	
	Repatriation, ambulance time (hours/day) ****	12	9	12	10	
All	Total first response, ambulance travel time (hours/day) ***	25	24	25	24	
	Total repatriation, ambulance time (hours/day) ****	15	12	15	13	

* Stroke clinical benefit = #patients MRS0-1 for every 100 patients clinically suitable for thrombolysis

* PPCI clinical benefit = #patients alive 1 year after treatment for every 100 patients

** PPCI standard admissions = 100/year; Stroke standard admissions = 600/year

*** First response: Twice time from patients home to hospital. In addition there are 6 & 22 hours per day (PPCI & stroke respectively) travelling to scene, on scene and handover (63 min per patient)

**** Repatriation: Twice time from chosen centre to home hospital plus 20 mins for handover time per patient transfer

Table 5.26 Cardiac and stroke parameters in four configurations ('scenarios') that include 7 Heart Attack Centres and 8,9 or 10 HASUs

		Admissions/year				
		PPCI*	Stroke			
	Scenario	All	5	11	13	16
	# Hospitals	7	8	9	9	10
Cardiac & HASU	Bristol 1	552	1,272	1,272	1,030	894
	Plymouth	255	762	762	762	762
	Glouc/Chelt	228	1,019	732	982	717
	Taunton	193	1,033	1,033	901	901
	Truro	278	729	729	729	729
	Exeter	202	717	717	717	717
	Torbay	187	550	550	550	550
HASU	Bath	-	950	796		
	Swindon	-		548		660
	Bristol 2	-			1,030	894
	Yeovil	-			598	598
	Out of region	139	736	628	470	345

Assumption: When two Bristol HASUs are open, they will share the total admissions going to both

Table 5.27 STEMI-PCI and hyperacute stroke admissions in four configurations ('scenarios') that include 7 Heart Attack Centres and 8,9 or 10 HASUs

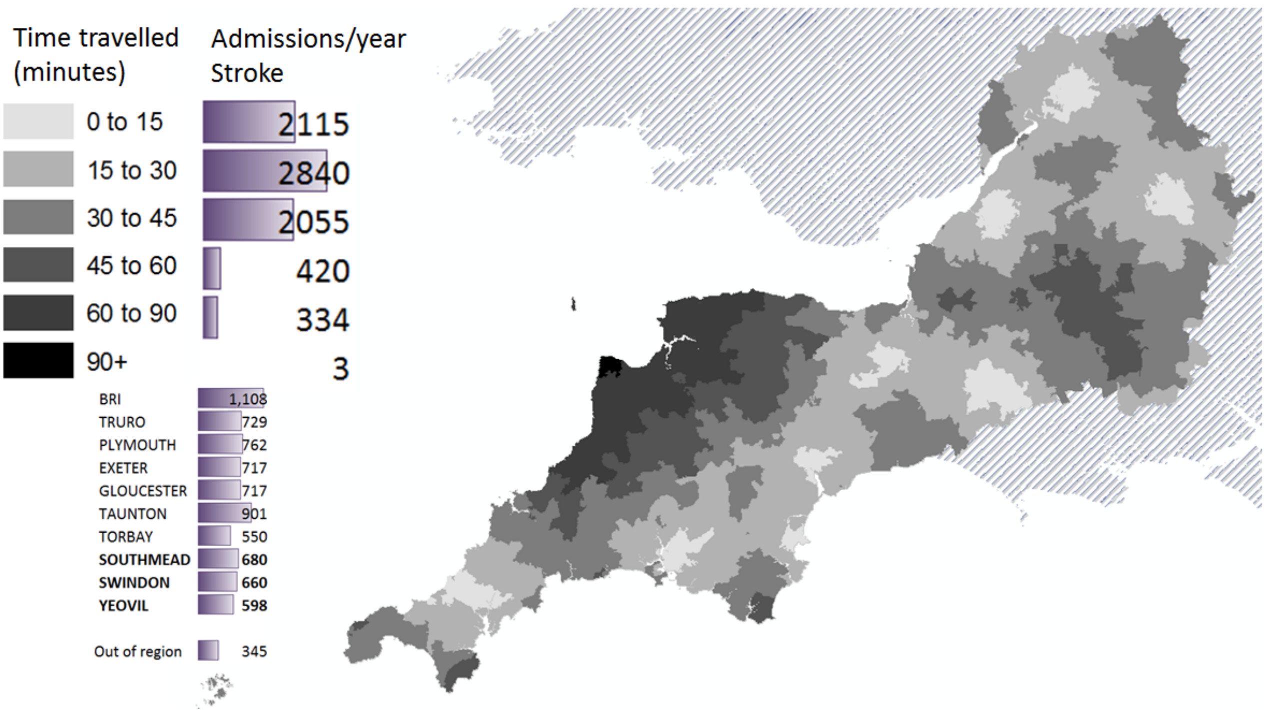


Figure 5.66 Ambulance travel times and admission numbers for hyperacute stroke in a 7 HAC/10 HASU configuration

HACs: 6 Vascular Centres plus Torbay; additional HASUs in Yeovil, Swindon and Bristol

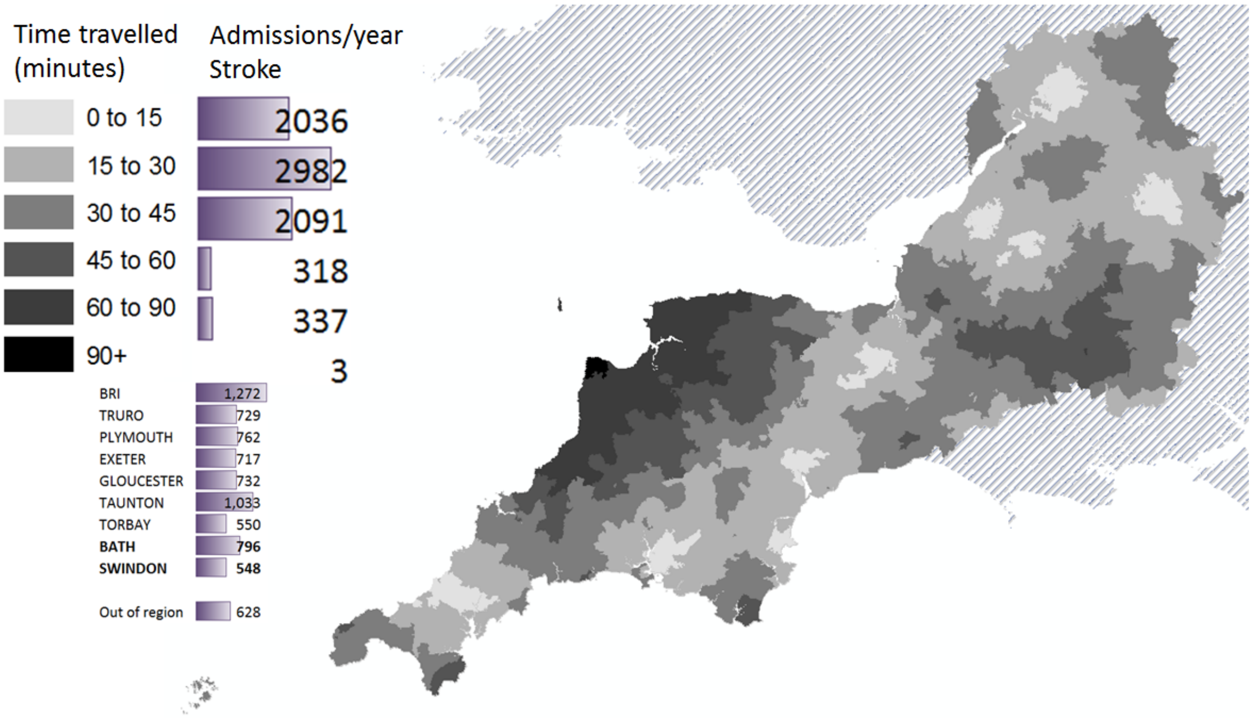


Figure 5.67 Ambulance travel times and admission numbers for hyperacute stroke in a 7 HAC/9 HASU configuration that prioritises minimising the average ambulance travel time and maximising the proportion of patients within 30 mins travel time of a HASU

HACs: 6 Vascular Centres plus Torbay; additional HASUs in Bath and Swindon

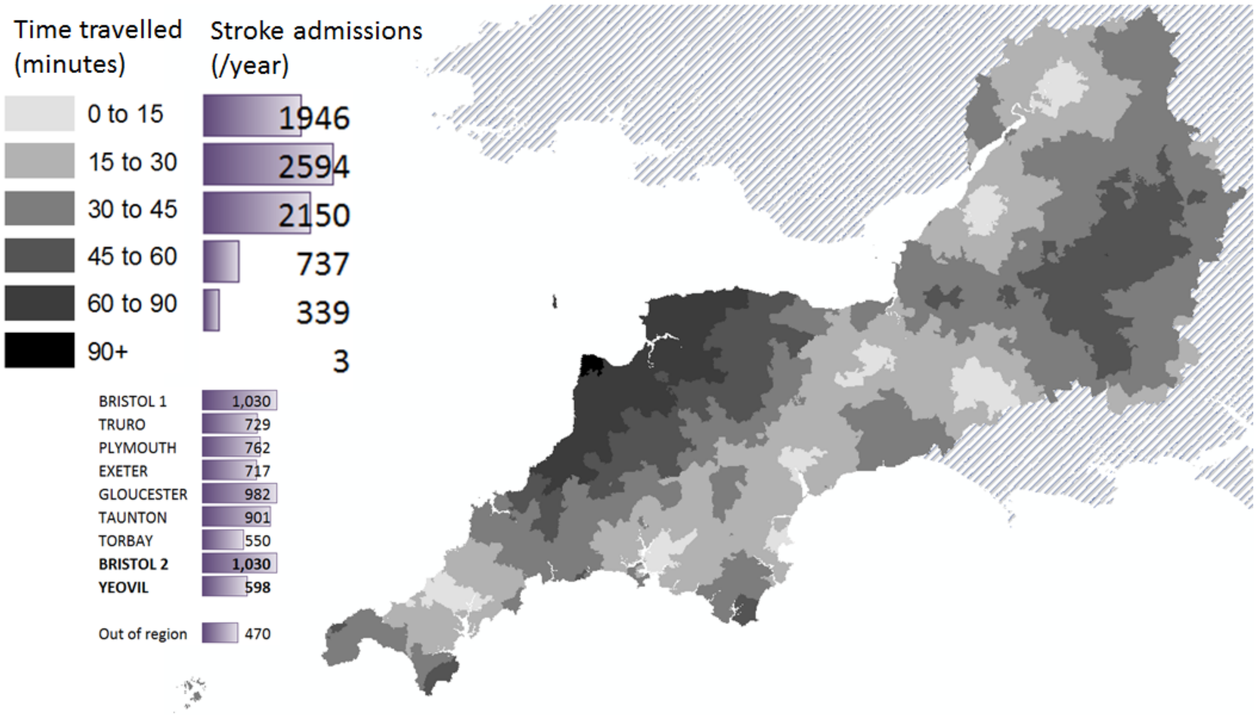


Figure 5.68 Ambulance travel times and admission numbers for hyperacute stroke in a 7 HAC/9 HASU configuration that prioritises minimising the number of patients displaced to HASUs outside the region

HACs: 6 Vascular Centres plus Torbay; additional HASUs in Yeovil and Bristol

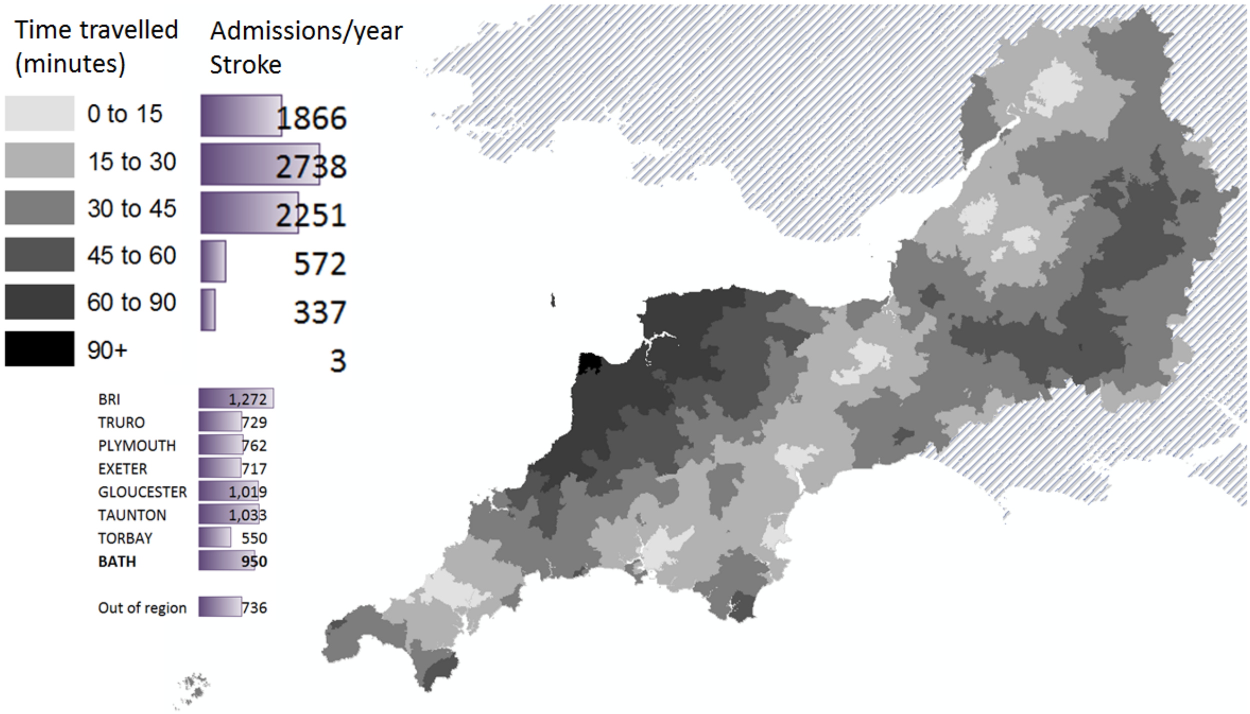


Figure 5.69 **Ambulance travel times and admission numbers for hyperacute stroke in a 7 HAC/8 HASU configuration**

HACs: 6 Vascular Centres plus Torbay; additional HASU in Bath

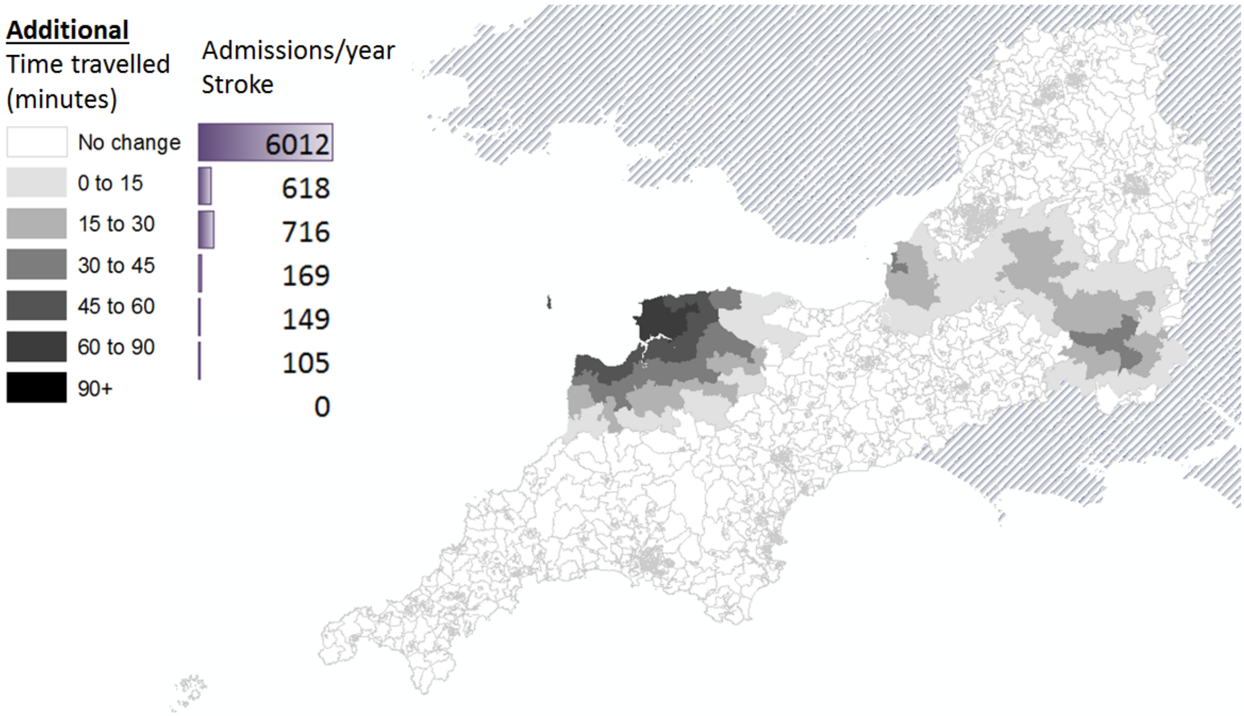


Figure 5.70 Additional ambulance travel times for hyperacute stroke in a 7 HAC/10 HASU configuration

HACs: 6 Vascular Centres plus Torbay; additional HASUs in Yeovil, Swindon and Bristol

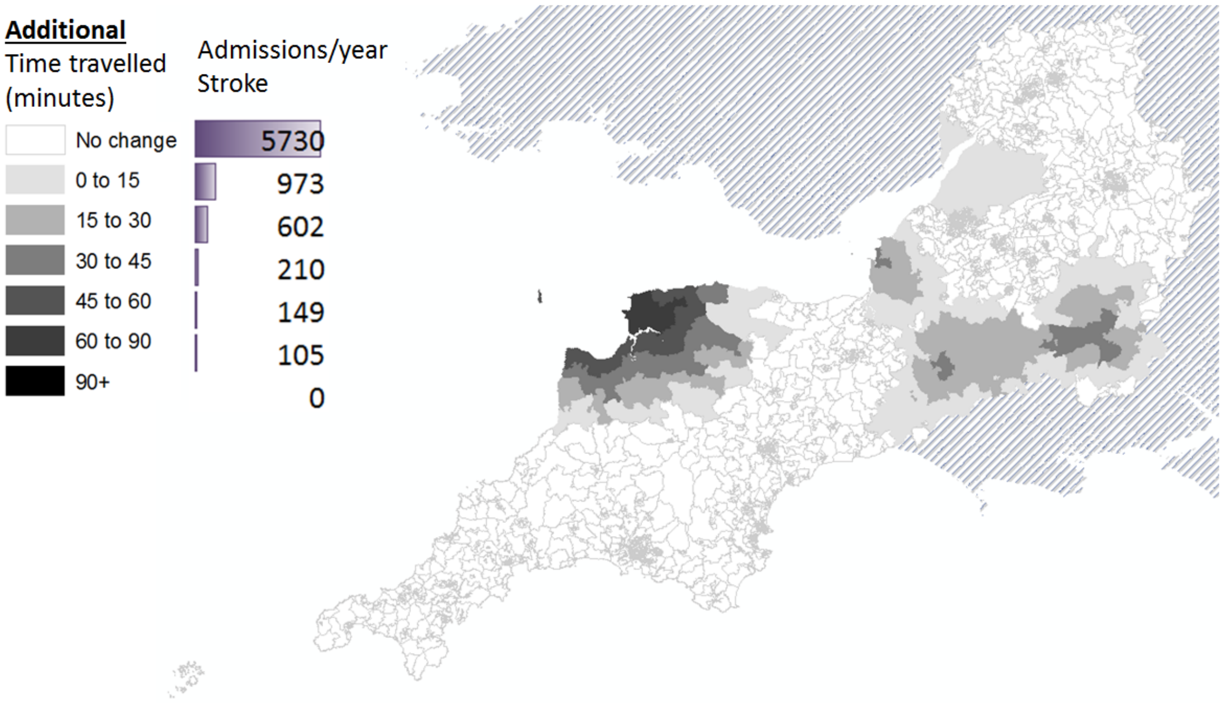


Figure 5.71 Ambulance travel times for hyperacute stroke in a 7 HAC/9 HASU configuration that prioritises minimising the average ambulance travel time and maximising the proportion of patients within 30 mins travel time of a HASU

HACs: 6 Vascular Centres plus Torbay; additional HASUs in Bath and Swindon

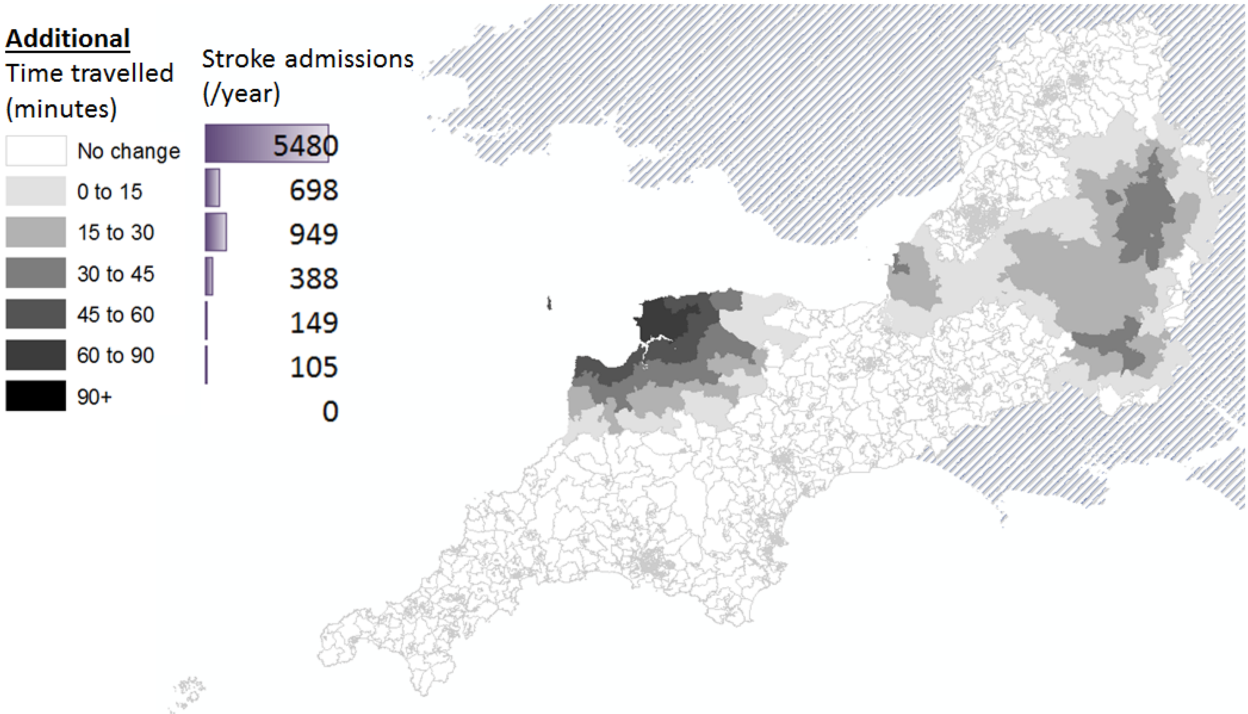


Figure 5.72 Ambulance travel times for hyperacute stroke in a 7 HAC/9 HASU configuration that prioritises minimising the number of patients displaced to HASUs outside the region

HACs: 6 Vascular Centres plus Torbay; additional HASUs in Yeovil and Bristol

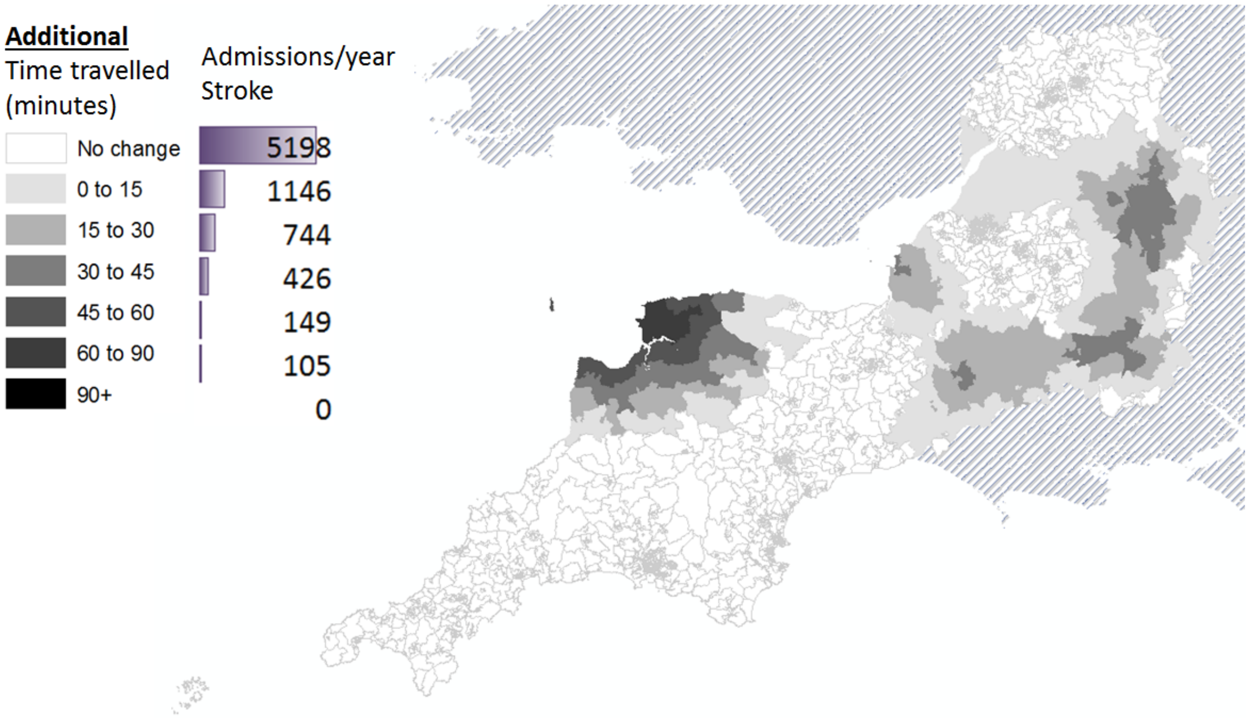


Figure 5.73 Ambulance travel times for hyperacute stroke in a 7 HAC/8 HASU configuration

HACs: 6 Vascular Centres plus Torbay; additional HASU in Bath

5.7 Forecast demographic growth in stroke

The table below shows regional population forecasts from the Office of National Statistics, coupled with the age breakdown of patients with a primary diagnosis of stroke (from HES). If there are no other changes (such as improved prevention that might stem from the National Vascular Screening Programme) the forecast demographic shift in the South West population would be expected to increase stroke incidence by approximately 37% over the 10 years from 2012, and 73% in 20 years.

Forecast Growth In Emergency Stroke Admissions

Age Band	Rate of stroke (per '000)	Forecast Regional Population (SW)						Forecast Incidence of Stroke					
		2012	2015	2020	2025	2030	2035	2012	2015	2020	2025	2030	2035
0 - 4 years	0.0	265	270	274	273	271	271	0	0	0	0	0	0
5 - 9 years	0.0	246	265	281	283	283	281	0	0	0	0	0	0
10 - 14 years	0.0	250	244	274	290	292	292	0	0	0	0	0	0
15 - 19 years	0.0	281	274	255	287	302	305	0	0	0	0	0	0
20 - 24 years	0.0	294	296	287	270	303	318	9	9	9	8	9	10
25 - 29 years	0.1	269	281	289	279	265	295	19	20	20	20	19	21
30 - 34 years	0.1	264	272	286	293	283	269	27	28	29	30	29	28
35 - 39 years	0.2	266	261	281	294	301	291	42	41	44	47	48	46
40 - 44 years	0.2	319	294	268	288	301	308	74	68	62	67	70	71
45 - 49 years	0.4	341	333	298	272	293	306	137	134	120	109	118	123
50 - 54 years	0.7	313	336	337	302	277	298	220	236	237	213	195	210
55 - 59 years	1.0	281	298	338	340	307	282	285	302	343	344	310	285
60 - 64 years	1.5	293	278	299	341	343	311	444	422	454	517	520	471
65 - 69 years	2.3	282	302	274	296	339	342	644	689	626	677	774	781
70 - 74 years	4.1	203	232	288	263	285	327	832	951	1,179	1,077	1,170	1,343
75 - 79 years	6.6	167	178	212	265	243	266	1,102	1,172	1,393	1,742	1,601	1,749
80 - 84 years	9.6	130	134	151	182	230	214	1,252	1,295	1,456	1,758	2,221	2,063
85 - 89 years	15.9	83	87	99	115	143	182	1,312	1,380	1,566	1,831	2,263	2,896
90+ years	18.1	48	54	66	83	106	138	868	977	1,189	1,499	1,915	2,495
All ages		4,595	4,688	4,853	5,016	5,166	5,294	7,267	7,724	8,727	9,939	11,263	12,592
								Projected growth from 2012:	6%	20%	37%	55%	73%

Table 5.28 Forecast growth in emergency stroke admissions, 2012-2035

5.8 Comparison of travel times when centres are selected by emergency stroke admissions, emergency STEMI admissions or whole populations

The chart below shows travel times to hospitals when the analysis is performed using 1) emergency stroke admissions, 2) emergency STEMI admissions or 3) whole populations (population in each LSOA). The analysis for this report has been based on specific patient groups (emergency STEMI admissions for PPCI or emergency stroke admissions for hyperacute stroke care). The chart below gives confidence that results appear generic; travel time breakdown is reasonably consistent across all three groups. This gives confidence that results for each of the patient group are not being significantly skewed by any potential imprecision in patient-level data.

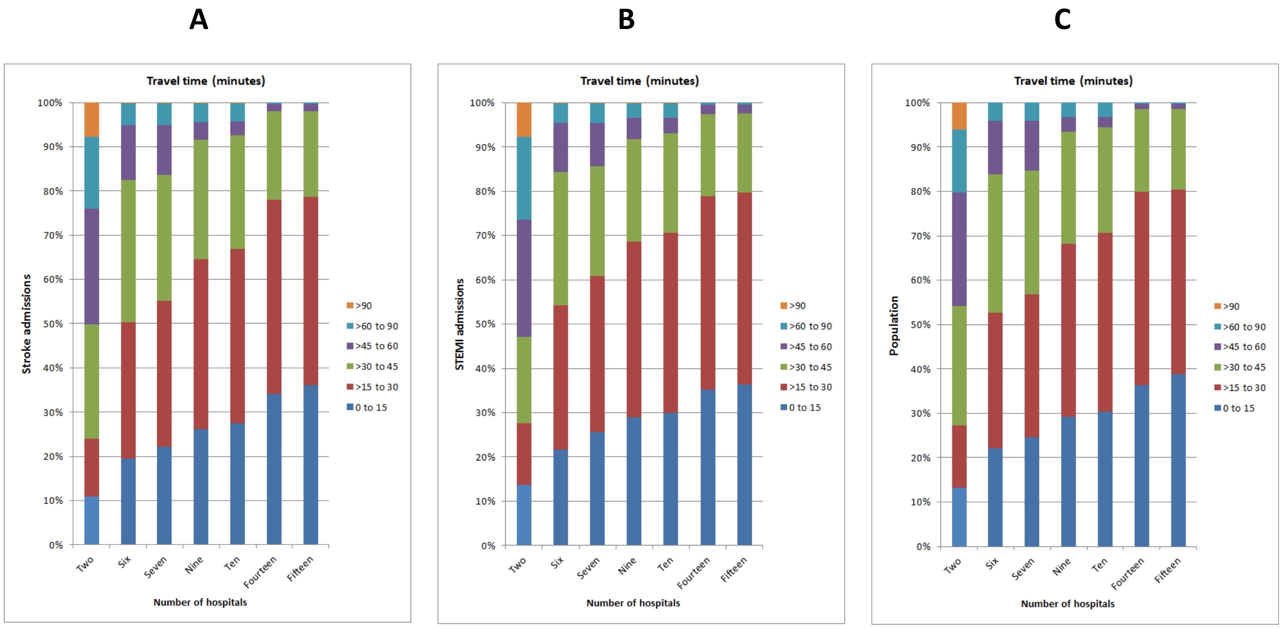


Figure 5.74 **Breakdown of emergency ambulance travel times under different configurations according to derivation from A. emergency stroke admissions, B. emergency STEMI admissions or C. population per LSOA.**

6. Discussion

The mapping project work undertaken by the SW CV SCN has clarified the options available to specialised and local commissioners in managing the transition to the sort of specialist emergency provision for heart attack and stroke that is envisaged in the UECR (NHS England, 2013) and the NHS Five Year Forward View (NHS England, 2014). In using a model based primarily on the clinical benefit from time- and volume-sensitive interventions for STEMI and hyperacute stroke, the project provides a sophisticated analysis of the impact of reconfiguration on the population of the South West as a whole, and on the benefits and disbenefits that might accrue from reconfiguration.

In seeking to strike the correct balance between these benefits and disbenefits, a number of important factors must be considered. These include:

1. The evidence base linking increased mortality to increased call to balloon times for STEMI patients undergoing PPCI is relatively modest. The mortality-time curves that do exist are relatively flat – i.e. the negative consequences from increases in travel times may themselves be fairly modest, at least when described solely in mortality terms. The evidence base for call to needle times for STEMI patients who are thrombolysed is stronger, and can be extrapolated to an extent into this analysis. However it is important to note that mortality is not the only important outcome and 'survival to poorer quality of life' is itself also an important outcome - for example due to heart failure post-STEMI (De Luca, 2004).

2. The relationship between call-to-treatment time and outcome for ischaemic stroke is steeper than that for STEMI, and is based upon the broader outcome of disability and death rather than mortality alone. The relation is illustrated by a doubling of the number needed to treat (NNT, the converse of the absolute benefit) for one additional patient to survive free of disability for every 90 minutes that elapses between onset and treatment (Emberson et al, 2014). Much as for STEMI, an outcome based purely on the proportion of patients left almost entirely free of disability (an mRS score of 0-1 indicating an excellent outcome at 3-6 months) understates the wider benefit from thrombolysis from an overall shift in the distribution of disability outcomes with treatment (Hong and Saver, 2010). It also understates the other benefits from the earlier delivery of interventions other than thrombolysis – for example, stroke unit access, earlier dysphagia assessment, and acute blood pressure management in intracerebral haemorrhage (Anderson et al, 2013).

3. The evidence base linking improved outcomes to institutional workload for PPCI is also somewhat modest. Historical evidence has focused on much lower levels of institutional activity than are presented here. Recent Myocardial Infarction National Audit Programme (MINAP)

data, with unadjusted 30-day mortality outcomes, have not shown a definite association of poorer outcome with smaller size provided the numbers are above the BCIS/National Service Specification absolute institutional minimum of 100 PPCI cases per year (MINAP, 2014).

4. The current Regional MINAP-based outcomes follow a similar pattern to the national data i.e. that STEMI outcomes from the region's smaller centres have not been definitively shown to be worse than outcomes from larger centres. There still remains significant and persisting overall variation in outcomes within the region, and sample sizes from smaller centres inevitably produce wider confidence intervals for infrequent outcomes such as mortality, with the result that many years' worth of data would need to be accumulated before a differential survival outcome became evident or statistically significant. This creates an issue regarding the 'burden of proof': is it incumbent on a centre treating fewer patients than stipulated in the National Service Specification to demonstrate that their outcomes are no different to those expected from a larger centre, something which would take many years and might act as a justification for 'no change', or is it legitimate for commissioners to use data from published large observational datasets to justify reconfiguration to larger centres in the reasonable belief that the observed differences in the literature would, given time, be reproduced in practice?

5. In this circumstance the rationale for reconfiguration should be understood in terms of the broader requirements of the UECR, which include co-dependency, National Service Specifications (based on specialty guidelines), and considerations of resilience and sustainability (especially in the context of 7/7 service provision, and emergency senior medical review), as much as to volume-outcome considerations.

With all of these provisions in mind, it could therefore be considered that a variety of solutions to the 'optimum number of Specialist Emergency Centres' question may be acceptable, and the choice between them may be based as much on considerations of workforce and sustainability as on the time- and volume-dependent factors. In this analysis configurations including 2, 6, 7, 9, 10 and 15 centres have been evaluated.

A two-centre configuration was assessed as the most extreme proposal that could be contemplated as a response to the UECR. Despite the modest time-mortality association for PPCI in STEMI, the consequences of this configuration on both travel time and institutional size have shown that it would not be realistic to implement this mega-centre configuration. Above a certain minimum threshold, the volume-outcome relationship levels off and other considerations come into play - it is not considered desirable, for example, for a HASU to be larger than 1500 stroke admissions/year, with none of the London HASUs being larger than this and most being much smaller.

At the other extreme, a 15-centre configuration (which would include the development of 5 additional PPCI centres and one additional acute stroke centre) was analysed to illustrate the maximum achievable health gain from having the shortest possible travel times across the region. However, at this end of the scale the additional gains from the modelled reductions in travel times are very small. Such gains are more than counterbalanced by other considerations, as it would fail to achieve the minimum operator/institutional competence numbers for many of the 15 PPCI providers, and likewise for the lower threshold for HASU activity. As such this configuration provides insufficient clinical justification for the substantial infrastructure investments that would be required.

A ten-centre configuration is the closest to the current status quo for PPCI provision, but with the notable difference that this option has been modelled only as ten full-time services (rather than the current mixture of 3 part time and 7 full time services). In the context of the drive towards 7/7 working and the increasing need for emergency senior medical review, the National Service Specification that only 24/7 services be commissioned should be regarded as a basic threshold to be met in planning services for anything beyond the short-term. For the foreseeable future, no configuration involving 10 HACs would entirely meet the minimum institutional activity requirements of 100 PPCI cases/year. At the time of writing it is not clear that all of the centres that might be commissioned in a 9 or 10 centre configurations would be able to provide a full time service, nor indeed that all such centres would be clinically sustainable in the long term. It is clear though that neither the 9 centre nor the 10 centre configurations would allow full compliance with all components of the National Service Specification for PPCI, and thus would not support the stated aims of the UECR.

6 and 7 centre configurations for PPCI services have also been evaluated. The 6–centre configuration is based upon the rationale for co-location of PPCI services with other vascular services to form the vascular hubs envisaged in the UECR, with the additional benefit of full compliance with the National Service Specification regarding minimum case number and full-time provision. A 7-centre configuration adds the current seventh fully specification-compliant service to the other six dictated by co-dependency with vascular surgery. This moves away from only providing PPCI in ‘vascular hubs’, but remains consistent with the National Service Specification, particularly with regard to minimum threshold of institutional activity, and still gives a sufficient degree of assurance regarding service resilience and sustainability.

The analysis of these various configurations of PPCI services is shown in the Results section above. It can be seen that there is an inflection point in travel times and mortality once fewer than 4 HACs are open, but with a significant increase in the number of patients treated outside the region once there are fewer than 6 centres within the region. Thus although analysis of the primary parameters might advance an argument for only 4 HACs within the region, secondary considerations (specifically the number of patients displaced to HACs outside the region and the co-dependency with vascular surgery) would support there being no fewer than 6 or 7. Balancing these priorities suggest that it is reasonable for the minimum clinically acceptable number of HACs in the South West to be 6, based in the currently designated or planned vascular hubs. This number also allows for full compliance with the relevant

National Service Specification and co-dependency with other vascular services, whilst still providing service sustainability. Nonetheless it remains at more than the number of HACs envisaged in the BCIS professional guideline, which specifies no more than 4 or 5 such centres for a population of 4.7 million.

The principal measure at hand, that of mortality 1 year after PPCI, is relatively but not absolutely flat for configurations of between 10 and 4 HACs (Figure 5.10). This modest slope represents an estimated mortality of between 82 and 85 deaths per year respectively, based on a background mortality rate of 5% for STEMI-PCI – a difference in 1-year survival of 95.1% versus 94.9% (absolute difference 0.18%)(the deterministic nature of the model precludes the use of confidence intervals for such differences, although if the modelled rate were to vary, the difference between them would remain approximately constant). What cannot be known or estimated is the effect on mortality of other changes within the system that might reasonably be expected to occur as a result of reconfiguration. Figure 5.15 illustrates the estimated effects on mortality of reductions in time on the scene and door-to-balloon time of 10 minutes (from 40 minutes to 30 minutes), either one of these alone equating to a reduction in predicted mortality approximately equal to the estimated impact from the longer average call-to-balloon times inherent in centralisation. If, as is implicit in the BCIS professional guideline, larger centres produce shorter door-to-balloon times or other clinical benefits from greater specialisation and activity, any effect on mortality from rationalising services would be at worst neutral or at best advantageous.

6.1.1 Principles of co-location of other complex cardiac services with PPCI services

In this analysis some principles related to complex cardiology service co-location have been adopted:

1. It is not essential to co-locate all other PCI services with PPCI services. It is clinically acceptable to have routine and urgent PCI services running in centres that do not provide a PPCI service, as long as those services fulfil their respective commissioning specifications. In the case of PCI services that would mean that there would still need to be a minimum institutional PCI number of 400 cases/year.

2. Centres that do provide PPCI services would also require co-location (or at least immediate access) to a number of related services – these would include: routine and urgent PCI, pacing, ICD, CRT, Cardiac MRI and CT Coronary Angiography services. These other services could also be undertaken in non-PPCI centres if they fulfil their respective commissioning specifications.

3. Simple/complex EPS services do not require co-location with PPCI services but would themselves need immediate access to ICD, CRT, MRI and pacing services.

4. Service provision for patients suffering out-of-hospital cardiac arrest should ideally be co-located with both critical care and PPCI services, to ensure rapid and full-time catheter lab availability for this patient group.

6.1.2 Effects of demographic change

This analysis has considered the consequences of demographic change on heart attack and hyperacute stroke service provision in the future, and considered the following issues:

1. The total number of PCIs undertaken in the UK, plus the proportion of routine vs. emergency PCIs (including the proportion of STEMI vs. NSTEMI cases), has remained stable or shown only a minimal increase in the last 3 years, according to MINAP data. This relative stability has occurred after a long period of increase in total PCI numbers, and a rapid increase in PPCI numbers until 2012. It is reasonable to assume that the prior rapid increase related to increasing capacity for PCI service provision, but that there is now more appropriate overall PCI capacity available. Alongside the development of UK-wide PPCI services there has been a significant shift from routine to urgent PCI provision (MINAP, 2014).

2. These forecast increases will not result in a material difference to the outcomes of the modelling of PPCI, i.e. no centre that is currently non compliant with National Service Specification will be rendered compliant in the 9 or 10 centre configurations as a result of this demographic change even up to 2030.

3. However, in stroke the greater absolute increases in incident stroke will have more implications for planning. Centres that at present are just below the current recommended institutional threshold of 600 admissions/year will, within a matter of a few years, accrue sufficient additional activity to cross that threshold. In particular, Torbay Hospital and Musgrove Park Hospital, Taunton, both of which have admissions in 2012-14 of 550-570 per year, can anticipate crossing that threshold within the next 5 years.

6.1.3 Impact of regional geography on specialist provision for the South West

The SW region is very large and presents significant, although not unique, geographical challenges. Although the population remains concentrated in the towns and cities, there are large areas of sparse population on Dartmoor, Exmoor and Salisbury Plain. This has a consequence on the region’s ability to deliver shorter call to balloon times for the entire population, and inequality in access to time-critical hospital treatments is inevitable. These are not new challenges for this reconfiguration project: even with the existing service provision for PPCI there is an area around North Devon which has particularly long travel times of >90 mins to any PPCI centre. Nonetheless, the absolute number of patients affected by these longer travel times is always going to remain small, if conspicuous.

In the analysis of the 'least change' 10-centre PPCI configuration it has been shown that, with current regional average ambulance at-scene times and door to balloon times, 97% of patients could meet the current National Service Specification requirement of a 150 minute call to balloon time, but that it would be very difficult to achieve the European Cardiac Society-recommended 120 minutes time in a similar proportion, with only 74% being treated within that time frame. As the number of HACs in the configuration is reduced, so does the percentage of patients able to achieve these target call-to-balloon times. Thus, although with 6 HACs 96% can still be treated within the 150-minute target, only 58% can be treated within the 120-minute target. In this geographical context it is likely that whichever configuration is adopted the 120-minute call to balloon time will remain impossible to fully deliver.

The situation with stroke is less specifically related to target call-to-treatment times, and in recent reconfigurations has been based far more on door-to-needle times (such as the specifications that the London HASUs achieve a door-to-needle time of 45 minutes for 90% of thrombolysed cases). Nonetheless, a similar impact on overall clinical benefit is seen when there are fewer HASUs within the region, and a similar mitigation is available through improved process times in larger centres. Existing clinical variation within the region in both call-to-balloon times for PPCI and door-to-needle times for stroke thrombolysis indicate significant residual capacity for improvements in the clinical benefit that have, in the present configuration, proved elusive. It can be seen in Figures 5.15 and 5.50 that relatively modest changes in at-scene and door-to-treatment times can confer substantial clinical benefits that would more than compensate for longer call-to-door times, even with fewer HACs and HASUs than are presently being considered.

Nonetheless, it is important to note that as we consider the net impact of configurations with fewer HASUs and HACs that the consequences upon travel times are not evenly distributed across the population. There is a disproportionate effect on the population around Wiltshire as the number of HACs drops from 10 or 9, to 6 or 7. This relates to a combination of the geography of Wiltshire and particularly Salisbury Plain, and the historic provision of part time centres around the periphery of that population in Salisbury, Bath and Swindon. The total numbers affected are small, and the consequences of the change relatively small compared to the current situation whereby for the majority of the time that population is already reliant upon more distant centres. However for that population, to move the existing office-hours provision to more distant centres would result in longer call-to-treatment times within office hours.

For stroke the issues are similar but on a larger scale, given the current wider dispersal of smaller acute stroke units, to an extent mirroring the impact of the original configuration of primary PCI services away from smaller centres. Consolidation to fewer HASUs has a consistent effect on travel times for people with stroke in North Devon, as all potential configurations involve a shift of those patients to HASUs elsewhere, principally in Exeter. With further reductions in HASU numbers, the principal other areas affected are in rural Wiltshire and around Brixham in Devon.

6.1.4 Implications for the Ambulance Service

Any geographical reconfiguration will have implications for ambulance services, especially the emergency ambulance response provided by SWASFT. The model anticipates increases in total ambulance time responding to STEMI and acute stroke calls and conveying patients to specialist HACs and HASUs. The magnitude of increase is less for STEMI, given that there is already a degree of centralisation in existing PPCI services and that the incidence is lower than for stroke. A reduction in HACs from 10 (estimated to occupy 4.7 hours/day of emergency ambulance time if all centres were open 24/7) to 7 or 6 would involve an increase in emergency ambulance time of 0.7-1.1 hours/day. A reduction in HASUs from the current 14 (occupying 15 hours/day of emergency ambulance time) to 8,9 or 10 centres would involve an increase in ambulance time of between 3 and 5 hours/day. The extent to which these estimates may be lower than the actual impact is dictated by the proportion of patients conveyed as *suspected* STEMI or acute stroke – estimated at 19% for stroke mimics (McMeekin et al, 2013). The proportion of false positives is observed to be lower for suspected STEMI (14.8%) given the greater specificity of ST-segment elevation for STEMI (Lu et al, 2016). It is worth noting that the model does take account of the 5% of cases of stroke that occur in hospital in-patients; HES allocates these patients to their home address, as opposed to the hospital in which they had their stroke, so their transfer to a HASU under any given configuration is still represented in the model.

Repatriation of patients after their initial PPCI or hyperacute stroke treatment is not provided by SWASFT, but instead by a range of private ambulance transport providers. Current repatriation activity after PPCI is estimated at 1.5 hours/day, and this would increase by between 1.5-2.2 hours/day in a 6 or 7 HAC configuration, based on the assumption that all PPCI patients will require repatriation to their local acute hospital. In reality, the proportion that require repatriation for continuing in-hospital care after PPCI is much lower than this, although estimates vary. Similarly, compared to the present situation in stroke where no repatriation is required, reconfiguration would entail an increase in ambulance time of 8-11 hours/day if all patients were repatriated to their local acute stroke unit from between 8-10 HASUs. Experience with the London reconfiguration identifies that at least a third of patients admitted directly to a HASU are discharged directly home without repatriation, indicating that additional demand would more likely be of the order of 6-7 hours/day. Taken together, these estimates represent additional ambulance activity for this range of options of 3.7-6.1 hours/day for emergency STEMI and stroke calls, and 7.5-10.7 hours/day for repatriation to local acute hospitals after hyperacute care.

6.1.5 Consequences of reconfiguration to a 6-7 HAC and an 8-10 HASU model

As well as the differential geographic effects from a reduction in the number of PPCI and hyperacute stroke centres within the region, a number of other important issues should be considered:

1. The benefits from reductions in on-scene times or door-to-treatment times for both PPCI and hyperacute stroke have the potential to outweigh significantly any disbenefits from increases in travel times. As such, if reconfiguration achieved reductions in door-to-treatment times, the benefits in comparison to the status quo could be substantial. These benefits have proved hard to realise over time under the existing structure. The relevant issue is therefore whether a reduction in the number of HACs and HASUs would make improvements in on-scene times or door-to-treatment times more likely. The evidence from the London HASU reconfiguration would suggest that this may well be the case for the latter, with these centres now producing among the highest thrombolysis rates and shortest door-to-treatment times in the UK.

2. The mapping analysis, including the total regional cath lab usage for non-PPCI procedures, has shown that the consequences of the changes in patient flow from a reduction in the number of PPCI centres to 6 or 7 are not large, and could be accommodated within the current cath labs capacity in the designated HACs.

3. A reduction to 6 or 7 centres would allow all HACs to be compliant with the National Service Specification for the first time, after several years of derogation. In the absence of such a reduction, it would be obligatory to consider how the National Service Specification might otherwise be met, as derogation is a time-limited provision to allow providers to make the adjustments necessary to achieve compliance.

4. However the consequences on some centres of losing their current PPCI workload could be significant. For some smaller centres, it is only the inclusion of the PPCI caseload that enables them to achieve the BCIS-recommended minimum of 400 total PCI cases/year. Without this, there is a risk that these centres will fall below the minimum activity for total PCI, which may jeopardise the entire coronary angiography service. Whilst neighbouring centres could potentially accommodate the PPCI workload as shown above, it is not clear that they could accommodate all the PCI workload if an adjacent angiography centre were to close. Nor is that a desirable outcome of this analysis, confined as it is to PPCI services. It is recommended therefore that before any alteration is made to PPCI services, that the local effects of such a change are considered as regards total centre-related PCI numbers, and mitigations are put in place to prevent placing non-emergency services under threat. This might require Network-type solutions between centres to mitigate the movement of emergency patients in one direction with a reciprocal elective service change in the other direction to ensure service stability and the maximum use of the available cath lab capacity.

5. Strategically, the provision of specialist emergency care in the hospital sector is increasingly driven towards fewer centres by co-dependency, workforce and technological considerations. Even in the absence of the UECR, this is a secular trend, which creates a planning imperative. A reduction to 6 HACs would allow a greater alignment with the stated co-dependency intentions of the UECR, without creating insoluble issues with HASU provision. Without reconfiguration at this juncture, alternative plans will need to be developed in response to these secular trends, or explicitly postponed until the next workforce shortage or medical advance.

7. Commissioning Options

In the light of the preceding discussion, the output from this modelling exercise can be summarised in the following options:

1. Retain the existing configuration of 10 HACs and 14 HASUs, but including the transition of the remaining office-hours HACs to 24/7;

2. Consolidate PPCI services into 6 or 7 HACs;

3. Consolidate hyperacute stroke services into 8,9 or 10 HASUs.

This gives seven options in all.

7.1.1 Option 1: 10 Heart Attack Centres and 14 Hyperacute Stroke Units

This 'least change' option accepts that the existing disposition of 10 HACs and 14 HASUs is optimal and cannot be improved upon, and concludes that the overall balance of risk and benefit from introducing larger scale change is not favourable. However, the modelling of 10 HACs includes the presumption that the remaining office-hours centres will alter their service provision to 24/7 going forward. Without this, much of the described advantages from the 'least change' option will be lost.

Advantages

1. Lowest costs (financial, organisational) from effecting change;
2. Travel times for emergency heart attack and stroke patients are minimised (and further reduced from present provision by the transition of the remaining office-hours HACs to 24/7);
3. Stroke (but not heart attack) services remain distributed in all acute receiving centres, thus eliminating hospital transfers for patients who suffer a stroke in hospital;
4. The most equitable geographical provision for the population as a whole.

Disadvantages

1. Not a neutral or 'no cost' option – organisational costs (from the transition to 24/7 HACs) and financial (increased transfers for vascular services) are implicit within the 'least change' option;
2. Several HACs are not anticipated to reach minimum levels of institutional activity for the foreseeable future, and thus this option includes the explicit acceptance that some HACs will continue to be non-compliant with the National Service Specification;

3. The option presenting the greatest risk of acute services being unable to meet the Clinical Standards contained within the UECR;
4. The option most likely to perpetuate the clinical variation between services that has persisted over recent years – in other words, the most inequitable clinical provision for the population as a whole;
5. This option is the most vulnerable to unplanned or enforced change due to workforce shortages. Future issues regarding the sustainability of small HACs and HASUs are not addressed, particularly with regard to the consultant workforce;
6. This option includes the greatest misalignment between heart attack and stroke provision and vascular services, perpetuating difficulties around access to vascular surgery for such patients.

7.1.2 Option 2: 6 Heart Attack Centres and 8 Hyperacute Stroke Units

This option describes PPCI provision that matches the current or planned vascular centres (Truro, Plymouth, Exeter, Taunton, Bristol and Cheltenham/Gloucester), with the addition of HASUs in Yeovil and a second HASU in Bristol. According to the modelling outputs, this option represents the 'base case' i.e. the minimum feasible number of centres for heart attack and stroke provision according to the specified criteria. Subsequent options including more HACs and/or HASUs will be described in terms of the incremental gain/loss from including more centres in the regional configuration compared to this base case.

Advantages

1. Offers the greatest long term clinical sustainability by creating the largest pools of expertise in heart attack and stroke;
2. Provides the greatest congruence with the developing vascular centres, thus minimising issues of access to vascular surgery for patients with stroke;
3. Represents the greatest opportunity to future-proof the configuration of 'cardiovascular centres' through the future development of intravascular services, especially endovascular treatment for major stroke.

Disadvantages

1. The biggest change in provision, creating the most issues for organisational change;
2. Creates the greatest geographical inequity, with the burden falling on specific parts of the region in terms of clinical disadvantage from increased travel times;

3. Creates the greatest need for repatriation of patients, and for the transfer of in-patient strokes, with attendant consequences for ambulance services;
4. Includes an increase in the number of patients travelling outside the region to receive their emergency care, especially in stroke (324 additional patients).

7.1.3 Option 3: 6 Heart Attack Centres and 9 Hyperacute Stroke Units

This configuration is similar to Option 2, containing an identical number of HACs, and with 3 additional HASUs in Yeovil, Swindon, and a second HASU in Bristol. Compared to Option 2, this option confers some marginal gains, with a 7% increase in the proportion of patients within 30 minutes travel time of a HASU, but with a 6% fall in the proportion of patients being cared for in a HASU of sufficient size. As both option 2 and 3 are on the 'flat' part of the curve of clinical benefit (if described purely in terms of the benefit from stroke thrombolysis), then no additional benefit is conferred by Option 3 compared to Option 2.

Advantages compared with Option 2

1. Reduces the overall magnitude of organisation change;
2. Reduces the number of patients receiving emergency stroke treatment outside the region (199 additional patients);
3. Reduces the impact of HASU reconfiguration on the population of Wiltshire, thereby reducing geographical inequity.

Disadvantages compared with Option 2

1. A small reduction (6%) in the proportion of patients treated in a HASU of sufficient size;
2. Less congruence with the developing vascular centres, thus creating issues of access for patients with stroke;
3. Reduced opportunities to future-proof the configuration of 'cardiovascular centres' and to allow for the development of future intravascular services, especially endovascular treatment for major stroke;
4. Geographical inequity persists, even though the number of HASUs has been increased;
5. Persisting need for the repatriation of patients, and for the transfer of in-patient strokes, with little reduction compared to options with fewer HASUs.

7.1.4 Option 4: 6 Heart Attack Centres and 10 Hyperacute Stroke Units

This configuration is similar to Option 3, containing an identical number of HACs, and with 4 additional HASUs in Yeovil, Swindon, Torbay and a second HASU in Bristol. Compared to Option 3, this option confers some marginal gains, with a 4% increase in the proportion of patients cared for in a HASU within the region. As options 2, 3 and 4 are on the 'flat' part of the curve of clinical benefit (if described purely in terms of the benefit from stroke thrombolysis) then no additional benefit is conferred by Option 4 compared to Options 2 or 3.

Advantages compared with Option 2

1. Reduces the overall magnitude of organisation change;
2. Reduces the number of patients receiving emergency stroke treatment outside the region (199 additional patients);
3. Reduces the impact of HASU reconfiguration on the population of Wiltshire and around Torbay, thereby reducing geographical inequity.

Disadvantages compared with Option 2

1. Compared to options with fewer HASUs, reduced congruence with the developing vascular centres, thus creating issues of access for patients with stroke;
2. Compared to options with fewer HASUs, less opportunity to future-proof the configuration of 'cardiovascular centres' and to allow for the development of future intravascular services, especially endovascular treatment for major stroke;
3. Geographical inequity persists, even though the number of HASUs has been increased;
4. Persisting need for the repatriation of patients, and for the transfer of in-patient strokes, with little reduction compared to options with fewer HASUs.

7.1.5 Option 5: 7 Heart Attack Centres and 8 Hyperacute Stroke Units

This option describes PPCI provision that includes all 7 HACs within the region that are able to presently comply with the National Service Specification (Truro, Plymouth, Torbay, Exeter, Taunton, Bristol and Cheltenham/Gloucs), with the addition of a HASU in Bath. Compared to a 6 HAC option (Options 2-4), Option 5 offers a 7% increase in the proportion of STEMI patients within 30 minutes ambulance travel time, a 6% increase in the proportion of STEMI patients with a call-to-treatment time of 120 minutes, and no significant change in clinical outcomes from revascularisation.

Subsequent options including additional HASUs will be described in terms of the incremental gain/loss from including more stroke centres in the regional configuration compared to this option.

Advantages compared with Option 2

1. Marginal gains in the proportions of STEMI patients accessing faster treatment (although not to an extent sufficient to improve overall clinical outcomes from revascularisation);
2. Reduces the impact of HAC reconfiguration on the population of Torbay, thereby reducing geographical inequity;
3. Less impact from organisational change by reconfiguring HACs to 7 rather than 6 centres. Only 1 (rather than 2) HASU will not be co-located with a HAC (Bath), providing a greater opportunity to future-proof the configuration of 'cardiovascular centres' and to allow for the development of future intravascular services, especially endovascular treatment for major stroke.

Disadvantages compared with Option 2

1. An almost equivalent magnitude of change in provision, for very modest marginal gains;
2. Includes the designation of a very large HASU in Bristol (1272 stroke admissions/year – the largest HASU of all the Options 2-7);
3. Includes the greatest number of stroke patients travelling outside the region to receive emergency care (590 additional patients).

7.1.6 Option 6: 7 Heart Attack Centres and 9 Hyperacute Stroke Units

This configuration is similar to Option 5 in containing an identical number of HACs, with the addition of 2 further HASUs. If priority is given to the average ambulance travel time and the proportion of people living within 30 mins travel time of a HASU, then the additional two HASUs should be in Bath and Swindon. If priority is instead given to the number of patients displaced to HASUs outside the SW region, then the additional two HASUs should be in Yeovil and a second in Bristol ('Bristol 2'). The difference between these two is that the Bath/Swindon option has an improved average travel time compared to Yeovil/Bristol 2 at 26 minutes compared to 28 minutes, and with 65% of patients living within 30 minutes of a HASU against 58%. By contrast, the Bath/Swindon option involves an additional 482 patients travelling to HASUs outside the region (the majority to Dorchester) compared with an additional 224 with the Yeovil/Bristol 2 option. The modelled overall clinical benefit between these two 7 HAC/9-HASU configurations is identical.

As both option 5 and 6 are on the 'flat' part of the curve of clinical benefit (when described purely in terms of the benefit from stroke thrombolysis) then no additional benefit is conferred by Option 6 compared to Option 5.

Advantages compared with Option 5

1. Reduces the overall magnitude of organisation change;
2. Reduces the number of patients receiving emergency stroke treatment outside the region (224-482 additional patients);
3. Reduces the impact of HASU reconfiguration on the population of Wiltshire, thereby reducing geographical inequity.

Disadvantages compared with Option 5

1. May include the designation of one HASU (Yeovil) that would have neither heart attack nor vascular provision (although non-emergency cardiology services are still present);
2. Less congruence with the developing vascular centres, thus creating issues of access to vascular surgery for patients with stroke;
3. Reduced opportunities to future-proof the configuration of 'cardiovascular centres' and to allow for the development of future intravascular services, especially endovascular treatment for major stroke;
4. Geographical inequity persists, even though the number of HASUs has been increased;
5. Persisting need for the repatriation of patients, and for the transfer of in-patient strokes, with little reduction compared to options with fewer HASUs.

7.1.7 Option 7: 7 Heart Attack Centres and 10 Hyperacute Stroke Units

This configuration is similar to Option 6, containing an identical number of HACs, and with the addition of 3 further HASUs, in Yeovil, Swindon and a second in Bristol. Compared to Option 6, this option confers some marginal gains, with a 6% increase in the proportion of patients within 30 minutes travel time of a HASU, and a 2% increase in the proportion of patients cared for in a HASU within the region. As options 5, 6 and 7 are all on the 'flat' part of the curve of clinical benefit from stroke thrombolysis, then no additional benefit is conferred by Option 7 compared to Options 5 or 6.

Advantages compared with Option 5

1. Reduces the overall magnitude of organisation change;

2. Reduces the number of patients receiving emergency stroke treatment outside the region (199 additional patients);
3. Reduces the impact of HASU reconfiguration on the population of Wiltshire and East Somerset, thereby reducing geographical inequity.

Disadvantages compared with Option 5

1. Includes the designation of two HASUs (Yeovil and Swindon) that would have neither heart attack nor vascular provision (although non-emergency cardiology services are still present);
2. Less congruence with the developing vascular centres, thus creating issues of access for patients with stroke;
3. Reduced opportunities to future-proof the configuration of ‘cardiovascular centres’ and to allow for the development of future intravascular services, especially endovascular treatment for major stroke;
4. Geographical inequity persists, even though the number of HASUs has been increased;
5. Persisting need for the repatriation of patients, and for the transfer of in-patient strokes, with little reduction compared to options with fewer HASUs.

8. Conclusions

The options described above subserve the obligations of CCGs to meet the current and future healthcare needs of their patients through the delivery of high quality care by services with long term sustainability. The results of this modelling project identify several configurations that take precedence because they represent the best available balance between a number of competing criteria – principally the clinical benefit that derives from onset to treatment times for both STEMI and hyperacute stroke, but also institutional activity and, as a secondary criterion the proportion of patients displaced to centres outside the South West region. Specifically, the analysis has demonstrated that the minimum clinically acceptable number of HACs in the South West is likely to be six or seven, providing equivalent clinical outcomes to configurations involving greater numbers of centres. The maximum number of HACs that allows full compliance with National Service Specifications is nine. Hence one consequence of selecting the 'least change' option (Option 1) is an explicit recognition that parts of the South West provision for STEMI would remain non-compliant with the National Service Specification for the foreseeable future – demographic change is unlikely to affect that conclusion before 2030. In conjunction with a reduction in the number of HACs, co-dependency of STEMI and hyperacute stroke services together with recommended levels of institutional activity dictate that there should be between 8 and 10 HASUs – again, a conclusion that is resilient to demographic change.

This analysis has demonstrated that the consequences for catheter lab capacity, including for other specialist procedures, from a reduction to a 6 or 7 HAC configuration are likely to be modest and could be accommodated within existing capacity. The consequences of such a change on some smaller centres losing their PPCI services could be more significant and should be mitigated wherever possible through the reciprocal transfer of elective angiography/angioplasty activity. Reconfiguration would result in substantial change in the numbers of patients with acute stroke being admitted to the designated HASUs – increases of up to two-fold for some centres. These changes would bring all HASUs within the region to within the recommended range for institutional activity (allowing for future demographic trends) of 500-1300 admissions/year.

Geographical analysis demonstrates that the consequences of such changes in STEMI and HASU provision fall disproportionately on the populations of North Devon and Wiltshire. Detailed analysis shows that the overall travel-time and clinical benefit consequences of such a change for the region as a whole (as opposed to the relative consequence on those local populations) are small. What has not been possible in this analysis has been a direct comparison between the adverse effects of the present disposition of services (in terms of the impact on outcomes of persisting clinical variation or variation in access to services) and the geographical variation that is introduced or increased through consolidation of specialist services in fewer centres. This point illustrates that the 'least change' option is not a neutral option – apart from involving the shift of all existing office-hours PPCI services to 24/7, it also involves an explicit acceptance that significant between-centre clinical variation, which has persisted despite the quality improvement effort of the Clinical Network(s) in recent years and is itself tangibly linked to adverse outcomes, is allowed to persist.

9. Recommendations

This detailed, evidence-based analysis of the clinical case for the reconfiguration of heart attack and hyperacute stroke services within the South West region has shown that in order to develop a regional network of cardiovascular centres that is resilient to anticipated changes in demand, technology and workforce, services should be provided in either 6 or 7 Heart Attack Centres and between 8 and 10 Hyperacute Stroke Units. Taken as a whole region, the incremental gains from configurations at the upper end of that range are marginal. However, the disbenefits from reconfiguration are not equally spread across the region, with particular issues of emergency access for people in North Devon, Wiltshire, and in some configurations, Torbay.

In order to move to the next stage in the process for large scale service change laid out in *Planning and Delivering Service Changes for Patients* (NHS England Strategy Unit, 2013), two further steps are now recommended:

1. Consultation with patients and the public. As with many similar geographical reconfigurations of specialist services, the views of patients and the public on the 'trade offs' between services that are local but may not be compliant with professional recommendations or National Service Specifications, and services that are more distant but more specialised need to be sought. For emergency cardiovascular services, this responsibility is shared between Specialised Commissioning and the CCGs in the region, and is particularly but not exclusively relevant in areas where the population will be most affected by change – for NHS Northern, Eastern and Western (NEW) Devon CCG, for NHS South Devon and Torbay CCG and NHS Wiltshire CCG. CCGs may be assisted in this process by further analysis of the local impact from some of the options appraised in this report. The views of the South West Clinical Senate are also key to this process, particularly in reconciling the differences between the desire to retain the full range of services locally and the benefits to the population of the South West as a whole from developing high quality, sustainable services.

In consulting with patients and the public, CCGs should be aware that there is no proposal for a 'do nothing' option – all options involve a trade-off of one kind or another, principally between accepting persistent clinical variation in services for the sake of more even geographical coverage, or vice versa.

Consultation will also be required with adjoining networks regarding the implications for hospitals accommodating additional cases of stroke and STEMI, particularly as some of the options considered involve significant numbers of patients displaced to HACs or HASUs outside the SW region.

2. Agreement on arrangements for collaborative commissioning. The regional/sub-regional nature of these service changes mean that the decision-making process cannot be fully devolved to the level of the individual CCG. Although there are some CCGs within the region that are relatively unaffected by the proposed reconfiguration (most notably NHS Kernow CCG), most of the impact of reconfiguration is shared across adjacent CCGs, so commissioning decisions cannot be made in isolation. The acknowledged and proven mechanism to progress joint commissioning decisions of this kind, particularly where they also involve Specialised Commissioning as in this case, is through the Strategic Clinical Network. The introduction of 'place-based' Sustainability and Transformation Plans (STPs) as the mechanism for agreeing a programme of transformational funding to close the 'care and quality gap' within a geographically defined area ('Transformational Footprint') provides the vehicle for progressing the changes recommended in this report. The footprints for STPs in Bath/Swindon/Wiltshire and in NEW Devon/South Devon & Torbay are particularly relevant to the most prominent (but not the only) changes recommended, but such footprints still involve some significant overlap, especially in the Bristol/Bath area, and so even at this level the decision-making process cannot proceed in isolation and continued regional oversight will be required. A timetable for the decision-making process will need to be agreed as part of the STPs, bearing in mind that the NHS Business Plan for 2014/15-2016/17 envisaged completion of business planning for reconfiguration by March 2017.

Achieving agreement from constituent CCGs will necessitate financial modelling of the available options so that proposals are consistent with and reflected in STPs. This financial modelling may require specific resources from Commissioning Support Units or other collaboration between CCGs.

Completion of these steps should result in the identification of a preferred regional option to be taken forward within Transformational Footprints for the reconfiguration of emergency cardiovascular services. This option should then be subject to the 'Four Tests' of major service change (NHS England Operations and Delivery, 2015):

• strong public and patient engagement;

• consistency with current and prospective need for patient choice;

• a clear clinical evidence base;

• support for the proposal from clinical commissioners.

Within any Transformational Footprint the selected option will need to be considered by Health and Wellbeing Boards and Overview and Scrutiny Committees before going through the NHS England assurance process before a final decision is made and implemented.

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Appendix 1

South West Strategic Clinical Network

SW CV SCN – Complex Cardiology and Stroke Service Mapping

Project Initiation Document

Purpose

This Service Mapping Project arises as a consequence of the following national drivers:

1. **The Urgent and Emergency Care Review (UECR) –** Specialist Emergency Centres to include at least two of the following:
   - Major trauma management including neurosciences, plastic surgery, burns;
   - Primary percutaneous angiography for myocardial infarction;
   - Stroke;
   - Emergency vascular surgery;
   - Specialist paediatric facilities;
   - Critical care;
   - Interventional Radiology.

   The UECR anticipates a rationalisation of many of these services to between 40 and 70 Specialist Emergency Centres across England. The principal objectives of the UECR are endorsed in the NHS England Five Year Forward View (October 2014).

2. **'Putting Patients First' - NHS England Business plan 2014/15-2016/17.**
   - Develop a specific case for acute stroke service reconfiguration in two geographical locations by April 2015;
   - Ensure the availability of resilient and sustainable seven day services where this makes a clinical difference to outcomes.

3. **Specialised Commissioning national service specifications.**

The SW CV SCN have been tasked by NHS England to coordinate the development of service maps and profiles for complex cardiac and stroke services across the SW SCN footprint, to provide robust evidence to support discussions regarding service configurations.

The SW CV SCN covers Devon, Cornwall & Isles of Scilly, Bath, Gloucestershire, Swindon & Wiltshire, Bristol, North Somerset, Somerset, South Gloucestershire and all Clinical Commissioning Groups/Unitary Authorities within these boundaries.

The patients included in the model are those who live within the SW SCN area **OR** those patients whose closest* acute/general hospital is within the Strategic Clinical Network area.

**Closest = lowest straight line distance, estimated using Microsoft MapPoint with MP Mile Charter Add-In.*

Where possible the identification of closest hospital will be restricted to those known to offer particular service (e.g. those hospitals accepting patients for stroke or primary PCI).

Scope

Stroke and complex cardiology services will be modelled to incorporate the South West population, taking full account of boundary issues. It will encompass the provision of emergency/primary coronary angioplasty (PPCI), together with elective provision for complex devices and electrophysiological services. It will also examine hyperacute stroke services, taking account of essential co-dependencies such as vascular surgery and interventional radiology.

The modelling will start from a blank canvas and include the following options:

1. Status quo;
2. Configurations meeting best/expert practice:
   i) Meeting national guidance

Cardiac	
Primary Percutaneous Coronary Intervention (PPCI)	• Minimum 100 PPCI per annum • Call to balloon (CTB) 150 mins • Door to balloon (DTB) 90 mins -75% or greater • Operating hours-24/7 • 300 or more patients per annum, with an absolute minimum of 100 PPCI patients per annum • 2 or more cardiac catheter laboratories
Percutaneous Coronary Intervention (PCI)	• 400 cases per annum • 1 cardiac catheter laboratory (BCIS)
Electrophysiology	• AF ablation – 100 per million • SVT ablation – 100-150 per million • Ventricular tachycardia ablation – 20 per million
Complex Cardiac Devices	• ICD - 100 per million • CRT - 130 per million
Cardiac Magnetic Resonance Imaging (CMR)	• Minimum 300 scans and >500 scans for training centres
Stroke	• 600-1500 stroke admissions per year • Maximum 45 minute travel time • 6 consultants with stroke expertise on rota • 7-day consultant ward rounds • Nursing input: 2.9 WTE nurses per bed for HASU (ratio 80:20 qualified to unqualified) and 1.35 (ratio 65:35) for ASU • Therapy input: 0.73 WTE Physio, 0.68 OT, 0.68 SALT per 10 beds (HASU)

   ii) Meeting international guidance;

Cardiac	
Primary Percutaneous Coronary Intervention (PPCI)	• *European Society of Cardiology (*ESC) guidance 600,000 to 1 million catchment population • ESC guidance Call to balloon (CTB) 120 mins

3. Co-location of complex cardiac and stroke services;
4. A two-centre option - Bristol and Plymouth (both organisations meet all the Major Emergency Centre criteria);
5. A range of intermediate geographical configurations up to and including the status quo.

The modelling exercise will be evidence based and be undertaken in collaboration with academic partners in the SW Peninsula CLAHRC with expertise in healthcare-related service modelling (see http://clahrc-peninsula.nihr.ac.uk/).

Outcomes

- The Service Mapping Project will produce a range of options intended to provide the greatest health benefit from interventions for acute stroke and heart disease, and improved access to complex cardiac services, to the maximum number of people in the South West. These options will take account of anticipated changes in demography and disease incidence over the next 10-20 years.
- The Service Mapping Project will provide an options appraisal to present to Clinical Commissioning groups and Specialised Commissioning to guide decision-making in response to the UECR.

Data requirements

The model will be populated using data from the time period 2010-2014. Data to be obtained from HES:

- Number of patients with primary diagnosis of stroke (ICD10 codes I-61, I-63 and I-64) along with home location (by Lower Layer Super Output area and hospital trust of treatment).
- Number of patients with primary diagnosis of myocardial infarction (ICD10 codes I-21) along with home location (by Lower Layer Super Output area and hospital trust of treatment).
- Number of patients with PCI (elective separated by emergency and STEMI separated from NSTEMI); Procedure codes K49, K50, K75) along with home location (by Lower Layer Super Output area and hospital trust of treatment).

Data from the National Cardiovascular Health Intelligence Network (NCVIN):

- Number of patients passing through cardiac catheter labs with breakdown of procedures: PCI, PPCI, Implantable Cardioverter Defibrillator (ICD), Cardiac Resynchronisation Therapy (CRT), Electrophysiology and ablation, transcatheter aortic valve implantation

(TAVI), angiography, pacemaker implantation. Broken down by type of admission (emergency/elective) and organisation.
- Catheter lab time required per procedure.

Data from relevant national audits (MINAP and SSNAP):

- 90th percentile door-to-balloon times for PPCI by hospital;
- Thrombolysis treatment times for hyperacute stroke.

Pre-hospital data from South Western Ambulance Service:

- 12 month ambulance data for patients attended with suspected stroke or myocardial infarction (identified by either phone triage or paramedic where paramedic classification is available):
  - Date and call origin time
  - Postcode (full)
  - Time Arrived At Scene
  - Time Left Scene
  - Hospital Attended
  - Arrival at hospital time
  - Reason for stopped call
  - Handover duration.

Constraints and Risks

Constraints

1. The project can make no assumptions regarding reconfigurations of adjacent services in boundary areas, which may affect services within the South West.
2. The project will, where necessary, assume the existing plan for the reconfiguration of acute vascular services into larger geographical networks will proceed as presently outlined.
3. There is an underlying assumption that any reconfiguration will be achieved within the existing specialised/locally commissioned financial envelope.
4. Although cardiovascular mortality will be modelled, sample size considerations will significantly reduce the confidence with which any conclusions relating to mortality can be drawn.

Risks

1. Failure to agree on the parameters of benefit for the population (or, prioritising organisational benefits and burdens above those for the population).
   Mitigation: Present opportunities to stakeholders through the SW CV SCN Commissioning Advisory Groups (CAGs) and other means to articulate the overarching priorities of the project.
2. Technical failure to produce a model capable of producing the desired outputs. This includes limitations of the data, which comes in part from NHS administrative datasets.
   Mitigations: [i] Selection of an academic group with established expertise in complex healthcare modelling of this kind; [ii] use of sensitivity testing to assess the robustness of the modelling outputs; [iii] a programme of regular project supervision and review between the SW CV SCN and the modelling team in PenCLAHRC.
3. Failure to deliver the project to the appointed timescale.
   Mitigation: Regular project supervision and review involving senior decision-makers from

the SW CV SCN and PenCLAHRC.

Governance
1. The Service Mapping Project is initiated and owned by the SW CV SCN, and will be overseen by a Project Management Group (PMG) consisting of: • The SW CV SCN Network Manager (chair) and Clinical Directors/Clinical Leads; • The Director of PenCHORD (Peninsula Collaboration for Health, Operational Research & Development) and lead modeller(s); • Public Health England representative; • South West Ambulance Service representative; • The Clinical Pathways and QIPP Lead for the SW SCN; • The Information and Quality Improvement Analyst for the SW SCN; • Other members will be co-opted according to necessity. 2. The PMG will meet approximately monthly over the lifetime of the project. 3. The PMG will be accountable to the SW CV SCN Steering Group, and will report to the Cardiac and Stroke CAGs (and other interested parties as appropriate). 4. Administrative support for the PMG will be provided by the SW CV SCN.

Timescale	
Preliminary model presented to Stroke CAGs	complete
Progress of PPCI modelling to be reported at Cardiac CAG Venue: SW House, Taunton.	complete
Progress of complex cardiology modelling to be reported at Cardiac Working Group. Venue: SW House, Taunton.	complete
Final modelling to be complete	complete
Final outcomes of complex cardiology and stroke modelling to be presented to commissioners Commissioner meeting 03.11.15 11-13.00hrs. Venue: SW House, Taunton.	complete
Final outcomes of complex cardiology and stroke modelling to be presented to providers and commissioners	complete

Joint provider and commissioner meeting 03.11.15 14-16.00hrs. Venue: SW House, Taunton.	
CV SCN options appraisal completed	18.01.16

Appendix 2
Reconfiguration options – CCG and provider-level impact

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NHS
National Institute for Health Research

Table of Contents

Reconfiguration options – CCG and provider-level impact

Introduction

The main report 'Bigger, Better, Faster?' contained proposed configurations of hyperacute stroke and primary PCI (STEMI) services for the South West region. This Appendix to the main report contains a more detailed analysis of the options in terms of key performance indicators and hospital activity, representing patient sub-populations as i) those living in each Clinical Commissioning Group, and ii) those living closest to each acute hospital that currently provides the service. The 7 options discussed in the main report are:

1. 10 Heart Attack Centres [HACs] and 14 Hyperacute Stroke Units [HASUs]
2. 6 HACs and 8 HASUs: Bristol 1, Plymouth, Gloucester/Cheltenham, Taunton, Truro, Exeter plus HASUs in Yeovil and Bristol 2
3. 6 HACs and 9 HASUs: Bristol 1, Plymouth, Gloucester/Cheltenham, Taunton, Truro, Exeter plus HASUs in Yeovil, Bristol 2 and Swindon
4. 6 HACs and 10 HASUs: Bristol 1, Plymouth, Gloucester/Cheltenham, Taunton, Truro, Exeter plus HASUs in Yeovil, Bristol 2, Torbay and Swindon
5. 7 HACs and 8 HASUs: Bristol 1, Plymouth, Gloucester/Cheltenham, Taunton, Truro, Exeter, Torbay plus HASU in Bath
6. 7 HACs and 9 HASUs: either
    A. Bristol 1, Plymouth, Gloucester/Cheltenham, Taunton, Truro, Exeter, Torbay plus HASUs in Bath and Swindon.
    B. Bristol 1, Plymouth, Gloucester/Cheltenham, Taunton, Truro, Exeter, Torbay plus HASUs in Yeovil and Bristol 2.
7. 7 HACs and 10 HASUs: Bristol 1, Plymouth, Gloucester/Cheltenham, Taunton, Truro, Exeter, Torbay plus HASUs in Yeovil, Swindon and Bristol 2.

By convention, 'Bristol 1' refers to the Bristol Royal Infirmary/Bristol Heart Institute as the existing Heart Attack Centre in Bristol, but the model is not able to discriminate on purely geographical grounds between the two acute hospitals in Bristol, and the distribution of hyperacute stroke services is likely to be determined by factors other than simple geography.

This equates to 3 STEMI scenarios and 7 stroke scenarios. The Heart Attack centres in each option are shaded in the table below:

Option	Number of HACs	Bristol (BRI)	Plymouth	Cheltenham	Taunton	Truro	Exeter	Torbay	Bath	Swindon	Salisbury
1	10										
2-4	6										
5-7	7										

The Hyperacute Stroke Units in each option are shaded in the table below:

Option	Number of HACs	Number of HASUs	Bristol (BRI)*	Plymouth	Gloucester	Taunton	Truro	Exeter	Torbay	Bath	Swindon	Salisbury	Yeovil	Bristol* (Southmead)	Barnstaple	Weston
1	10	14														
2	6	8														
3	6	9														
4	6	10														
5	7	8														
6A	7	9														
6B	7	9														
7	7	10														

*The model is not precise enough to differentiate between the two Bristol sites. The selection of a HASU in Bristol (if only one were present) should be made on grounds other than the geographic model

Regional level (all patients)

The key performance indicators for these scenarios at the regional level are:

STEMI: 2111 admissions

The table below shows the admissions to each hospital for the STEMI patients in the region, for each scenario. Use this table to understand how the key performance indicators differ across the scenarios.

Option	Bath	Bristol (BRI)	Cheltenham	Exeter	Plymouth	Salisbury	Swindon	Taunton	Torbay	Truro	Out of region	Grand Total
1	167	383	155	210	265	72	116	199	194	289	62	2111
2-4		573	236	389	279			200		289	144	2111
5-7		573	236	210	265			200	194	289	144	2111

Key performance indicators for the STEMI scenarios for all the patients in the region

Option	Number of HACs	Average travel (mins)	Max travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Mortality (number of patients)	Patients using hospital with >100 PPCI (%)*	Patients with CTT time of 120 mins (%)**	Patients with CTT time of 150 mins (%)**
1	10	25	92	97	71	82.2	96	74	97
2-4	6	30	92	93	54	83.9	100	58	96
5-7	7	28	92	93	61	83.3	100	64	96

* Of the patients attending an in region hospital; ** CTT = Call-to-treatment

Stroke: 7768 admissions

The table below shows the admissions to each hospital for the stroke patients in the region, for each option. Use this table to understand how the key performance indicators differ across the options.

Option	Barnstaple	Bath	Bristol (BRI)*	Bristol (Southmead)*	Exeter	Gloucester	Plymouth	Salisbury	Swindon	Taunton	Torbay	Truro	Weston	Yeovil	Out of region	Grand Total
1	406	680	548	497	548	717	750	246	532	528	550	729	426	465	146	7768
2			1108	951	1216	982	813			901		729		598	470	7768
3			1108	680	1216	717	813		660	901		729		598	345	7768
4			1108	680	717	717	762		660	901	550	729		598	345	7768
5		950	1272		717	1019	762			1033	550	729			736	7768
6A		796	1272		717	732	762		548	1033	550	729			628	7768
6B			1108	951	717	982	762			901	550	729		598	470	7768
7			1108	680	717	717	762		660	901	550	729		598	345	7768

*The model is not precise enough to differentiate between the two Bristol sites. The selection of a HASU in Bristol (if only one were present) should be made on grounds other than the geographic model

Key performance indicators for the stroke options for all the patients in the region

Option	Number of HASUs	Average travel (mins)	Maximum travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Clinical benefit*	Patients using hospital with >600 admissions (%) **
1	14	21	65	98	78	10.9	38
2	8	30	92	94	54	10.5	92
3	9	28	92	96	59	10.6	92
4	10	27	92	96	64	10.6	85
5	8	28	92	91	59	10.6	92
6A	9	26	92	92	65	10.6	85
6B	9	28	92	94	58	10.6	84
7	10	27	92	96	64	10.6	85

* Additional mRS 0-1 patients (per 100 clinically suitable patients for IV thrombolysis); ** Of the patients attending an in region hospital

CCG-level results

Results are presented per population of patients living within each Clinical Commissioning Group.

NHS Bath and North East Somerset CCG

STEMI: 60 admissions

The table below shows the admissions to each hospital for the STEMI patients in this CCG, for each option. Use this table to understand how the key performance indicators differ across the options.

Option	Bath	Bristol (BRI)	Grand Total
1	57	3	60
2-4		60	60
5-7		60	60

Key performance indicators for the STEMI options for the patients in this CCG

Option	Number of HACs	Average travel (mins)	Max travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Mortality (number of patients)	Patients using hospital with >100 PPCI (%)*	Patients with CTT time of 120 mins (%)**	Patients with CTT time of 150 mins (%)**
1	10	16	32	100	100	2.3	100	100	100
2-4	6	31	43	100	35	2.4	100	52	100
5-7	7	31	43	100	35	2.4	100	52	100

* Of the patients attending an in region hospital; ** CTT = Call-to-treatment

Stroke: 275 admissions

The table below shows the admissions to each hospital for the stroke patients in this CCG, for each option. Use this table to understand how the key performance indicators differ across the options.

Option	Bath	Bristol (BRI)*	Bristol (Southmead)*	Grand total
1	264	11		275
2		238	37	275
3		238	37	275
4		238	37	275
5	264	11		275
6A	264	11		275
6B		238	37	275
7		238	37	275

*The model is not precise enough to differentiate between the two Bristol sites

Key performance indicators for the stroke options for the patients in this CCG

Option	Number of HASUs	Average travel (mins)	Maximum travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Clinical benefit*	Patients using hospital with >600 admissions (%) **
1	14	16	32	100	99	11.2	96
2	8	31	43	100	34	10.4	100
3	9	31	43	100	34	10.4	100
4	10	31	43	100	34	10.4	100
5	8	16	32	100	99	11.2	100
6A	9	16	32	100	99	11.2	100
6B	9	31	43	100	34	10.4	100
7	10	31	43	100	34	10.4	100

* Additional mRS 0-1 patients (per 100 clinically suitable patients for IV thrombolysis); ** Of the patients attending an in region hospital

NHS Bristol CCG

STEMI: 169 admissions

The table below shows the admissions to each hospital for the STEMI patients in this CCG, for each option. Use this table to understand how the key performance indicators differ across the options.

Option	Bristol (BRI)	Total
1	169	169
2-4	169	169
5-7	169	169

Key performance indicators for the STEMI options for the patients in this CCG

Option	Number of HACs	Average travel (mins)	Max travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Mortality (number of patients)	Patients using hospital with >100 PPCI (%)*	Patients with CTT time of 120 mins (%)**	Patients with CTT time of 150 mins (%)**
1	10	12	23	100	100	6.3	100	100	100
2-4	6	12	23	100	100	6.3	100	100	100
5-7	7	12	23	100	100	6.3	100	100	100

* Of the patients attending an in region hospital; ** CTT = Call-to-treatment

Stroke: 559 admissions

The table below shows the admissions to each hospital for the stroke patients in this CCG, for each option. Use this table to understand how the key performance indicators differ across the options.

Option	Bristol (BRI)*	Bristol (Southmead)*	Grand total
1	376	182	559
2	376	182	559
3	376	182	559
4	376	182	559
5	559		559
6A	559		559
6B	376	182	559
7	376	182	559

*The model is not precise enough to differentiate between the two Bristol sites

Key performance indicators for the stroke options for the patients in this CCG

Option	Number of HASUs	Average travel (mins)	Maximum travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Clinical benefit*	Patients using hospital with >600 admissions (%) **
1	14	11	20	100	100	11.4	0
2	8	11	20	100	100	11.4	100
3	9	11	20	100	100	11.4	100
4	10	11	20	100	100	11.4	100
5	8	12	23	100	100	11.3	100
6A	9	12	23	100	100	11.3	100
6B	9	11	20	100	100	11.4	100
7	10	11	20	100	100	11.4	100

* Additional mRS 0-1 patients (per 100 clinically suitable patients for IV thrombolysis); ** Of the patients attending an in region hospital

NHS Gloucestershire CCG

STEMI: 173 admissions

The table below shows the admissions to each hospital for the STEMI patients in this CCG, for each option. Use this table to understand how the key performance indicators differ across the options.

Option	Bristol (BRI)	Cheltenham	Swindon	Out of region	Grand total
1	14	146	9	4	173
2-4	15	155		4	173
5-7	15	155		4	173

Key performance indicators for the STEMI options for the patients in this CCG

Option	Number of HACs	Average travel (mins)	Max travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Mortality (number of patients)	Patients using hospital with >100 PPCI (%)*	Patients with CTT time of 120 mins (%)**	Patients with CTT time of 150 mins (%)**
1	10	23	51	98	72	6.7	100	75	100
2-4	6	23	51	98	71	6.7	100	74	100
5-7	7	23	51	98	71	6.7	100	74	100

* Of the patients attending an in region hospital; ** CTT = Call-to-treatment

Stroke: 844 admissions

The table below shows the admissions to each hospital for the stroke patients in this CCG, for each option. Use this table to understand how the key performance indicators differ across the options.

Option	Bristol (BRI)*	Bristol (Southmead)*	Gloucester	Swindon	Out of region	Grand Total
1		37	705	61	41	844
2		39	758		46	844
3		37	705	61	41	844
4		37	705	61	41	844
5	19		777		47	844
6A	19		720	62	42	844
6B		39	758		46	844
7		37	705	61	41	844

*The model is not precise enough to differentiate between the two Bristol sites

Key performance indicators for the stroke options for patients in this CCG

Option	Number of HASUs	Average travel (mins)	Maximum travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Clinical benefit*	Patients using hospital with >600 admissions (%) **
1	14	22	43	95	77	10.9	88
2	8	22	43	95	74	10.8	100
3	9	22	43	95	77	10.9	100
4	10	22	43	95	77	10.9	100
5	8	23	44	94	74	10.8	100
6A	9	22	44	95	77	10.9	92
6B	9	22	43	95	74	10.8	100
7	10	22	43	95	77	10.9	100

* Additional mRS 0-1 patients (per 100 clinically suitable patients for IV thrombolysis); ** Of the patients attending an in region hospital

NHS Kernow CCG

STEMI: 359 admissions

The table below shows the admissions to each hospital for the STEMI patients in this CCG, for each option. Use this table to understand how the key performance indicators differ across the options.

Option	Exeter	Plymouth	Truro	Grand Total
1	3	67	289	359
2-4	3	67	289	359
5-7	3	67	289	359

Key performance indicators for the STEMI options for the patients in this CCG

Option	Number of HACs	Average travel (mins)	Max travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Mortality (number of patients)	Patients using hospital with >100 PPCI (%)*	Patients with CTT time of 120 mins (%)**	Patients with CTT time of 150 mins (%)**
1	10	30	80	100	54	14.2	100	60	97
2-4	6	30	80	100	54	14.2	100	60	97
5-7	7	30	80	100	54	14.2	100	60	97

* Of the patients attending an in region hospital; ** CTT = Call-to-treatment

Stroke: 975 admissions

The table below shows the admissions to each hospital for the stroke patients in this CCG, for each option. Use this table to understand how the key performance indicators differ across the options.

Option	Barnstaple	Exeter	Plymouth	Truro	Grand Total
1	31		214	729	975
2		19	226	729	975
3		19	226	729	975
4		19	226	729	975
5		19	226	729	975
6A		19	226	729	975
6B		19	226	729	975
7		19	226	729	975

Key performance indicators for the stroke options for the patients in this CCG

Option	Number of HASUs	Average travel (mins)	Maximum travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Clinical benefit*	Patients using hospital with >600 admissions (%) **
1	14	30	65	100	53	10.5	97
2	8	30	80	100	53	10.5	100
3	9	30	80	100	53	10.5	100
4	10	30	80	100	53	10.5	100
5	8	30	80	100	53	10.5	100
6A	9	30	80	100	53	10.5	100
6B	9	30	80	100	53	10.5	100
7	10	30	80	100	53	10.5	100

* Additional mRS 0-1 patients (per 100 clinically suitable patients for IV thrombolysis); ** Of the patients attending an in region hospital

NHS North Somerset CCG

STEMI: 94 admissions

The table below shows the admissions to each hospital for the STEMI patients in this CCG, for each option. Use this table to understand how the key performance indicators differ across the options.

Option	Bristol (BRI)	Taunton	Grand Total
1	91	3	94
2-4	91	3	94
5-7	91	3	94

Key performance indicators for the STEMI options for the patients in this CCG

Option	Number of HACs	Average travel (mins)	Max travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Mortality (number of patients)	Patients using hospital with >100 PPCI (%)*	Patients with CTT time of 120 mins (%)**	Patients with CTT time of 150 mins (%)**
1	10	30	44	100	53	3.7	100	54	100
2-4	6	30	44	100	53	3.7	100	54	100
5-7	7	30	44	100	53	3.7	100	54	100

* Of the patients attending an in region hospital; ** CTT = Call-to-treatment

Stroke: 370 admissions

The table below shows the admissions to each hospital for the stroke patients in this CCG, for each option. Use this table to understand how the key performance indicators differ across the options.

Option	Bristol (BRI)*	Taunton	Weston	Grand Total
1	109		261	370
2	353	17		370
3	353	17		370
4	353	17		370
5	353	17		370
6A	353	17		370
6B	353	17		370
7	353	17		370

*The model is not precise enough to differentiate between the two Bristol sites

Key performance indicators for the stroke options for the patients in this CCG

Option	Number of HASUs	Average travel (mins)	Maximum travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Clinical benefit*	Patients using hospital with >600 admissions (%) **
1	14	16	29	100	100	11.1	0
2	8	32	44	100	44	10.4	100
3	9	32	44	100	44	10.4	100
4	10	32	44	100	44	10.4	100
5	8	32	44	100	44	10.4	100
6A	9	32	44	100	44	10.4	100
6B	9	32	44	100	44	10.4	100
7	10	32	44	100	44	10.4	100

* Additional mRS 0-1 patients (per 100 clinically suitable patients for IV thrombolysis); ** Of the patients attending an in region hospital

NHS North, East, West Devon CCG

STEMI: 466 admissions

The table below shows the admissions to each hospital for the STEMI patients in this CCG, for each option. Use this table to understand how the key performance indicators differ across the options.

Option	Exeter	Plymouth	Taunton	Torbay	Out of region	Grand Total
1	193	196	58	17	1	466
2-4	195	211	58		1	466
5-7	193	196	58	17	1	466

Key performance indicators for the STEMI options for the patients in this CCG

Option	Number of HACs	Average travel (mins)	Max travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Mortality (number of patients)	Patients using hospital with >100 PPCI (%)*	Patients with CTT time of 120 mins (%)**	Patients with CTT time of 150 mins (%)**
1	10	28	92	100	70	18.4	100	72	89
2-4	6	28	92	100	67	18.4	100	70	89
5-7	7	28	92	100	70	18.4	100	72	89

* Of the patients attending an in region hospital; ** CTT = Call-to-treatment

Stroke: 1553 admissions

The table below shows the admissions to each hospital for the stroke patients in this CCG, for each option. Use this table to understand how the key performance indicators differ across the options.

Option	Barnstaple	Exeter	Plymouth	Taunton	Torbay	Yeovil	Out of region	Grand Total
1	363	505	532	78	60	15		1553
2		664	583	291		15		1553
3		664	583	291		15		1553
4		655	532	291	60	15		1553
5		655	532	303	60		3	1553
6A		655	532	303	60		3	1553
6B		655	532	291	60	15		1553
7		655	532	291	60	15		1553

Key performance indicators for the stroke options for the patients in this CCG

Option	Number of HASUs	Average travel (mins)	Max travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Clinical benefit*	Patients using hospital with >600 admissions (%) **
1	14	21	57	100	82	10.9	34
2	8	33	92	100	60	10.4	99
3	9	33	92	100	60	10.4	99
4	10	32	92	100	63	10.4	95
5	8	32	92	100	63	10.4	96
6A	9	32	92	100	63	10.4	96
6B	9	32	92	100	63	10.4	95
7	10	32	92	100	63	10.4	95

* Additional mRS 0-1 patients (per 100 clinically suitable patients for IV thrombolysis); ** Of the patients attending an in region hospital

NHS Somerset CCG

STEMI: 199 admissions

The table below shows the admissions to each hospital for the STEMI patients in this CCG, for each option. Use this table to understand how the key performance indicators differ across the options.

Option	Bath	Bristol (BRI)	Taunton	Out of region	Grand Total
1	32	4	138	25	199
2-4		31	139	29	199
5-7		31	139	29	199

Key performance indicators for the STEMI options for the patients in this CCG

Option	Number of HACs	Average travel (mins)	Max travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Mortality (number of patients)	Patients using hospital with >100 PPCI (%)*	Patients with CTT time of 120 mins (%)**	Patients with CTT time of 150 mins (%)**
1	10	30	52	88	40	7.9	100	46	100
2-4	6	32	61	86	39	7.9	100	45	100
5-7	7	32	61	86	39	7.9	100	45	100

* Of the patients attending an in region hospital; ** CTT = Call-to-treatment

Stroke: 1036 admissions

The table below shows the admissions to each hospital for the stroke patients in this CCG, for each option. Use this table to understand how the key performance indicators differ across the options.

Option	Barnstaple	Bath	Bristol (BRI)*	Bristol (Southmead)*	Taunton	Weston	Yeovil	Out of region	Grand Total
1	12	101			450	166	308		1036
2			76	1	593		367		1036
3			76	1	593		367		1036
4			76	1	593		367		1036
5		164	16		714			143	1036
6A		164	16		714			143	1036
6B			76	1	593		367		1036
7			76	1	593		367		1036

*The model is not precise enough to differentiate between the two Bristol sites

Key performance indicators for the stroke options for the patients in this CCG

Option	Number of HASUs	Average travel (mins)	Maximum travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Clinical benefit*	Patients using hospital with >600 admissions (%) **
1	14	23	45	100	69	10.8	10
2	8	26	53	100	58	10.7	65
3	9	26	53	100	58	10.7	65
4	10	26	53	100	58	10.7	65
5	8	30	54	86	39	10.5	100
6A	9	30	54	86	39	10.5	100
6B	9	26	53	100	58	10.7	65
7	10	26	53	100	58	10.7	65

* Additional mRS 0-1 patients (per 100 clinically suitable patients for IV thrombolysis); ** Of the patients attending an in region hospital

NHS South Devon and Torbay CCG

STEMI: 192 admissions

The table below shows the admissions to each hospital for the STEMI patients in this CCG, for each option. Use this table to understand how the key performance indicators differ across the options.

Option	Exeter	Plymouth	Torbay	Grand Total
1	14	1	177	192
2-4	191	1		192
5-7	14	1	177	192

Key performance indicators for the STEMI options for the patients in this CCG

Option	Number of HACs	Average travel (mins)	Max travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Mortality (number of patients)	Patients using hospital with >100 PPCI (%)*	Patients with CTT time of 120 mins (%)**	Patients with CTT time of 150 mins (%)**
1	10	16	38	100	99	7.2	100	99	100
2-4	6	35	56	100	34	7.8	100	41	100
5-7	7	16	38	100	99	7.2	100	99	100

* Of the patients attending an in region hospital; ** CTT = Call-to-treatment

Stroke: 536 admissions

The table below shows the admissions to each hospital for the stroke patients in this CCG, for each option. Use this table to understand how the key performance indicators differ across the options.

Option	Exeter	Plymouth	Torbay	Grand Total
1	42	4	490	536
2	532	4		536
3	532	4		536
4	42	4	490	536
5	42	4	490	536
6A	42	4	490	536
6B	42	4	490	536
7	42	4	490	536

Key performance indicators for the stroke options for the patients in this CCG

Option	Number of HASUs	Average travel (mins)	Maximum travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Clinical benefit*	Patients using hospital with >600 admissions (%) **
1	14	17	38	100	99	11.1	1
2	8	35	56	100	38	10.2	100
3	9	35	56	100	38	10.2	100
4	10	17	38	100	99	11.1	9
5	8	17	38	100	99	11.1	9
6A	9	17	38	100	99	11.1	9
6B	9	17	38	100	99	11.1	9
7	10	17	38	100	99	11.1	9

* Additional mRS 0-1 patients (per 100 clinically suitable patients for IV thrombolysis); ** Of the patients attending an in region hospital

NHS South Gloucestershire CCG

STEMI: 110 admissions

The table below shows the admissions to each hospital for the STEMI patients in this CCG, for each option. Use this table to understand how the key performance indicators differ across the options.

Option	Bath	Bristol (BRI)	Grand Total
1	8	102	110
2-4		110	110
5-7		110	110

Key performance indicators for the STEMI options for the patients in this CCG

Option	Number of HACs	Average travel (mins)	Max travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Mortality (number of patients)	Patients using hospital with >100 PPCI (%)*	Patients with CTT time of 120 mins (%)**	Patients with CTT time of 150 mins (%)**
1	10	19	31	100	98	4.2	100	100	100
2-4	6	20	31	100	98	4.2	100	100	100
5-7	7	20	31	100	98	4.2	100	100	100

* Of the patients attending an in region hospital; ** CTT = Call-to-treatment

Stroke: 351 admissions

The table below shows the admissions to each hospital for the stroke patients in this CCG, for each option. Use this table to understand how the key performance indicators differ across the options.

Option	Bath	Bristol (BRI)*	Bristol (Southmead)*	Grand Total
1	24	52	274	351
2		66	285	351
3		66	285	351
4		66	285	351
5	36	315		351
6A	36	315		351
6B		66	285	351
7		66	285	351

*The model is not precise enough to differentiate between the two Bristol sites

Key performance indicators for the stroke options for the patients in this CCG

Option	Number of HASUs	Average travel (mins)	Maximum travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Clinical benefit*	Patients using hospital with >600 admissions (%) **
1	14	17	28	100	100	11.1	7
2	8	17	28	100	100	11.1	100
3	9	17	28	100	100	11.1	100
4	10	17	28	100	100	11.1	100
5	8	19	31	100	99	11.0	100
6A	9	19	31	100	99	11.0	100
6B	9	17	28	100	100	11.1	100
7	10	17	28	100	100	11.1	100

* Additional mRS 0-1 patients (per 100 clinically suitable patients for IV thrombolysis); ** Of the patients attending an in region hospital

NHS Swindon CCG

STEMI: 62 admissions

The table below shows the admissions to each hospital for the STEMI patients in this CCG, for each option. Use this table to understand how the key performance indicators differ across the options.

Option	Bristol (BRI)	Cheltenham	Swindon	Grand Total
1			62	62
2-4	2	60		62
5-7	2	60		62

Key performance indicators for the STEMI options for the patients in this CCG

Option	Number of HACs	Average travel (mins)	Max travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Mortality (number of patients)	Patients using hospital with >100 PPCI (%)*	Patients with CTT time of 120 mins (%)**	Patients with CTT time of 150 mins (%)**
1	10	13	21	100	100	2.3	100	100	100
2-4	6	45	52	99	0	2.6	100	0	100
5-7	7	45	52	99	0	2.6	100	0	100

* Of the patients attending an in region hospital; ** CTT = Call-to-treatment

Stroke: 243 admissions

The table below shows the admissions to each hospital for the stroke patients in this CCG, for each option. Use this table to understand how the key performance indicators differ across the options.

Option	Bath	Bristol (Southmead)*	Gloucester	Swindon	Out of region	Grand Total
1				243		243
2		49	190		5	243
3				243		243
4				243		243
5	43		195		5	243
6A				243		243
6B		49	190		5	243
7				243		243

*The model is not precise enough to differentiate between the two Bristol sites

Key performance indicators for the stroke options for the patients in this CCG

Option	Number of HASUs	Average travel (mins)	Maximum travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Clinical benefit*	Patients using hospital with >600 admissions (%) **
1	14	13	21	100	100	11.3	0
2	8	46	54	98	0	9.7	100
3	9	13	21	100	100	11.3	100
4	10	13	21	100	100	11.3	100
5	8	46	54	98	0	9.7	100
6A	9	13	21	100	100	11.3	0
6B	9	46	54	98	0	9.7	100
7	10	13	21	100	100	11.3	100

* Additional mRS 0-1 patients (per 100 clinically suitable patients for IV thrombolysis); ** Of the patients attending an in region hospital

NHS Wiltshire CCG

STEMI: 159 admissions

The table below shows the admissions to each hospital for the STEMI patients in this CCG, for each option. Use this table to understand how the key performance indicators differ across the options.

Option	Bath	Bristol (BRI)	Cheltenham	Salisbury	Swindon	Out of region	Grand Total
1	69			54	36		159
2-4		95	14			51	159
5-7		95	14			51	159

Key performance indicators for the STEMI options for the patients in this CCG

Option	Number of HACs	Average travel (mins)	Max travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Mortality (number of patients)	Patients using hospital with >100 PPCI (%)*	Patients with CTT time of 120 mins (%)**	Patients with CTT time of 150 mins (%)**
1	10	27	47	100	60	6.2	66	68	100
2-4	6	50	71	68	1	6.8	100	2	89
5-7	7	50	71	68	1	6.8	100	2	89

* Of the patients attending an in region hospital; ** CTT = Call-to-treatment

Stroke: 718 admissions

The table below shows the admissions to each hospital for the stroke patients in this CCG, for each option. Use this table to understand how the key performance indicators differ across the options.

Option	Bath	Bristol (Southmead)*	Gloucester	Salisbury	Swindon	Yeovil	Out of region	Grand Total
1	291	4		228	174	14	8	718
2		358	22			84	254	718
3		138			303	84	193	718
4		138			303	84	193	718
5	440		35				244	718
6A	329				190		199	718
6B		358	22			84	254	718
7		138			303	84	193	718

*The model is not precise enough to differentiate between the two Bristol sites

Key performance indicators for the stroke options for the patients in this CCG

Option	Number of HASUs	Average travel (mins)	Maximum travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Clinical benefit*	Patients using hospital with >600 admissions (%) **
1	14	26	42	99	58	10.7	41
2	8	45	60	65	1	9.8	82
3	9	39	59	73	16	10.1	84
4	10	39	59	73	16	10.1	84
5	8	38	62	66	19	10.1	100
6A	9	33	62	72	33	10.3	63
6B	9	45	60	65	1	9.8	82
7	10	39	59	73	16	10.1	84

* Additional mRS 0-1 patients (per 100 clinically suitable patients for IV thrombolysis); ** Of the patients attending an in region hospital

Provider-level results

Results are presented per sub-population patients living closest to each acute hospital that is currently offering the service.

North Devon District Hospital, Barnstaple

STEMI: Does not currently offer the service

Stroke: 406 admissions

Key performance indicators for the stroke options for the patients with this as their nearest acute hospital

Option	Number of HASUs	Average travel (mins)	Maximum travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Clinical benefit*	Patients using hospital with >600 admissions (%) **
1	14	26	64	100	74	10.7	0
2	8	69	92	100	0	8.6	100
3	9	69	92	100	0	8.6	100
4	10	69	92	100	0	8.6	100
5	8	69	92	100	0	8.6	100
6A	9	69	92	100	0	8.6	100
6B	9	69	92	100	0	8.6	100
7	10	69	92	100	0	8.6	100

* Additional mRS 0-1 patients (per 100 clinically suitable patients for IV thrombolysis); ** Of the patients attending an in region hospital

Royal United Hospital, Bath

STEMI: 167 admissions

Key performance indicators for the STEMI options for the patients with this as their nearest acute hospital

Option	Number of HACs	Average travel (mins)	Max travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Mortality (number of patients)	Patients using hospital with >100 PPCI (%)*	Patients with CTT time of 120 mins (%)**	Patients with CTT time of 150 mins (%)**
1	10	27	50	100	62	6.5	100	68	100
2-4	6	42	63	98	15	6.9	100	22	98
5-7	7	42	63	98	15	6.9	100	22	98

* Of the patients attending an in region hospital; ** CTT = Call-to-treatment

Stroke: 680 admissions

Key performance indicators for the stroke options for the patients with this as their nearest acute hospital

Option	Number of HASUs	Average travel (mins)	Maximum travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Clinical benefit*	Patients using hospital with >600 admissions (%) **
1	14	25	42	100	63	10.7	100
2	8	39	60	100	16	10.0	85
3	9	39	58	100	16	10.1	85
4	10	39	58	100	16	10.1	85
5	8	25	42	100	63	10.7	100
6A	9	25	42	100	63	10.7	100
6B	9	39	60	100	16	10.0	85
7	10	39	58	100	16	10.1	85

* Additional mRS 0-1 patients (per 100 clinically suitable patients for IV thrombolysis); ** Of the patients attending an in region hospital

Bristol Royal Infirmary

Important: the geographical model is not precise enough to differentiate between the two Bristol sites (Bristol Royal Infirmary and Southmead). The choice of which is the primary hospital (if only one were present) should be made on grounds other than the geographic model. Bristol Royal Infirmary is open in every option (for both STEMI and stroke) because it was a chosen site for the STEMI options, upon which all of the stroke options are based with some extra locations open.

STEMI: 383 admissions

Key performance indicators for the STEMI options for the patients with this as their nearest acute hospital

Option	Number of HACs	Average travel (mins)	Max travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Mortality (number of patients)	Patients using hospital with >100 PPCI (%)*	Patients with CTT time of 120 mins (%)**	Patients with CTT time of 150 mins (%)**
1	10	20	51	100	85	14.6	100	86	100
2-4	6	20	51	100	85	14.6	100	86	100
5-7	7	20	51	100	85	14.6	100	86	100

* Of the patients attending an in region hospital; ** CTT = Call-to-treatment

Stroke: 548 admissions

Key performance indicators for the stroke options for the patients with this as their nearest acute hospital

Option	Number of HASUs	Average travel (mins)	Maximum travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Clinical benefit*	Patients using hospital with >600 admissions (%) **
1	14	15	29	100	100	11.2	0
2	8	15	29	100	100	11.2	100
3	9	15	29	100	100	11.2	100
4	10	15	29	100	100	11.2	100
5	8	15	29	100	100	11.2	100
6A	9	15	29	100	100	11.2	100
6B	9	15	29	100	100	11.2	100
7	10	15	29	100	100	11.2	100

* Additional mRS 0-1 patients (per 100 clinically suitable patients for IV thrombolysis); ** Of the patients attending an in region hospital

Southmead Hospital, Bristol

Important: the geographical model is not precise enough to differentiate between the two Bristol sites (Bristol Royal Infirmary and Southmead). The choice of which is the primary hospital (if only one were present) should be made on grounds other than the geographic model. Bristol Royal Infirmary is open in every option (for both STEMI and stroke) because it was a chosen site for the STEMI options, upon which all of the stroke options are based with some extra locations open.

STEMI: Does not currently offer the service

Stroke: 497 admissions

Key performance indicators for the stroke options for the patients with this as their nearest acute hospital

Option	Number of HASUs	Average travel (mins)	Maximum travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Clinical benefit*	Patients using hospital with >600 admissions (%) **
1	14	15	43	100	93	11.2	0
2	8	15	43	100	93	11.2	100
3	9	15	43	100	93	11.2	100
4	10	15	43	100	93	11.2	100
5	8	19	44	100	92	11.0	100
6A	9	19	44	100	92	11.0	100
6B	9	15	43	100	93	11.2	100
7	10	15	43	100	93	11.2	100

* Additional mRS 0-1 patients (per 100 clinically suitable patients for IV thrombolysis); ** Of the patients attending an in region hospital

Bristol: Combining the two acute hospitals (Bristol Royal Infirmary and Southmead Hospital)

STEMI: 383 admissions

Key performance indicators for the STEMI options for the patients with this as their nearest acute hospital (the values here are the same as the individual Bristol Royal Infirmary results due to Southmead not currently offering the service).

Option	Number of HACs	Average travel (mins)	Max travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Mortality (number of patients)	Patients using hospital with >100 PPCI (%)*	Patients with CTT time of 120 mins (%)**	Patients with CTT time of 150 mins (%)**
1	10	20	51	100	85	14.6	100	86	100
2-4	6	20	51	100	85	14.6	100	86	100
5-7	7	20	51	100	85	14.6	100	86	100

* Of the patients attending an in region hospital; ** CTT = Call-to-treatment

Stroke: 1046 admissions

Key performance indicators for the stroke options for the patients with this as their nearest acute hospital

Option	Number of HASUs	Average travel (mins)	Maximum travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Clinical benefit*	Patients using hospital with >600 admissions (%) **
1	14	15	43	100	97	11.2	0
2	8	15	43	100	97	11.2	100
3	9	15	43	100	97	11.2	100
4	10	15	43	100	97	11.2	100
5	8	17	44	100	96	11.1	100
6A	9	17	44	100	96	11.1	100
6B	9	15	43	100	97	11.2	100
7	10	15	43	100	97	11.2	100

* Additional mRS 0-1 patients (per 100 clinically suitable patients for IV thrombolysis); ** Of the patients attending an in region hospital

Cheltenham General Hospital

STEMI: 155 admissions

Key performance indicators for the STEMI options for the patients with this as their nearest acute hospital

Option	Number of HACs	Average travel (mins)	Max travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Mortality (number of patients)	Patients using hospital with >100 PPCI (%)*	Patients with CTT time of 120 mins (%)**	Patients with CTT time of 150 mins (%)**
1	10	21	49	100	78	5.9	100	82	100
2-4	6	21	49	100	78	5.9	100	82	100
5-7	7	21	49	100	78	5.9	100	82	100

* Of the patients attending an in region hospital; ** CTT = Call-to-treatment

Stroke: Does not currently offer the service

Royal Devon & Exeter Hospital, Exeter

STEMI: 210 admissions

Key performance indicators for the STEMI options for the patients with this as their nearest acute hospital

Option	Number of HACs	Average travel (mins)	Max travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Mortality (number of patients)	Patients using hospital with >100 PPCI (%)*	Patients with CTT time of 120 mins (%)**	Patients with CTT time of 150 mins (%)**
1	10	32	92	100	67	8.4	100	67	87
2-4	6	32	92	100	67	8.4	100	67	87
5-7	7	32	92	100	67	8.4	100	67	87

* Of the patients attending an in region hospital; ** CTT = Call-to-treatment

Stroke: 548 admissions

Key performance indicators for the stroke options for the patients with this as their nearest acute hospital

Option	Number of HASUs	Average travel (mins)	Maximum travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Clinical benefit*	Patients using hospital with >600 admissions (%) **
1	14	23	57	100	83	10.8	0
2	8	23	57	100	83	10.8	100
3	9	23	57	100	83	10.8	100
4	10	23	57	100	83	10.8	100
5	8	23	57	100	83	10.8	100
6A	9	23	57	100	83	10.8	100
6B	9	23	57	100	83	10.8	100
7	10	23	57	100	83	10.8	100

* Additional mRS 0-1 patients (per 100 clinically suitable patients for IV thrombolysis); ** Of the patients attending an in region hospital

Gloucestershire Royal Hospital, Gloucester

STEMI: Does not currently offer the service

Stroke: 717 admissions

Key performance indicators for the stroke options for the patients with this as their nearest acute hospital

Option	Number of HASUs	Average travel (mins)	Maximum travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Clinical benefit*	Patients using hospital with >600 admissions (%) **
1	14	20	43	100	85	10.9	100
2	8	20	43	100	85	10.9	100
3	9	20	43	100	85	10.9	100
4	10	20	43	100	85	10.9	100
5	8	20	43	100	85	10.9	100
6A	9	20	43	100	85	10.9	100
6B	9	20	43	100	85	10.9	100
7	10	20	43	100	85	10.9	100

* Additional mRS 0-1 patients (per 100 clinically suitable patients for IV thrombolysis); ** Of the patients attending an in region hospital

Derriford Hospital, Plymouth

STEMI: 265 admissions

Key performance indicators for the STEMI options for the patients with this as their nearest acute hospital

Option	Number of HACs	Average travel (mins)	Max travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Mortality (number of patients)	Patients using hospital with >100 PPCI (%)*	Patients with CTT time of 120 mins (%)**	Patients with CTT time of 150 mins (%)**
1	10	21	77	100	77	10.2	100	79	97
2-4	6	21	77	100	77	10.2	100	79	97
5-7	7	21	77	100	77	10.2	100	79	97

* Of the patients attending an in region hospital; ** CTT = Call-to-treatment

Stroke: 750 admissions

Key performance indicators for the stroke options for the patients with this as their nearest acute hospital

Option	Number of HASUs	Average travel (mins)	Maximum travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Clinical benefit*	Patients using hospital with >600 admissions (%) **
1	14	21	65	100	77	10.9	100
2	8	21	65	100	77	10.9	100
3	9	21	65	100	77	10.9	100
4	10	21	65	100	77	10.9	100
5	8	21	65	100	77	10.9	100
6A	9	21	65	100	77	10.9	100
6B	9	21	65	100	77	10.9	100
7	10	21	65	100	77	10.9	100

* Additional mRS 0-1 patients (per 100 clinically suitable patients for IV thrombolysis); ** Of the patients attending an in region hospital

Salisbury District Hospital

STEMI: 72 admissions

Key performance indicators for the STEMI options for the patients with this as their nearest acute hospital

Option	Number of HACs	Average travel (mins)	Max travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Mortality (number of patients)	Patients using hospital with >100 PPCI (%)*	Patients with CTT time of 120 mins (%)**	Patients with CTT time of 150 mins (%)**
1	10	26	52	100	61	2.8	0	61	100
2-4	6	49	71	6	4	3.1	100	8	88
5-7	7	49	71	6	4	3.1	100	8	88

* Of the patients attending an in region hospital; ** CTT = Call-to-treatment

Stroke: 246 admissions

Key performance indicators for the stroke options for the patients with this as their nearest acute hospital

Option	Number of HASUs	Average travel (mins)	Maximum travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Clinical benefit*	Patients using hospital with >600 admissions (%) **
1	14	20	42	100	80	11.0	0
2	8	40	59	12	6	10.0	0
3	9	40	59	19	6	10.0	34
4	10	40	59	19	6	10.0	34
5	8	40	62	12	6	10.0	100
6A	9	39	62	15	6	10.0	56
6B	9	40	59	12	6	10.0	0
7	10	40	59	19	6	10.0	34

* Additional mRS 0-1 patients (per 100 clinically suitable patients for IV thrombolysis); ** Of the patients attending an in region hospital

Great Western Hospital, Swindon

STEMI: 116 admissions

Key performance indicators for the STEMI options for the patients with this as their nearest acute hospital

Option	Number of HACs	Average travel (mins)	Max travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Mortality (number of patients)	Patients using hospital with >100 PPCI (%)*	Patients with CTT time of 120 mins (%)**	Patients with CTT time of 150 mins (%)**
1	10	20	42	100	80	4.4	100	85	100
2-4	6	45	67	91	3	4.9	100	5	95
5-7	7	45	67	91	3	4.9	100	5	95

* Of the patients attending an in region hospital; ** CTT = Call-to-treatment

Stroke: 532 admissions

Key performance indicators for the stroke options for the patients with this as their nearest acute hospital

Option	Number of HASUs	Average travel (mins)	Maximum travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Clinical benefit*	Patients using hospital with >600 admissions (%) **
1	14	21	40	100	82	10.9	0
2	8	44	60	80	4	9.8	100
3	9	21	40	100	82	10.9	100
4	10	21	40	100	82	10.9	100
5	8	43	54	81	4	9.8	100
6A	9	21	40	100	82	10.9	0
6B	9	44	60	80	4	9.8	100
7	10	21	40	100	82	10.9	100

* Additional mRS 0-1 patients (per 100 clinically suitable patients for IV thrombolysis); ** Of the patients attending an in region hospital

Musgrove Park Hospital, Taunton

STEMI: 199 admissions

Key performance indicators for the STEMI options for the patients with this as their nearest acute hospital

Option	Number of HACs	Average travel (mins)	Max travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Mortality (number of patients)	Patients using hospital with >100 PPCI (%)*	Patients with CTT time of 120 mins (%)**	Patients with CTT time of 150 mins (%)**
1	10	34	88	100	44	8.1	100	52	85
2-4	6	34	88	100	44	8.1	100	52	85
5-7	7	34	88	100	44	8.1	100	52	85

* Of the patients attending an in region hospital; ** CTT = Call-to-treatment

Stroke: 528 admissions

Key performance indicators for the stroke options for the patients with this as their nearest acute hospital

Option	Number of HASUs	Average travel (mins)	Maximum travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Clinical benefit*	Patients using hospital with >600 admissions (%) **
1	14	22	45	100	71	10.9	0
2	8	22	45	100	71	10.9	100
3	9	22	45	100	71	10.9	100
4	10	22	45	100	71	10.9	100
5	8	22	45	100	71	10.9	100
6A	9	22	45	100	71	10.9	100
6B	9	22	45	100	71	10.9	100
7	10	22	45	100	71	10.9	100

* Additional mRS 0-1 patients (per 100 clinically suitable patients for IV thrombolysis); ** Of the patients attending an in region hospital

Torbay Hospital

STEMI: 194 admissions

Key performance indicators for the STEMI options for the patients with this as their nearest acute hospital

Option	Number of HACs	Average travel (mins)	Max travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Mortality (number of patients)	Patients using hospital with >100 PPCI (%)*	Patients with CTT time of 120 mins (%)**	Patients with CTT time of 150 mins (%)**
1	10	17	45	100	98	7.3	100	98	100
2-4	6	37	56	100	27	7.9	100	33	100
5-7	7	17	45	100	98	7.3	100	98	100

* Of the patients attending an in region hospital; ** CTT = Call-to-treatment

Stroke: 550 admissions

Key performance indicators for the stroke options for the patients with this as their nearest acute hospital

Option	Number of HASUs	Average travel (mins)	Maximum travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Clinical benefit*	Patients using hospital with >600 admissions (%) **
1	14	18	45	100	96	11.1	0
2	8	37	56	100	28	10.1	100
3	9	37	56	100	28	10.1	100
4	10	18	45	100	96	11.1	0
5	8	18	45	100	96	11.1	0
6A	9	18	45	100	96	11.1	0
6B	9	18	45	100	96	11.1	0
7	10	18	45	100	96	11.1	0

* Additional mRS 0-1 patients (per 100 clinically suitable patients for IV thrombolysis); ** Of the patients attending an in region hospital

Royal Cornwall Hospital, Truro

STEMI: 289 admissions

Key performance indicators for the STEMI options for the patients with this as their nearest acute hospital

Option	Number of HACs	Average travel (mins)	Max travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Mortality (number of patients)	Patients using hospital with >100 PPCI (%)*	Patients with CTT time of 120 mins (%)**	Patients with CTT time of 150 mins (%)**
1	10	28	65	100	59	11.4	100	64	100
2-4	6	28	65	100	59	11.4	100	64	100
5-7	7	28	65	100	59	11.4	100	64	100

* Of the patients attending an in region hospital; ** CTT = Call-to-treatment

Stroke: 729 admissions

Key performance indicators for the stroke options for the patients with this as their nearest acute hospital

Option	Number of HASUs	Average travel (mins)	Maximum travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Clinical benefit*	Patients using hospital with >600 admissions (%) **
1	14	28	65	100	58	10.6	100
2	8	28	65	100	58	10.6	100
3	9	28	65	100	58	10.6	100
4	10	28	65	100	58	10.6	100
5	8	28	65	100	58	10.6	100
6A	9	28	65	100	58	10.6	100
6B	9	28	65	100	58	10.6	100
7	10	28	65	100	58	10.6	100

* Additional mRS 0-1 patients (per 100 clinically suitable patients for IV thrombolysis); ** Of the patients attending an in region hospital

Weston General Hospital

STEMI: Does not currently offer the service

Stroke: 426 admissions

Key performance indicators for the stroke options for the patients with this as their nearest acute hospital

Option	Number of HASUs	Average travel (mins)	Maximum travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Clinical benefit*	Patients using hospital with >600 admissions (%) **
1	14	17	38	100	96	11.1	0
2	8	35	50	100	24	10.2	99
3	9	35	50	100	24	10.2	99
4	10	35	50	100	24	10.2	99
5	8	35	46	100	24	10.3	100
6A	9	35	46	100	24	10.3	100
6B	9	35	50	100	24	10.2	99
7	10	35	50	100	24	10.2	99

* Additional mRS 0-1 patients (per 100 clinically suitable patients for IV thrombolysis); ** Of the patients attending an in region hospital

Yeovil District Hospital

STEMI: Does not currently offer the service

Stroke: 465 admissions

Key performance indicators for the stroke options for the patients with this as their nearest acute hospital

Option	Number of HASUs	Average travel (mins)	Maximum travel (mins)	Patients using hospital in region (%)	Patients within 30 mins (%)	Clinical benefit*	Patients using hospital with >600 admissions (%) **
1	14	24	43	100	60	10.8	0
2	8	24	43	100	60	10.8	0
3	9	24	43	100	60	10.8	0
4	10	24	43	100	60	10.8	0
5	8	40	58	42	5	10.0	100
6A	9	40	58	42	5	10.0	100
6B	9	24	43	100	60	10.8	0
7	10	24	43	100	60	10.8	0

* Additional mRS 0-1 patients (per 100 clinically suitable patients for IV thrombolysis); ** Of the patients attending an in region hospital

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