Acute Ischaemic Stroke Pathways
Drip and Ship

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What are we trying to achieve?

- Accurate diagnosis: stroke vs. non-stroke
- High quality hyper-acute stroke care
- Rapid brain imaging CT+CTA to differentiate
  ICH / Large vessel / small vessel occlusion
- iv rtPA where indicated (15%)
- Mechanical thrombectomy where indicated (10%)
- Minimise unnecessary travel – ambulance service capacity
- Enhance patient / relative experience

Management of Acute Stroke

Recognise	Symptom recognition, Call 999
React	Transfer to hospital with Acute Stroke Unit
Respond	Brain imaging and medical assessment
Reveal	Confirm diagnosis, assess for thrombolysis drugs
Rx/Reperfusion	Thrombolysis drugs, aspirin, monitoring on Acute Stroke Unit
Rehabilitation	Stroke Team assessment and treatment
Reintegration	Patient support groups, family, community

Recognise a patient likely to have acute stroke and transport to the nearest stroke centre able to deliver hyperacute care that may benefit that patient

Hyperacute and Acute Stroke Evidence Based Treatments

	% ischaemic stroke patients that benefit	Prevention death/dependency per 100 treated	Prevention death/dependency per 100 admitted
Acute Stroke Unit	100%	5	5
Thrombolysis 0-3 hr	15%	12	1.8
Thrombolysis 3-4.5 hr	3%	7	0.2
Thrombectomy 0-6 hr	10%	20	2
Aspirin 0-48 hr	65%	1	0.5
IPC Stockings 0-72 hr	50%	3 (death)	1.5
Hemicraniectomy 0-48 hr	0.5%	22	0.1

Adapted from Gilligan AK et al. Cerebrovascular Diseases 2005

Models

- Mothership
  - Admit all suspected stroke patients to comprehensive stroke centre able to deliver brain imaging, iv rtPA, Thrombectomy
- Drip and ship
  - Admit all suspected stroke patients to nearest hospital with acute stroke unit, secondary transfer to comprehensive stroke centre for iv rtPA and/or thrombectomy
- Alternative
  - Scan in a van
- Hybrid
  - Telemedicine for iv rtPA. Selective transfer for thrombectomy

Time is Brain

IV alteplase **Mechanical thrombectomy**

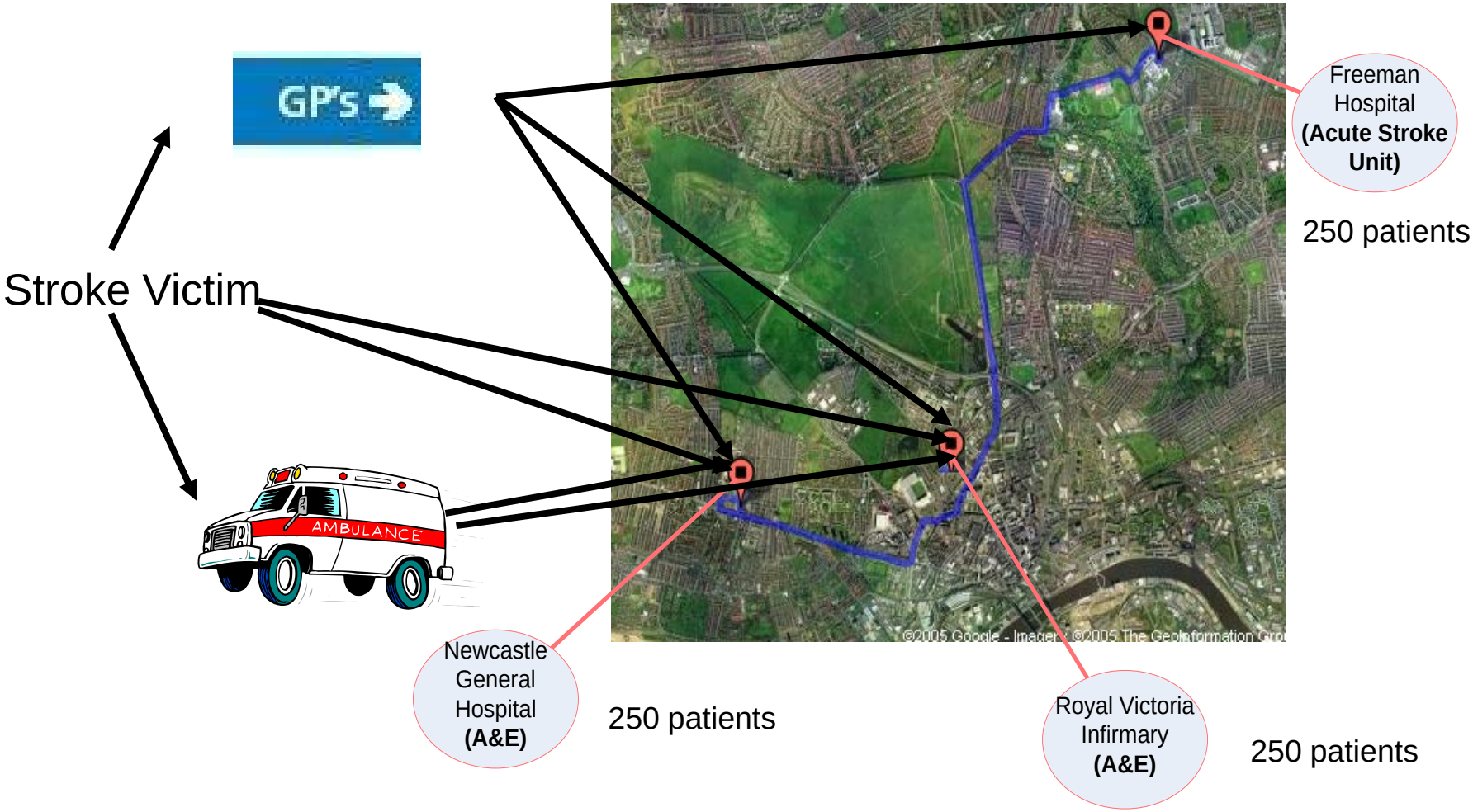
…..among every 1000 patients achieving substantial endovascular reperfusion, for every 15-minute faster emergency department door–to-reperfusion time, an estimated 39 patients would have a less-disabled outcome at 3 months, including 25 more whowould achieve functional independence (mRS 0-2).

Emberson et al, Lancet 2014; Saver et al, JAMA 2016

Thrombectomy and Thrombolysis Unanswered questions

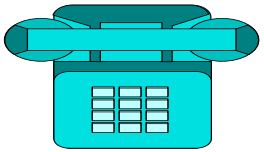
- Should we use advanced imaging to select patients in 4.5 hour time window?
- Does earlier delivery of thrombectomy outweigh delay in giving iv rtPA?
- Is iv rtPA of benefit if recanalisation is achieved with thrombectomy?

Newcastle Stroke Admissions 1993



Rapid Ambulance Protocol

Acute Stroke Symptoms 999



All 999 patients with suspected stroke not in coma to be taken to Freeman Emergency Admission Suite

Ambulance Control

Paramedical team

Paramedical Assessment

radio control

notify unit

Suspected Stroke

Freeman Stroke Unit

Non-stroke

A & E Dept, Newcastle General

Rapid Ambulance Protocol

May 1997 – July 1998

- 123 patients referred directly to the Acute Stroke Unit by paramedics
- 102 acute stroke, 21 non-stroke

Time from first symptom to admission to the Stroke Unit:

• Referral from GP	6.0 hrs
• Via Rapid Ambulance Protocol	1.2 hrs
Symptom onset to contact emergency service	33 mins
Contact to arrival of paramedic team	8 mins
Time from arrival of paramedics to arrival at stroke unit	22 mins

25-30 patients / month triaged to Newcastle ASU

80%+ confirmed stroke/TIA maintained over 10 yrs

Harbison et al, Lancet 1999

Paramedic Assessment instruments – systematic review

- 7 instruments identified; Face Arm Speech Test (FAST)
  Recognition of Stroke in the Emergency Room (ROSIER)
  Los Angeles Prehospital Stroke Screen (LAPSS)
  Melbourne Ambulance Stroke Scale (MASS)
  Ontario Prehospital Stroke Screening tool (OPSS)
  Medic Prehospital Assessment for Code Stroke (MedPACS)
  Cincinnati Prehospital Stroke Scale (CPSS)
- Cohorts 50 - 1225 individuals, with 17.5% to 92% stroke diagnosis. Sensitivity and specificity for the same instrument varied across settings. Prevalence of instrument detectable stroke varied between cohorts and over time.
- CPSS and the similar FAST report the highest level of sensitivity, with more complex instruments such as LAPSS reporting higher specificity at the cost of lower detection rates.

Rudd et al, Em J Med 2015

Paramedic Assessment Large Vessel Occlusion

- Higher stroke severity associated with a higher likelihood of LVO in patients – time dependent
- NIHSS > 12 91% PPV but impractical for use by paramedics
- RACE – Rapid Arterial Occlusion Evaluation
  Gaze/Head deviation, facial palsy, motor arm, motor leg, aphasia , neglect
- Identifies 75% LVO
- Current scales result in 20-25% of LVO patients being missed and 12-25% of triage positive patients would not have LVO.

Point of Care Diagnostics

- No reliable blood biomarkers to identify stroke yet developed
- Purines released by ischaemic cells.
- Novel biosensor (SMARTChip) with coupled cascade of three enzymes (adenosine deaminase, purine nucleoside phosphorylase and xanthine oxidase) rapidly detects the combined whole blood purine concentrations of adenosine, inosine and hypoxanthine
- Potentially could be used by paramedics in the field to differentiate stroke and mimic conditions
- Validation studies ongoing and planned

sarissa Biomedical

Hyperacute Stroke Services

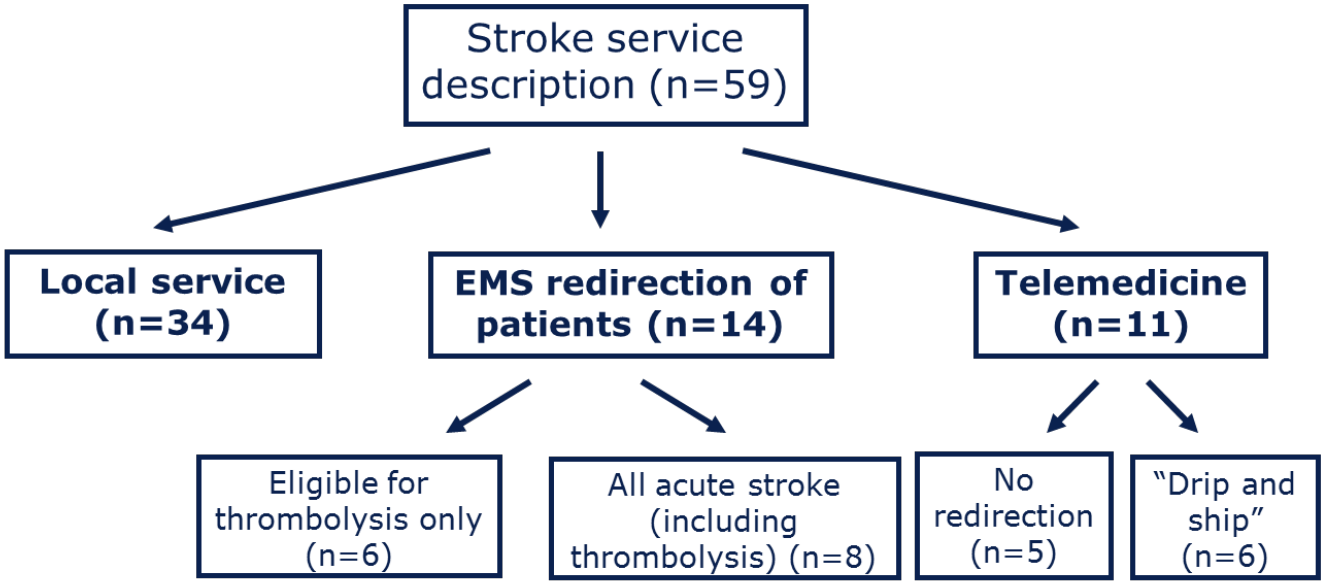
Collaborative

Local

Redirection

Telemedicine

Collaborative service models achieve higher thrombolysis treatment rates

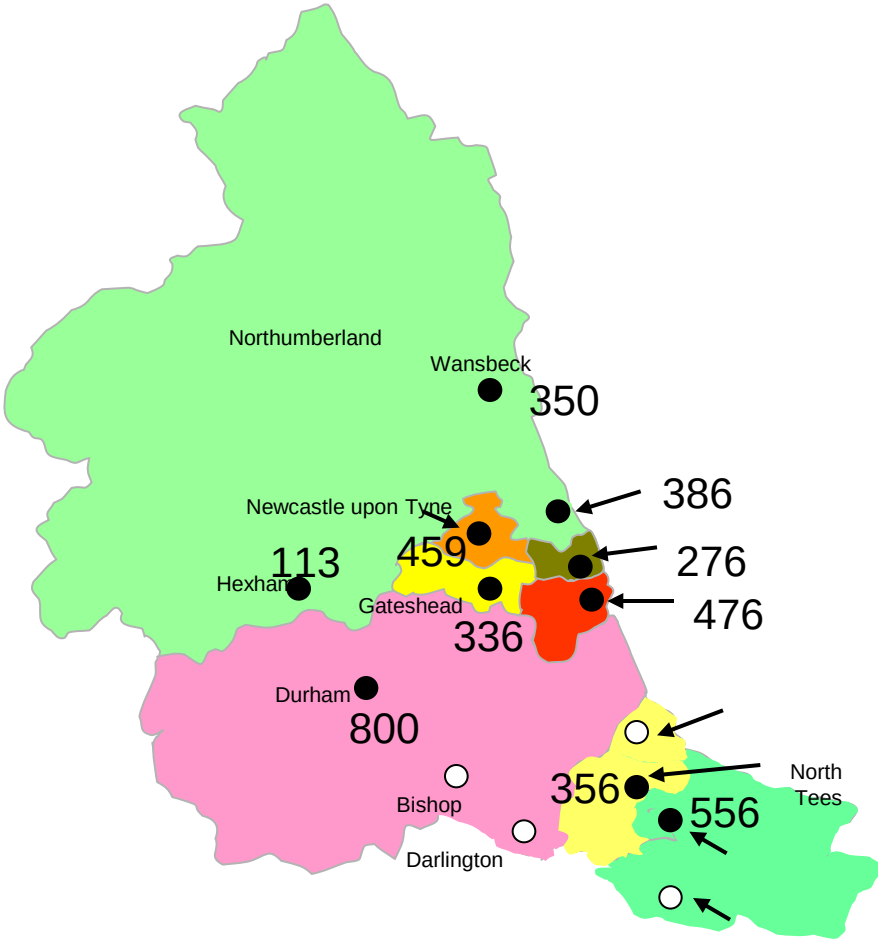


Service descriptions	Pooled treatment rate (95% CI) per 100 strokes	Pooled treatment rate (95% CI) per 100 ischemic strokes
Local service design (no collaboration)	2.5 (1.4 – 3.6) [n=21,417]	3.1 (2.1 – 4.1) [n=31,411]
Pooled estimate for 5 collaborative services with comprehensive stroke register	3.8 (3.0 – 4.5) [n=10,403]	5.7 (4.6 – 6.9) [n=7,815]

Price et al, Exp Rev Neurotherapeutics, 2009

North East Redirection

- Modelled redirection patients from 10 ASUs to 2 Neuroscience Centres using hospital and ambulance data
- Thrombolysis received by 223/1884 emergency admissions
- Redirection additional 68 patients treated after redirection 1269 stroke and 363 stroke mimics
- Median ambulance journey increased 10.5 to 12.2 miles, 17 min longer
- But door to needle shorter
- 12.6 QALYs over 5 years
- Cost/QALY £534



Price et al, Stroke 2013

Pre-hospital Stroke Asssessment using Telemedicine

- 4G technology
- Assessment in moving ambulances two actors
- Examination time 3 min (mean)
- Good inter-rater and intra-rater reliability using Unassisted Telestroke Scale

Van Hooff R et al. Stroke 2013

Unassisted TeleStroke Scale

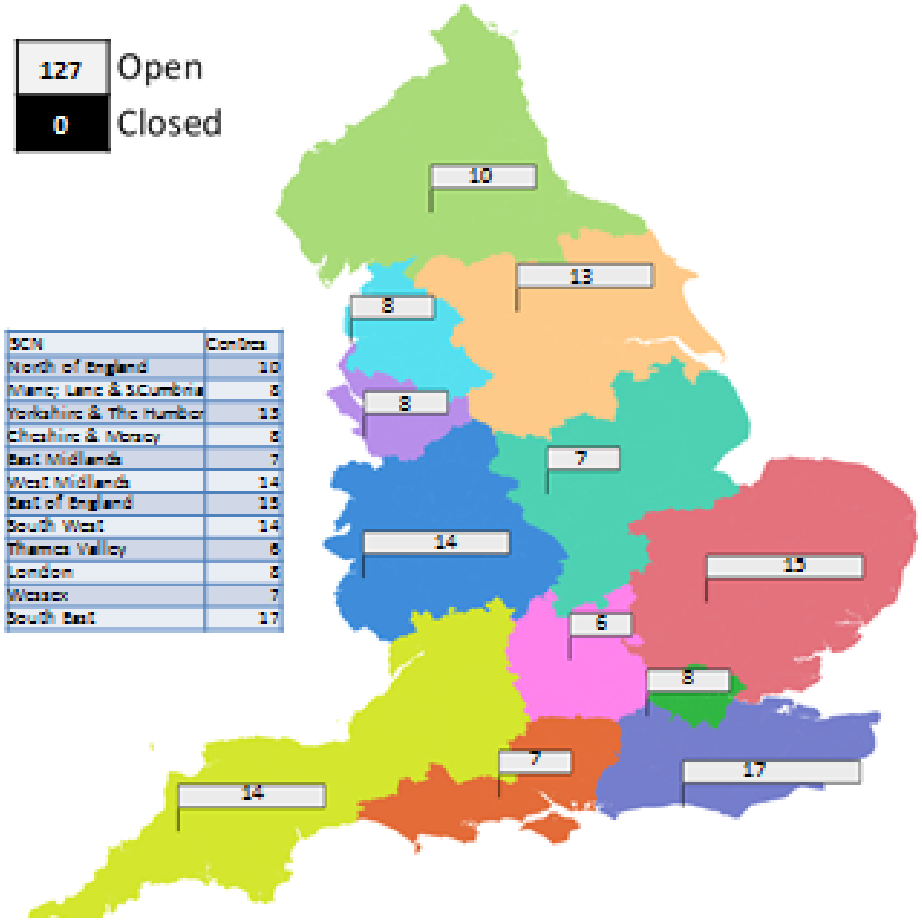
- Software tool presents the instructions to the rater in the language preferred by the patient (Dutch, French or English)

New Models of Stroke Care

- Better identification of patients in pre-hospital setting with
  - acute stroke
  - acute stroke due to large vessel occlusion
    ~ 10% stroke admissions
- Possible approaches
  - Improve paramedic diagnosis
    - better clinical assessment tools
    - telemedicine specialist support
    - point of care biomarker diagnostics
  - Take the CT scanner to the patient

Current Acute Stroke Service Provision

Number of stroke centres per Strategic Clinical Network (SCN)



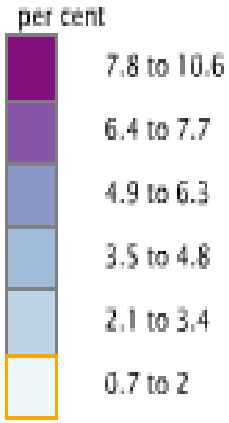
SCN	Centres
North of England	10
Manc; Lanc & Scumbria	8
Yorkshire & The Humber	13
Cheshire & Mersey	8
East Midlands	7
West Midlands	14
East of England	15
South West	14
Thames Valley	6
London	8
Wessex	7
South East	17

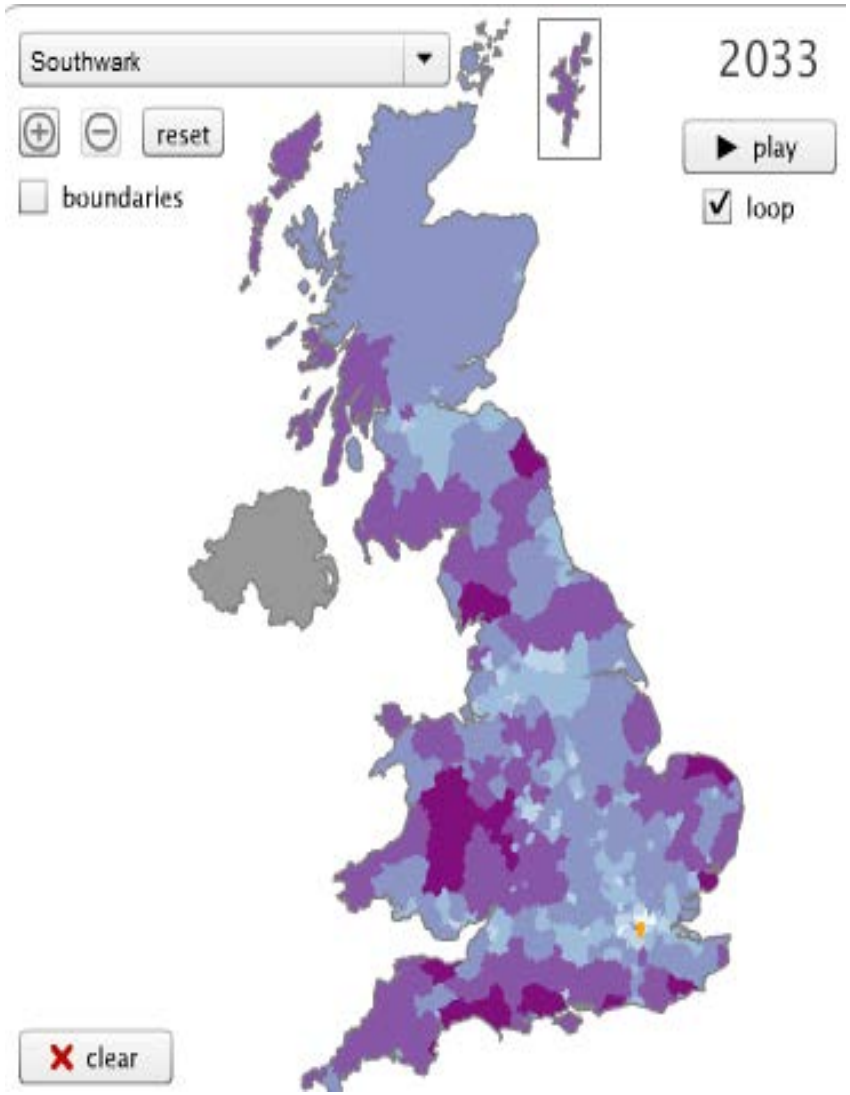
Performance indicators	Status quo
Number of hospitals	127
Ave distance (km)	10
Max distance (km)	96
Max admissions	1693
Min admissions	105
Max/Min admissions ratio	16
Patients within 30 mins	98%
Patients within 45 mins	100%
Patients within 60 mins	100%
Patients attending unit with >1,000 admissions…	20%
…and within 30 mins	19%
…and within 45 mins	20%
…and within 60 mins	20%

‘Drip and Ship’ or direct to ‘Mothership’

- Hyperacute stroke care (HASU and capability to deliver iv thrombolysis) could be delivered by ~ 50 HASUs across England to 80,000 patients
- Thrombectomy likely to be delivered by ~ 20 centres across England: neuroscience units +/- selected cardiac interventional centres
- Drip and Ship: earlier initiation iv tPA, stroke care local, manageable, avoid long journeys for mimics
- Mothership: earlier initiation thrombectomy for patients with large vessel occlusion, delays in iv tPA
- Need more public / patient involvement and qualitative research about patient experience for stroke mimics

Population 85 and over: 1992, 2015, 2033





ONS data

Designing pre-hospital stroke services for older people

- Improved working across pre-hospital / hospital boundary with stroke / geriatrician support to paramedics via telemedicine and use of point of care diagnostic biomarkers
- Large urban conurbations – paramedic direction to consolidated hyper-acute stroke services admitting 1,500-2,500 stroke patients in population 1 - 3 million
- Rural areas – initial remote specialist assessment in the field +/- assessment at major Emergency Centre able to deliver iv thrombolysis with drip and ship to stroke centres
- Reduce number of hospitals delivering hyperacute stroke care to 50-60
- Thrombectomy likely to be delivered by ~ 20-25 centres in England: neuroscience units +/- selected cardiac interventional centres