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

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

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 who would achieve functional independence (mRS 0-2).

Emerson 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

Stroke Victim

- Newcastle General Hospital (A&E) - 250 patients
- Royal Victoria Infirmary (A&E) - 250 patients
- Freeman Hospital (Acute Stroke Unit) - 250 patients

GP's

250 patients
Rapid Ambulance Protocol

Acute Stroke Symptoms 999

Notify radio control

Ambulance Control

Paramedical team

Paramedical Assessment

Suspected Stroke

Freeman Stroke Unit

Non-stroke

A & E Dept, Newcastle General

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


- 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


- 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
Hyperacute Stroke Services

Collaborative

Local

Redirection

Telemedicine
Collaborative service models achieve higher thrombolysis treatment rates

**Stroke service description (n=59)**

- **Local service (n=34)**
  - Eligible for thrombolysis only (n=6)
- **EMS redirection of patients (n=14)**
  - All acute stroke (including thrombolysis) (n=8)
  - No redirection (n=5)
- **Telemedicine (n=11)**
  - "Drip and ship" (n=6)

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

Performance indicators

<table>
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<th>Indicator</th>
<th>Status quo</th>
</tr>
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<tbody>
<tr>
<td>Number of hospitals</td>
<td>127</td>
</tr>
<tr>
<td>Ave distance (km)</td>
<td>10</td>
</tr>
<tr>
<td>Max distance (km)</td>
<td>96</td>
</tr>
<tr>
<td>Max admissions</td>
<td>1693</td>
</tr>
<tr>
<td>Min admissions</td>
<td>105</td>
</tr>
<tr>
<td>Max/Min admissions ratio</td>
<td>16</td>
</tr>
<tr>
<td>Patients within 30 mins</td>
<td>98%</td>
</tr>
<tr>
<td>Patients within 45 mins</td>
<td>100%</td>
</tr>
<tr>
<td>Patients within 60 mins</td>
<td>100%</td>
</tr>
<tr>
<td>Patients attending unit with &gt;1,000 admissions…</td>
<td>20%</td>
</tr>
<tr>
<td>...and within 30 mins</td>
<td>19%</td>
</tr>
<tr>
<td>...and within 45 mins</td>
<td>20%</td>
</tr>
<tr>
<td>...and within 60 mins</td>
<td>20%</td>
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</table>
‘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