Pre-hospital Stroke Care

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Stroke Mortality
Stroke in the Very Old > 80yrs

- Common (> 25% all strokes) and increasing
- Poor outcome – high mortality
  – substantial disability
  – 20% reasonable/good outcome
- Patients frequently have pre-stroke disability, comorbidities, and frailty
- Age profile of patients presenting with acute stroke will change profoundly
  - population demographics
  - successful prevention in middle age
  - reduced mortality following first ever stroke
# 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>15</td>
<td>1.5</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
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.
…..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
Pre-hospital Stroke Care

- 1990s  Education campaigns to shorten admission delays for thrombolysis trials; NINDS, ECASS
- 1998  Los Angeles Paramedic Stroke Scale
- 1999  Cincinnati Pre-hospital Stroke Scale
- 1999  Newcastle Rapid Ambulance Protocol
- 2000  Fast MAG pilot – first report paramedic administered stroke therapy
- 2004+  Randomised paramedic stroke trials
- 2010+  Widespread implementation paramedic triage to stroke centres
- 2011  Pre-hospital thrombolysis
- 2014  Fast MAG results - first multi-centre phase III pre-hospital stroke trial
Newcastle Stroke Admissions 1993

250 patients

250 patients

250 patients

Freeman Hospital (Acute Stroke Unit)

Royal Victoria Infirmary (A&E)

Newcastle General Hospital (A&E)

GP's

Stroke Victim
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

Suspected Stroke

Freeman Stroke Unit

Non-stroke

A & E Dept, Newcastle General
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
Face Arm Speech Test

• Service development to produce a simple assessment, to be incorporated in existing ambulance record form
• Modified Cincinnati instrument – speech and conscious level

  • Facial Palsy
  • Arm Weakness
  • Speech Impairment
  • Test All Three

• Exclude patients with Glasgow Coma Scale < 6

Harbison et al, Stroke 2003
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
Public Recognition of Stroke

Recognise stroke F.A.S.T.

Only a hospital test can confirm a stroke for sure, but it is important to know the signs and the Face Arm Speech Time test (F.A.S.T.) can help you recognise them for stroke or TIA.

F.A.S.T. was developed by leading stroke physicians and is used by emergency services to help them detect the signs.

![Image showing the F.A.S.T. acronym with a signboard indicating the signs: Facial weakness, Arm & leg weakness, Speech problems, Test these signs.]

Has their face fallen on one side? Can they smile? Can they raise both arms and keep them there? Is their speech slurred? Time to call 999 if you see any single one of these signs.

If the person has failed any of these tests, dial 999 for an ambulance immediately so they can be taken to hospital for urgent treatment. Paramedics and ambulance staff are trained to assess patients with suspected stroke and get them to hospital quickly.
Impact of FAST Campaign

A: Emergency admissions with a primary diagnosis of stroke in England
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)
- Telemedicine (n=11)
  - No redirection (n=5)
  - “Drip and ship” (n=6)

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<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>
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</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>
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*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
Direct paramedic admission
Newcastle Stroke Assessment Room

- Two trolley assessment bay with monitoring
- Suspected stroke / high risk TIA
- Stroke nurse specialist ASU consultant
- Mon-Fri 0900-1700h
Hyperacute Stroke Alarm Study

- Stockholm 2008. RCT increased priority level for stroke < 6hrs, from level 2 to 1 dispatch.
- Priority level 1 (immediate) or level 2 (within 30 min). Educational program on stroke identification and early treatment to medical dispatchers, ambulance and emergency department personnel.
- 942 patients 53% (n=496) stroke/TIA. Intervention group reached the stroke 26 min earlier ($P<0.001$) after call. Thrombolysis rate 24% vs.10% controls ($P<0.001$). The higher priority level showed no negative effect on other critically ill patients.

Berglund et al, Stroke 2012
PEARS – Promoting Effective And Rapid Stroke Care

• Determine the feasibility, clinical-and cost-effectiveness of an enhanced paramedic role during pre-hospital and acute hospital care to reduce time from admission to brain imaging for stroke patients with an urgent indication

• Paramedics stay for up to 30 min with patient until brain imaging and stroke team assessment taken place.

• Cluster randomised trial in 4 ambulance services across England comparing enhanced to standard paramedic role

• Outcomes: scene to needle time and 3 month clinical outcome (mRS)
Paramedic Treatment

• Correct hypoglycaemia
• Correct hypoxia
• BP lowering potentially of benefit
  - Feasibility studies completed PILFAST, RIGHT
  - RIGHT 2 ongoing – GTN patch. Target 850 patients
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
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.
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)
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
“Scan in a Van”
STROKE Emergency MOBILE Unit

Neurologist, paramedic, radiographer
CT scanner, point-of-care laboratory, teleradiology system
PHANTOM-S Study

- Pre-Hospital Acute Neurological Treatment and Optimization of Medical care in Stroke
- Deployed by dispatch when suspected acute stroke situation.
- Feb to April, 2011, 152 subjects treated.
- Forty-five (58%) had an acute ischemic stroke
- 23 (51%) received tPA.
- Call-to-needle time 62 min (mean) compared with 98 min in 50 consecutive patients treated in 2010
- Call to scene time 14 min, onset to needle time 117 min.
- Technical failures encountered were 1 CT dysfunction and 2 delayed CT image transmissions

Weber et al, Neurology 2013
Current Acute Stroke Service Provision
‘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
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

- Thrombectomy likely to be delivered by ~ 20-25 centres in England: neuroscience units +/- selected cardiac interventional centres