Hyperacute Stroke Assessment

Dr Ali Ali
Consultant Stroke and Geriatrics
Sheffield Teaching Hospitals
Objectives

- Importance of assessment
- Key aspects of the pathway
- Know where the problems are
- Enhancing efficiency
What are we aiming for?

• As many patients who suffer stroke presenting as early as possible.
• Rapid assessment by decision makers.
• Deliver thrombolysis **all** eligible patients with stroke.
• Deliver it as quickly as possible.
• Minimise risks to those with mimics.
• Offer mechanical thrombectomy to those patients eligible for such treatments.
• Ensure an optimised patient journey throughout.

• **Improved long term outcomes.**
Time dependent treatment

- Normal flow, normal function
- Low flow, raised O2 extraction, normal function
- Reversible reduced function
- Irreversible reduced function
A  Modified Rankin score 0-1

- Odds ratio estimated by model
- 95% CI for estimated odds ratio

NNT=4
NNT=10
NNT=14

Lees et al. Lancet 2010
## Stroke – Worldwide burden

<table>
<thead>
<tr>
<th>World</th>
<th>Deaths x 10^6</th>
<th>% deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coronary heart dx</td>
<td>7.20</td>
<td>12.2</td>
</tr>
<tr>
<td>Stroke</td>
<td>5.71</td>
<td>9.7</td>
</tr>
<tr>
<td>Lower resp infections</td>
<td>4.18</td>
<td>7.1</td>
</tr>
<tr>
<td>COPD</td>
<td>3.02</td>
<td>5.1</td>
</tr>
<tr>
<td>Diarrhoeal diseases</td>
<td>2.16</td>
<td>3.7</td>
</tr>
<tr>
<td>HIV/AIDS</td>
<td>2.04</td>
<td>3.5</td>
</tr>
<tr>
<td>Tuberculosis</td>
<td>1.46</td>
<td>2.5</td>
</tr>
<tr>
<td>Pulmonary cancers</td>
<td>1.32</td>
<td>2.3</td>
</tr>
<tr>
<td>MVA</td>
<td>2.27</td>
<td>2.2</td>
</tr>
<tr>
<td>Prematurity/LBW</td>
<td>1.18</td>
<td>2.0</td>
</tr>
</tbody>
</table>

*WHO 2012*
Stroke – National burden

• Approx. 150,000 strokes each year in the UK
• 4th leading cause of death in the UK
• Leading cause of disability
• 30 day mortality of 15%
• 1 in 4 < 65 years old

• Costs:  
  - £2.8 billion direct care costs
  - £1.8 billion lost productivity & disability
  - £2.4 billion informal care costs

At least £7 billion per year
Stroke - Sheffield

• ~ 450,000 people 16 yrs and over.

• Annually we see:
  – 400 high risk TIA’s
  – 1800 admissions to stroke unit:
    • 850 – stroke mimics
    • 925 – stroke (2/3 new)

<table>
<thead>
<tr>
<th>Incidence / prevalence</th>
<th>Sheffield</th>
<th>UK</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1/1000</td>
<td>1.2-1.3/1000</td>
</tr>
</tbody>
</table>

• ~ 11,500 stroke survivors 2.1% 1.7%

• ~ 3,500 living with severe stroke.

Hyperacute stroke assessment

So how do we get it right?
Stroke care chain


<table>
<thead>
<tr>
<th>Time</th>
<th>Neurons Lost</th>
<th>Synapses Lost</th>
<th>Myelinated Fibers Lost</th>
<th>Accelerated Aging</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 second</td>
<td>32,000</td>
<td>230 million</td>
<td>218 yards</td>
<td>8.7 hours</td>
</tr>
<tr>
<td>1 minute</td>
<td>1.9 million</td>
<td>14 billion</td>
<td>7.5 miles</td>
<td>3.1 weeks</td>
</tr>
<tr>
<td>1 hour</td>
<td>120 million</td>
<td>830 billion</td>
<td>447 miles</td>
<td>3.6 years</td>
</tr>
<tr>
<td>Avg. stroke</td>
<td>1.2 billion</td>
<td>8.3 trillion</td>
<td>4470 miles</td>
<td>36 years</td>
</tr>
</tbody>
</table>
Symptoms to call

• The main delay to treatment – biggest barrier to thrombolysis.

Mosely et al. Stroke, 2007
Stroke awareness campaigns help to educate the general population on the signs of stroke:

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

Emergency medical services (EMS) need to be alerted immediately. Rapid EMS response and pre-notification of stroke risk can improve the thrombolytic treatment rate for ischaemic stroke patients and reduce the time to thrombolysis.
Stroke awareness campaigns – 2009 in the UK

• Many don’t remember what the acronym stands for (60%) – don’t recognise it could be a stroke.
• Some feel ‘burning brain’ is misleading.

• Possible factors that increase likelihood of early help seeking:
  • Increased stroke severity
  • Presence of witness

• Many other barriers:
  • No time / fear or anxiety
Effect of public awareness campaigns on emergency calls

Number of patients with ischaemic stroke treated by rt-PA in the Nord Pas de Calais region (France)
(approximately 5500 ischaemic strokes / year)

1st regional campaign promoting calls to emergency number
(TV, newspapers, bus, metro …)

Goldstein P & Leys D, personal data on file
Assessment and transfer

Recognition / YAS

HASU or A&E

Agreement between paramedic and physician reported neurological signs using FAST

Nor AM, et al. Stroke 2004
FAST - recognition

• Good points:
  • Easy to use with reliability (inter and intra-rater)
  • Reasonable sensitivity (60-80%)

• Bad points:
  • Poor specificity (40-65%)
  • Don’t pick up posterior circulation
Ambulance response times

• ORCON category A – Chest Pain
  Breathing difficulty
  Unconscious
  Child < 2 yrs
  8 mins.

• Unless stroke causes any of above – category B – 19 mins.

• Only ~50% of these targets are met – therefore even longer waits in reality.

• 90% of our patients arrive by ambulance.

Turner et al, 2006, Costs and benefits of changing ambulance service response time performance standards
https://www.strokeaudit.org/results/regional.aspx last accessed 14/07/15
Pre-hospital notification

Mosely et al. Stroke, 2007
Paramedic triage

• Split hospital sites – HASU vs A&E – medical stability (airway)

• Suitability for endovascular treatment:
  • NIHSS
  • Pre-morbid function
  • Onset time

NIHSS > 6
Premorbid MRS 0-2
Onset to groin likely < 6 hrs
A&E assessment

• Initial derivation and validation study suggested:
  • Sensitivity 93%
  • Specificity 83%

• Subsequent studies:
  • Sensitivity 80-90%
  • Specificity 40-80%

Nor et al. Lancet Neurology, 2005
Jiang et al. PloS One, 2014
‘Stay and play’ or ‘Scoop and run’

• YAS:
  • Stabilised
  • FAST
  • Collateral and background
  • BM
  • Cannula en-route (not essential)

• Aim for rapid transfer and pre-hospital notification
‘Stay and play’ – the mobile stroke unit

• Operational mobile stroke units in Berlin since 2011.
• Consists:
  • Neurologist
  • Paramedic
  • Radiographer
  • CT
  • Point of care testing
  • Teleradiology
‘Stay and play’ – the mobile stroke unit

• Pilot RCT - can reduce ‘call to needle time’ by 36 mins.
• Safe – similar rates ICH.

• Trend towards better outcomes – not significant.

Prehospital interventions

• Research activity:
  • GTN patch – RIGHT-2 trial
  • Remote ischaemic conditioning
  • Oral decontamination
  • Other neuroprotective agents
ESO & NINDS guidelines

- Guidelines – neurological diagnosis < 15 mins & DNT < 60 mins

Sheffield = approx. 30-40mins DNT
Prior to patient arrival

- Organise the team – *stroke bleep*
- Check bloods
- Check old neuroimaging
- Look at digitalised correspondence, ICE discharges, System One.
- Meet at the door / in CT – pre-warn CT.

- Delegate responsibilities to the team.
On arrival

**Decision to treat:**
- Collateral history
- Time last seen well
- Acute onset vs staggered
- Drug history
- Contraindications to tPA
- ICE results (FBC, coag)
- Background problems
- Prior scans

**Preparation:**
- BP and routine obs
- BM
- *Weigh*
- IV access
- Bloods – urgent
- NIHSS
- Inform senior decision maker – if not already
Straight to CT

• Plain CT
  • Quick
  • Easy to interpret
  • Widely available

• CTA – if eligible for endovascular treatment:
  • High NIHSS
  • Pre-morbidly well

Neuroradiology

Neuro ITU

Thrombectomy bleep
Stroke thrombolysis counselling

Risk of intracranial haemorrhage following tPA ~ 5%.

Generally speaking:
- for every 100 patients treated with tPA within 3 hrs, 33 would be better off and 3 would be worse off.
- NNT to prevent 1 dead or dependant = 10
- NNT to prevent 1 dead or dependant up to 4.5 hrs = 14

Factors that may increase the risk of ICH following tPA:
- Uncontrolled high blood pressure
- Uncontrolled high blood sugars
- More widespread ischaemic change on CT (high ASPECTS score)
- Longer OTT times
- Dual anti-platelets
Endovascular treatment counselling

- In addition to thrombolysis if found to have large vessel occlusion.
- ICH – 5% - same as IV tPA
- Groin haematoma (3-4%)
- Nearly twice the chance of independence at 3 months if LVO

*Badhiwala et al. JAMA, 2015*
Deliver tPA

• If CT confirms no bleeding and no CI’s – deliver tPA in CT department.

• Bolus and set up infusion.

• Ensure resuscitation is available.

• Liaise with neuroradiology and anaesthetics if LVO confirmed and transfer to angio suite.
ESO & NINDS guidelines

- Guidelines – neurological diagnosis < 30 mins

Sheffield = approx. 30-40 mins DNT
How to enhance efficiency?

- Helsinki group – single centre experience.

- Instituted 12 measures over a period of 7 years.

- University hospital, covering 9,000 Km2 and 1.5 million population – neurologist on-site 24/7.

**Table 1** Twelve measures to reduce treatment delays

<table>
<thead>
<tr>
<th>Measure</th>
<th>Description</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>EMS involvement</td>
<td>Education of dispatchers and EMS personnel, stroke high-priority dispatch</td>
<td>1998</td>
</tr>
<tr>
<td>Hospital prenotification</td>
<td>EMS contacts stroke physician directly via mobile phone</td>
<td>2001</td>
</tr>
<tr>
<td>Alarm and preorder of tests</td>
<td>Laboratory and CT computer-ordered and alarmed at prenotification</td>
<td>2001</td>
</tr>
<tr>
<td>No-delay CT interpretation</td>
<td>Stroke physician interprets the CT scan, not waiting for formal radiology report</td>
<td>2001</td>
</tr>
<tr>
<td>Premixing of tPA</td>
<td>With highly suspect thrombolysis candidates, tPA premixed prior to patient arrival</td>
<td>2002</td>
</tr>
<tr>
<td>Delivery of tPA on CT table</td>
<td>Bolus administered on CT table</td>
<td>2002</td>
</tr>
<tr>
<td>CT relocated to ER</td>
<td>Patient transfers of several hundred meters, including elevators, were no longer needed</td>
<td>2003</td>
</tr>
<tr>
<td>CT priority and CT transfer</td>
<td>CT emptied prior to patient arrival, and patient transferred straight onto CT table, not ER bed</td>
<td>2004</td>
</tr>
<tr>
<td>Rapid neurologic evaluation</td>
<td>Patient is examined upon arrival, on CT table</td>
<td>2004</td>
</tr>
<tr>
<td>Preacquisition of history</td>
<td>Statewide electronic patient records and eyewitness interview before/during transportation</td>
<td>2005</td>
</tr>
<tr>
<td>Point-of-care INR</td>
<td>Laboratory personnel draw blood while patient on CT table, and perform instant POC INR</td>
<td>2005</td>
</tr>
<tr>
<td>Reduced imaging</td>
<td>While all patients have a CT, advanced imaging reserved for unclear cases only</td>
<td>2005</td>
</tr>
</tbody>
</table>

Abbreviations: EMS = emergency medical service; ER = emergency room; INR = international normalized ratio; POC = point-of-care; tPA = tissue plasminogen activator.
• Emergency call centre and EMS staff systematically educated.

• Stroke priority dispatch code – equal priority to myocardial infarction. Only surpassed by cardiac arrest.
• Clinicians generally need a number of things to make a decision on tPA:
  • History / examination / CT head / INR and BM.
• History takes the most time.
• Hospital pre-notification was made directly to the stroke physician –
  history taken from witness / NOK during transport.
<table>
<thead>
<tr>
<th>Alarm and preorder of tests</th>
<th>Laboratory and CT computer-ordered and alarmed at prenotification</th>
</tr>
</thead>
</table>

- Patient admitted onto hospital computer systems, bloods printed, CT ordered all prior to arrival.
<table>
<thead>
<tr>
<th>No-delay CT interpretation</th>
<th>Stroke physician interprets the CT scan, not waiting for formal radiology report</th>
</tr>
</thead>
</table>

- Treating stroke physician responsible for CT interpretation – oral radiology reports only utilised when immediately available or in complex cases.
<table>
<thead>
<tr>
<th>Premixing of tPA</th>
<th>With highly suspect thrombolysis candidates, tPA premixed prior to patient arrival</th>
<th>2002</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delivery of tPA on CT table</td>
<td>Bolus administered on CT table</td>
<td>2002</td>
</tr>
</tbody>
</table>

- Weight estimated from NOK or patient.
- Didn’t report on how much tPA wasted.
• Avoided estimated 10 minute delay from bed to CT transfer.

• Avoided delay in waiting for CT to become available.
• National electronic patient records reviewed prior to arrival.

• For all patients – accessible by all health professionals.
• Blood sampled for POC testing (glucose and INR) on the CT scanner.

• Proven reliability.
Outcomes

• Cannot clearly state improved outcomes for patients – design and confounders.

• 1.4% eventually turned out to be mimics:
  • Low rate

• Express assessment is likely to have also benefited ICH patients also.
Applicability to other healthcare settings

- Median (IQR) DNT reduced from 61 mins (43-75) to 46 mins (24-79) (p=0.04).
- In hours DNT fell 43 mins (33-59) to 25 mins (19-48), (p=0.009).
- Out of hours = unchanged (~ 65 mins).

- Pre-notification to stroke team and meet on arrival.
- Straight onto CT table.
- tPA on CT scanner.
- POC testing for INR.

Meretoja et al. Neurology, 2013
Real life effect of reduced OTT

- Finnish and Australian tPA registries with outcome data at 3 months.

- Modelled to provide robust estimates of the longer term outcomes (disability and life years lost) with varying delays in tPA delivery.

Each minute OTT saved = 1.8 days healthy life.

Biggest effect in young but severely affected (3.5 days).

Overall, each 15 minutes saved was the equivalent of 1 month of disability-free life.

Meretoja et al. Stroke, 2014
Real life effect of reduced OTT

• US nationwide role out of best practise guidelines for tPA administration in stroke.

• Implemented 2009.

Fanarrow et al. JAMA, 2014
Real life effect of reduced OTT

Time Trend in the Proportion of Patients with DTN Times within 60 Minutes
Pre- and Post-Target: Stroke

(P<0.0001 for comparison of the two slopes)

Target: Stroke Initiation

Fanarrow et al. JAMA, 2014
Real life effect of reduced OTT

Effects of improvement in DNT of only 15 mins – over 3 years.

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Pre-Target: Stroke (n=27,319)</th>
<th>Post-Target: Stroke (n=43,850)</th>
<th>Difference Pre and Post</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-Hospital Mortality</td>
<td>9.93%</td>
<td>8.25%</td>
<td>-1.68%</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Discharge Home</td>
<td>37.6%</td>
<td>42.7%</td>
<td>+5.1%</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Ambulatory Status Independent</td>
<td>42.2%</td>
<td>45.4%</td>
<td>+3.2%</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Symptomatic ICH</td>
<td>5.68%</td>
<td>4.68%</td>
<td>-1.00%</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Any tPA Complications</td>
<td>6.68%</td>
<td>5.50%</td>
<td>-1.18%</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>
Simple 😊 – what can go wrong?

• Unstable patient - seizures, vomiting, respiratory distress etc.

• High BP – to treat or not to treat?

• Awaiting INR for patients on warfarin – delay in labs.

• Clarifying collateral history and onset time:
  • Calling family / witnesses
  • Looking through texts
Stroke Mimics

• Wide variety of conditions can mimic stroke:

Fernandez et al 2013
Stroke Mimics

- Mimics are diagnosed as stroke by all professions.

Harbison et al 2003
• 350 acute ‘stroke’ presentations.

• 109 mimics (31%).

• Reviewed pre-morbid and presenting features to help identify key indicators of mimic.
Favour Mimic:

- Hx dementia
- Confusion
- LOC
- Seizure at onset
- No lateralising symptoms
- No neurological signs

Favours Stroke:

- CVD history
- IHD, PVD
- Exact time of onset
- Definite neurology
- Demonstrable neurological
- Signs consistent with clinical stroke syndrome
# Stroke Mimics and Age

<table>
<thead>
<tr>
<th></th>
<th>&lt;50 y (total 87)</th>
<th>≥50 y (total 583)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stroke</td>
<td>69 (79%)</td>
<td>568 (97%)</td>
<td></td>
</tr>
<tr>
<td>Conversion disorder</td>
<td>6 (7%)</td>
<td>7 (1%)</td>
<td>.002</td>
</tr>
<tr>
<td>Migraine</td>
<td>12 (14%)</td>
<td>3 (1%)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Epilepsy</td>
<td>0</td>
<td>4 (1%)</td>
<td>.63</td>
</tr>
<tr>
<td>Hypoglycemia</td>
<td>0</td>
<td>1</td>
<td>-</td>
</tr>
</tbody>
</table>

Percentages mentioned are percentages in the age group that has the particular disorder. P values are based on Chi-square statistics for 2 × 2 table of separate nonstroke diagnosis versus stroke compared between two groups.

Vroomen et al 2008
Clinical features - History

• **Nature of symptoms:**

  • *Positive* : excess of neuronal discharge – visual (flashing lights, zig-zags, lines, shapes), sensory (pain, paraesthesia), motor (limb jerking)

  • *Negative* : loss of neuronal function – loss of vision, hearing, sensation or power.

  • Ischaemia – *negative* symptoms mostly – arterial territory.

  • Seizure & migraine – *positive* symptoms particularly at the outset.
Migraine

• Hemiplegic Migraine.
• Acephalgic Migraine.
• Ophthalmoplegic Migraine.
• Basillar Migraine.
• Prolonged Aura.
• Status migrainosus.

• Gradual Onset (> 5 mins)
• Positive symptoms.
• Symptom spread over several seconds to minutes.
• Gradual resolution - minutes to days.
• Headache – not always.
• Recurrent Stereotyped attacks.
• Typically young.
Headache and stroke

• Mild headache – relatively common in stroke (20%).

• More common in posterior ischaemia.

• Usually ipsilateral to affected carotid territory if anterior circulatory.

• Dissection / ICH / SAH.
Seizures

• Partial seizure:
  • Young or middle aged adults.
  • Antecedent symptoms.
  • Positive neurological symptoms.
  • ‘March’ of symptoms.
  • Sterotypical attacks.
  • +/- amnesia of event.
Seizures

• Todds paresis:
  • Complicates ~ 15% of seizures.
  • Mainly GTC seizures.
  • Commonly causes unilateral weakness.
  • Uncommonly – aphasia, sensory disturbance, visual field defect.
  • Usually lasts < half an hour, but can last days.

• Collateral history very important.
Seizure

• Caution:

  • 2% of strokes can have seizures at onset – mainly TACS, PICH, SAH.
  
  • 5% strokes complicate by seizures within first 2 weeks.
  
  • Incidence higher in ICH/SAH.

Gaze – towards a stroke vs away from a seizure
Acute vestibular syndrome

• Dizziness / giddiness – what does this mean?
  • True rotational vertigo vs. presyncope vs. unsteadiness

• Population-based study – only 3% of emergency presentations for ‘dizziness’ have posterior circulation ischaemia.

• Dix-Hallpike & Head-impulse tests are specific but not sensitive.

• In those with vascular risk factors – difficult to determine.

Kerber et al 2006
Posterior circulation Ischaemia

• Unlikely if isolated:
  • Unsteadiness / vertigo
  • Dysarthria
  • Diplopia
  • Drop-attacks
  • Simultaneous bilateral weakness
  • Sensory loss confined to one part of face / limb

Usually at least 2 of these posterior circ. symptoms present in true ischaemia.
HINTS

• Nystagmus – unidirectional = vestibular – bidirectional = central.

• Test of skew – abnormal vertical skew = central.

• Head impulse test – abnormal catch up saccades = vestibular / nerve
  no catch up saccades = ? Central

Sensitivity for ruling out stroke 100%, specificity 96%.

Kattah et al. Stroke, 2009
Functional Disorders

• Frequently triggered – panic attack or dissociative episode.
  • Non-ergonomic gait.
  • Inconsistent history / neurology.
  • Hoover’s sign / give way weakness.
  • Indifferent appearance.

• Can be very difficult – ‘soft ware’ problem vs ‘hard ware’.
• Benefit from CBT, psychological input.
Safety of tPA in stroke mimics and neuroimaging-negative cerebral ischemia

- 512 patients receiving tPA over 4 years.
- 21% non-stroke.
- ICH rate among stroke mimics – 0%.

Among meta-analyses - <1% ICH

Cherneyshev et al 2010
Out of hours (OOH) thrombolysis

- Often employs telemedicine.
- Reliable and safe.
- Often incurs extra delays:
  - NZ – 33 mins
  - Australian – 15 mins
- Most patients admitted OOHs!

Fang et al. J Stroke Cerebro Dis, 2014
Early presenters

• Effect seen in a number of studies.

• Early presentation – ‘lots of time before 4.5 hours is up’.

• Results in unnecessarily increased DNT’s.

• Often the most to gain!
Conclusions

• Rapid recognition and assessment of patients with stroke can be challenging.

• Improved and enhanced patient pathways can result in quicker delivery of urgent and time dependent treatments.

• Do as much before the patient arrives to hospital and as little as required once the patient has arrived.
Conclusions

• Thrombolysis of stroke mimics is difficult to avoid – risks are very low.

• Main challenges ahead will be:
  • To incorporate triage mechanisms for patients eligible for thrombectomy.
  • Ensure low DNTs in ‘out of hours’.

• Improved treatment times will benefit individual patients and society as a whole.
Thank You

Questions?