

Aggregation of marginal gains in the care of acute stroke

The chain of events between a patient first suffering symptoms of acute ischaemic stroke and receiving treatment in an acute stroke unit contains the potential for many delays. Identifying and minimizing these delays can make the difference between life and death, serious debilitation and complete recovery.

At the recent Olympic Games the performance director of the all-conquering British cycling team coined a phrase: 'aggregation of marginal gains'. It describes the process of identifying minor enhancements whose combined effect is to produce highly significant improvements in performance.

For the cyclists in Beijing the reward was eight gold medals. In the Southend acute stroke unit the same philosophy has been used to save lives.

By identifying and minimizing a series of potential delays in the transfer, assessment and treatment of patients with acute ischaemic stroke the authors have been able to reduce mortality rates from 27% in 2005–6 to 12.6% during the period between September 2007 and March 2008 (Table 1). They now thrombolysed 15% of patients with acute ischaemic stroke compared to a national target of 10% and a national average of under 1% (Intercollegiate Stroke Working Party, 2008).

Of the 56 patients who have been thrombolysed in the authors' unit in 2008, 14 have walked out of the hospital with no disability whatsoever and 55% have had a positive outcome as judged by the National Institutes of Health Stroke Scale (National Institutes of Health, 2003). The average length of hospital stay for acute ischaemic stroke patients has reduced from 30 days in 2005 to under 18 days. The average door-to-needle time is currently around 30 minutes.

The key to this success has been the systematic reduction of delays throughout the stroke chain of survival. Every link of this chain:

- Detection of symptoms
- Dispatch of ambulance
- Delivery to hospital
- Door admission policy
- Data processing
- Decision making
- Drug delivery;

has been examined to determine where delays exist and how they can be minimized. The authors' experience shows that even a few minutes saved here and there can add up to make the difference between life and death, serious debilitation and complete recovery.

Time is brain

It is well established that time is of the essence in treating acute ischaemic stroke. For every minute that an acute ischaemic stroke goes untreated, 1.9 million neurons, 14 billion synapses and 7.5 miles of myelinated fibres are destroyed (Saver, 2006). For every hour that treatment is delayed, the ischaemic brain ages 3.6 years.

The Department of Health (2007) has estimated that if just 10% of acute ischaemic stroke patients were to receive thrombolysis, over 1000 people would regain their independence rather than die or face long-term dependency.

The key to a favourable outcome appears to be the early administration of thrombolytic therapy. A pooled analysis of the ATLANTIS, ECASS, and NINDS trials found that, compared to placebo, the odds of a favourable outcome were 2.8 times higher in patients given recombinant tissue plasminogen activator (rt-PA) within 90 minutes of symptom onset and 1.6 times higher if given between 91 and 180 minutes (Hacke et al, 2004).

Intravenous thrombolysis with alteplase also appears to be safe and efficacious in the 3–4.5 hour time window

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Table 1. Southend audit data

Year	No of acute ischaemic stroke patients	Mortality rate	Average length of hospital stay	Discharged to live independently at home	Discharged to residential or nursing home
2005–6	395	27%	30 days	32.4%	15.1%
2006–7	346	23.4%	26.5 days	31.7%	14.6%
Sept 2007–March 2008	240	12.6%	17.8 days	55%	9%

(Hacke et al, 2008). However, the drug license is currently still limited to 0–3 hours. Consequently the patient may have more time, but the physician does not.

Delays in detection

In 2005 a MORI poll commissioned by the Stroke Association (Stroke Association, 2005) suggested that 51% of the population could not identify what a stroke is and only 40% could correctly name three stroke symptoms. Only a third of respondents would call an ambulance or go to hospital. Just over half of GPs said they would immediately refer someone they suspected was suffering a stroke.

A study by Harraf et al (2002) found that only 37% of stroke patients arrived at hospital within 3 hours of the onset of their symptoms. The average delay was 6 hours. Patients referred by their GP waited on average 7 hours 12 minutes before arriving at hospital. By contrast, those using the emergency services arrived after a median delay of 2 hours 3 minutes.

Clearly there is a need to increase public and professional awareness of stroke symptoms and the importance of immediately calling the emergency services. An education campaign has been carried out in Southend targeting the public, local media and primary care staff including GP receptionists. The message of the campaign is the 'FAST' protocol for recognizing stroke:

- Facial weakness
- Arm weakness
- Speech problems
- Test all three and dial 999 if they point to a stroke.

Delays in dispatch and delivery

Once the emergency services have been called, it is essential that cases of potential stroke are prioritized. After negotiation with the ambulance service in Essex, potential strokes have now been reclassified from category B (target time of ambulance arrival: 20 minutes) to category A (target time: 9 minutes).

Elsewhere the implementation of a rapid ambulance protocol for stroke has resulted in significant improvements. For instance, in Newcastle the mean time between onset of symptoms to arrival at hospital is 1 hour 12 minutes for patients admitted under a rapid ambulance protocol, compared to 6 hours for patients admitted via GPs (Harbison et al, 1999). Diagnostic accuracy was maintained above 80%.

Paramedics in Southend have all been trained in the FAST protocol and will record the estimated time of symptom onset before conducting a 'blue light' transfer to the acute stroke unit. They will pre-alert the hospital that a potential stroke case is arriving. Paramedics also encourage a member of the family or a carer to accompany the patient in the ambulance to help answer any queries during the patient assessment.

Delays at the door

Any potential acute ischaemic stroke patient who arrives at hospital, whether by ambulance or self-admission should be assessed using the ROSIER (Recognition of Stroke in A&E; accident and emergency) criteria (Table 2). In one study of over 340 admissions, this system achieved a sensitivity of 92% and a specificity of 86% (Nor et al, 2005).

At Southend a daily transient ischaemic attack clinic is also conducted to identify high risk patients.

Data processing, decision making and drug delivery

All patients with suspected acute ischaemic stroke are reviewed in the accident and emergency resuscitation room and given thrombolysis there if they meet the criteria. To reduce portering delays, medical staff from the stroke unit or accident and emergency take samples to the lab themselves and also transfer patients for computed tomography (CT) scanning.

Patients who satisfy the eligibility criteria for thrombolysis according to the summary of product characteristics (Boehringer Ingelheim, 2007) – less than 3 hours since symptom onset, intracranial bleeding excluded by CT scan, under 80 years of age – are then informed of the risks and benefits of thrombolysis and asked for their verbal consent. Once consent for thrombolysis is given the patient receives a final review by a consultant stroke physician who then authorizes the treatment.

If there is doubt about whether the patient should receive thrombolysis or not, the patient is offered the option to join the MRC Third International Stroke Trial. This is an international multi-centre, randomized, controlled trial to investigate the safety and efficacy of treatment with intravenous rt-PA within 6 hours of onset of acute ischaemic stroke. This trial is designed to help ascertain:

- What is the 'time window' for thrombolysis? The current data suggest that the time window for treatment with thrombolysis may extend out to 6 hours from stroke onset

Table 2. Recognition of Stroke in A&E (ROSIER)

	Yes	No
Has there been loss of consciousness or syncope?	-1	0
Has there been a seizure?	-1	0
Asymmetric facial weakness?	1	0
Asymmetric hand weakness?	1	0
Asymmetric leg weakness?	1	0
Speech disturbance?	1	0
Visual field disturbance?	1	0

If total score >0 stroke likely; if total score -2, -1 or 0 stroke unlikely. A&E = accident and emergency.
From Nor et al (2005)

- What is the effect of thrombolysis in older patients? Only 42 patients aged over 80 years old have been included in the rt-PA trials to date (mainly as a consequence of the 80 years age limit in the ECASS studies).

Thrombolysis is delivered by a trained physician and consists of 0.9 mg/kg (maximum 90 mg) of alteplase given intravenously over 1 hour: 10% given as a bolus over 2 minutes and the remainder via a syringe pump over 1 hour (Boehringer Ingelheim, 2007).

All patients with a confirmed stroke are transferred to the acute stroke unit. This comprises a multidisciplinary team, 14 acute beds and 27 rehabilitation beds.

A key element of care for people with acute stroke is the maintenance of cerebral blood flow and oxygenation to prevent or reduce the burden of secondary brain damage. All patients undergo continuous physiological monitoring of blood pressure, oxygen saturation and blood glucose, as well as routine testing of urea and electrolytes, cardiac rhythm, respiratory and neurological function. People who have had a stroke receive supplemental oxygen only if their oxygen saturation drops below 95% (National Institute for Health and Clinical Excellence, 2008).

People with acute stroke should be treated to maintain a blood glucose concentration between 4 and 11 mmol/litre (National Institute for Health and Clinical Excellence, 2008). Optimal insulin therapy, which can be achieved by the use of intravenous insulin and glucose, is provided to all adults with diabetes.

Antihypertensive treatment in people with acute stroke is recommended only if there is a hypertensive emergency. Blood pressure reduction to 185/110 mmHg or lower is mandatory in people who receive thrombolysis (National Institute for Health and Clinical Excellence, 2008).

Rehabilitation services include physiotherapy (including respiratory physiotherapy), speech and language therapy (including swallowing), dietetic services (including nutrition screening) and critical care for stroke patients who require enhanced monitoring or who develop complications.

KEY POINTS

- Southend University Hospital has reduced mortality rates in patients with acute ischaemic stroke from 27% in 2005–6 to 12% in 2008.
- This success has been achieved through the systematic reduction of delays throughout the stroke chain of survival.
- Early administration of thrombolytic therapy in eligible patients is key to a favourable outcome.
- Use of the FAST protocol and the ROSIER assessment criteria by paramedics has dramatically reduced the time of assessment.
- All patients with a confirmed stroke are transferred to the acute stroke unit.

The future

According to the latest Sentinel Stroke Audit, 96% of hospitals in England now offer specialist acute stroke care with 54% having an acute stroke unit and 47% a combined stroke unit (Intercollegiate Stroke Working Party, 2008). However, the rate of thrombolysis, at 0.8% of stroke admissions, is still lamentably low. It is also disappointing that 81% of stroke patients are still being initially admitted to a general rather than an acute stroke unit. In Southend the authors have shown that an acute stroke unit can significantly increase the availability of thrombolysis for patients with acute ischaemic stroke resulting in reduced morbidity and mortality. Ideally such a service would be offered 24 hours a day 7 days a week – around 20% of thrombolysis in the authors' unit takes place out of office hours. This would require an increase in the number of stroke physicians (there are currently two) although there is potential to combine forces with other acute stroke units using telemedicine and web-based assessments under strict protocols. This, along with developments such as intracranial clot aspiration, intra-arterial thrombolysis and stenting, may be the future for acute stroke care. But for the present the authors will continue to seek out delays in the stroke survival chain and endeavour to aggregate these marginal gains. **BJHM**

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