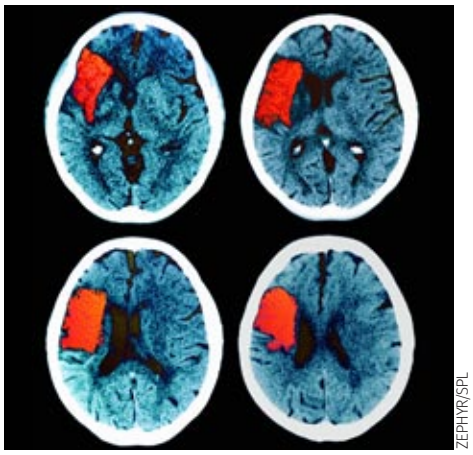
Getting the priorities right for stroke care

Cathie Sudlow and **Charles Warlow** question whether the current emphasis on hyperacute stroke care to improve access to thrombolysis may distract attention and resources from a truly comprehensive stroke service



ZEPHYR/SPL

Coloured computed tomographic scans of the brain of a stroke patient

Stroke services in the UK are currently being overhauled in response to the UK government's 2007 national stroke strategy.[1] The strategy was developed after the National Audit Office (NAO) report on stroke services laid out the features of a first rate service and how improvements in the service could reduce death, disability, and recurrent stroke along with costs.[2] The strategy highlights markers of a quality service (box) that are entirely appropriate. However, possibly inaccurate estimates of clinical benefits and cost savings in the NAO report may have influenced subsequent plans for stroke services.[3 4] These have a strong emphasis on hyperacute stroke care (the first 72 hours) and on greatly increasing the proportion of patients being given intravenous thrombolysis, but with the risk that the many other effective components of a comprehensive stroke service might not receive as much attention. The stroke strategy for London is a good example.[5]

London's stroke strategy

The plan is for all acute stroke patients to be taken by ambulance to a "hyperacute stroke unit" less than 30 minutes away and immediately assessed by a specialist who will arrange prompt computed tomography of the brain and intravenous thrombolysis if appropriate, within 30 minutes. After the first 72 hours, patients will be transferred to a non-hyperacute stroke unit in the same or a nearby hospital for ongoing care.[5] The estimated cost to London is £23m (€26m; $36m) a year: £21m for the acute stroke hospital costs, £1m for necessary developments in the ambulance service, and £1m for rehabilitation and community care costs as a result of changes in the acute system.[5] Of potential concern is that some hospitals that have performed consistently well in the national sentinel stroke audit[6] are unlikely to have hyperacute stroke units, whereas others that have performed less well, will have units.[7]

The stroke strategy for London aims to be comprehensive, and so the need for a stroke prevention plan and for commissioning of rehabilitation and early supported discharge services is mentioned. However, the current and future costs of these crucial parts of the stroke service have unfortunately not yet been evaluated, even though the new acute stroke service will be phased in from later this year.[5] This is of particular concern given that Dudley and Blacktop have suggested that the NAO report overemphasised the benefits and cost savings to be gained from thrombolysis and underestimated the gains from comprehensive care in a stroke unit.[8] In the light of these criticisms, we have examined the current performance of stroke services against what we know works for acute stroke and revisited how the NAO reached its conclusions.

Markers of quality stroke service from UK stroke strategy[1]

- *Awareness raising*—Educating the public and health and care staff
- *Managing risk*—Assessment and management of vascular risk factors
- *Information and advice*—For people with stroke
- *Involving patients with stroke and their carers in service development*
- *Prompt assessment and follow-up of transient ischaemic attack and minor stroke*
- *Acute stroke urgent response, assessment, and treatment*—Immediate transfer to a hospital with 24 hour hyperacute services for expert triage, clinical assessment, urgent brain imaging, intravenous thrombolysis if appropriate, prompt access to an acute stroke unit, and early multidisciplinary assessment
- *High quality specialist rehabilitation* in hospital and following discharge
- *Seamless transfer of care* from hospital to community
- *Long term care and support*—Local services to support people with stroke and their carers
- *Assessment and review* of health, social care, and secondary prevention need after stroke and then annually
- *Enabling patients and carers to return to work and participate in community life*
- *Workforce review and development, including of staff leadership and skills*
- *Stroke networks* to organise services
- *Research and audit* by all trusts

How are we doing now?

The three evidence based, effective interventions for stroke are organised stroke unit care (not specifically hyperacute care) for all patients with acute stroke,[9] early administration of aspirin for almost all patients with acute ischaemic stroke,[10] and intravenous thrombolysis for selected patients with acute ischaemic stroke.[11] While aspirin can be given in primary or secondary care, and to outpatients as well as inpatients, admission to a stroke unit and thrombolysis clearly both require hospital admission, and thrombolysis is suitable only for those who arrive early enough to be assessed and have a brain scan to exclude intracranial haemorrhage within three hours of symptom onset, and who fulfil the other licence criteria, the most restrictive of which is age <80 years.[12]

In the UK, hospital admission rates for acute stroke in recent community based stroke incidence studies range from 56% in Oxfordshire[13] through 83% in South London[14] to 91% in the Scottish Borders.[15] At least part of this variation is the result of differences in definition of hospital admission: in the Oxford Vascular Study, this clearly implies admission for inpatient care[13]; it is unclear for the South London Stroke Register (but admission rates may be higher in London given the relatively high proportion of stroke cases that occur among visitors to the city who are not registered with a general

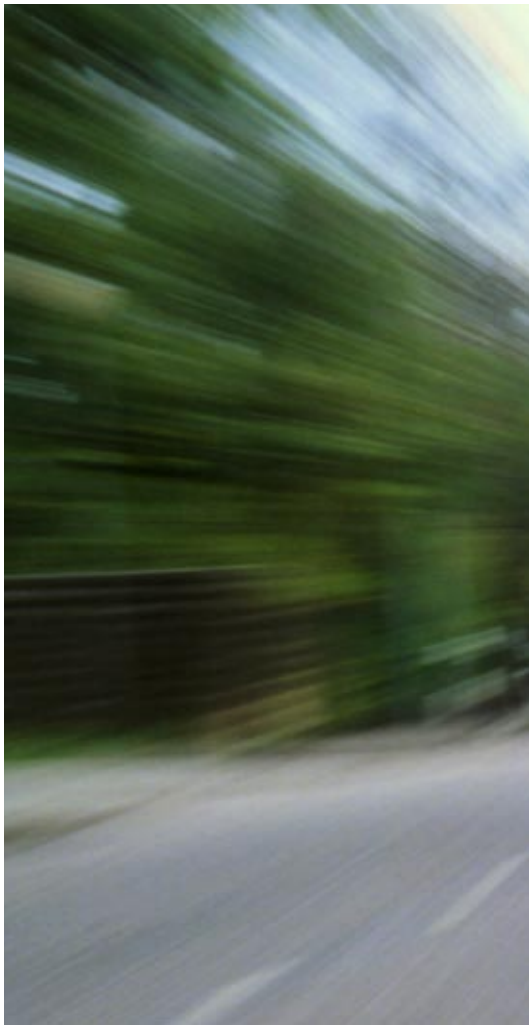


Table 1 | Estimated effects of interventions for acute stroke on poor outcome (death or dependency) in a notional UK population of one million people and 2260 patients with a first or recurrent acute stroke each year*

Intervention	Relative risk reduction (%)	% of population with poor outcome		Absolute risk reduction (%)	No of poor outcomes avoided/1000 treated	No treated to prevent one poor outcome
		Without intervention†	With intervention			
Stroke unit‡	8	55	50.6	4.4	44	23
Aspirin§	3	50	48.5	1.5	15	67
Thrombolysis¶	17	60	49.8	10.2	102	10

*Estimated number of stroke patients taken from recent population based study of stroke incidence in Oxfordshire (population structure closely resembles that of the UK).[19]
†Estimate of outcome without stroke unit care at one year and without aspirin at three months (ischaemic stroke patients only) from Oxfordshire community stroke project (done in 1980s before these interventions were widely used);[20] estimate of outcome at three months without thrombolysis taken from control groups of randomised trials assessing intravenous alteplase within three hours in the Cochrane systematic review,[11] since patients eligible for treatment with thrombolysis are not typical of ischaemic stroke patients in the community.
‡Estimate of relative effect of stroke unit versus general medical ward at one year from the most recent Cochrane systematic review.[9]
§Estimate of relative effect of aspirin at three months from the most recent Cochrane systematic review.[10]
¶Estimate of relative effect of intravenous alteplase (within three hours of symptom onset) at three months from the most recent Cochrane systematic review.[11]

practice)[5 14]; and in the Scottish study the 91% refers to patients who were reviewed at the hospital but the proportion actually admitted for inpatient care was not stated.[15]

Patients not admitted for inpatient care are generally—and appropriately—those with a very mild stroke (for which there is a smaller proportional benefit from organised stroke unit care and no clear evidence of benefit from intravenous thrombolysis) or a very severe stroke with pre-existing poor quality of life and a poor prognosis. Around a quarter of all strokes in the population are very mild strokes from which patients recover quickly to independence without specific treatment.[13] Such patients do not necessarily need to be admitted to hospital but, because of the high early risk of recurrence, should be assessed and treated urgently in an outpatient neurovascular service, as should people with transient ischaemic attacks.

The most recent national sentinel stroke audit gives data on treatment of patients with stroke admitted to hospital for inpatient care (not those who remain in the community).[6] In 2008, 68% of patients admitted with an acute stroke spent more than half of their admission on a stroke unit, 85% of inpatients with acute ischaemic stroke and without a contraindication (which we estimate to be 72% of all acute stroke admissions) received early aspirin, and 1.4% of all inpatients with acute ischaemic stroke received intravenous thrombolysis (less than 10% of those deemed eligible because they were in hospital within three hours and younger than 80).[6] All of these figures can—and should according to the existing evidence—be improved on. The question is, how much improvement can we realistically expect and what will be the net benefits and costs?

NAO arithmetic

The NAO addressed this question with reference to a formal and extensive analysis of the costs of stroke, the benefits of all the various interventions, and an economic model to predict the net benefits of changes from levels of service provision in 2004 to target levels.[2 16] It summarised this analysis by reporting that increasing stroke unit admissions from 50% to 95% would cost up to £54m and would lead to 991 fewer deaths and 368 more people being independent each year in the population of England; while giving intravenous thrombolysis to 9% of all stroke patients in England would cost £9.9m. Because of higher rates of recovery to independence among those treated this would lead to savings of £26.4m, a net saving of about £16m.[2] It is impossible directly to compare these two interventions because the report did not give the increase in numbers of patients recovering to independence for

Table 2 | Effect of interventions for acute stroke on poor outcome (death or dependency) based on current performance and realistic and optimistic targets for future performance*

Intervention	No (%) treated (n=2260)			No needed to treat to prevent one poor outcome§	No (%) of 1240 poor outcomes in population avoided†			Drug cost per poor outcome avoided (£s)¶
	Current performance‡[6]	Realistic target	Optimistic target		Current performance	Realistic target	Optimistic target	
Stroke unit	859 (38)	1356 (60)	1695 (75)	23	37 (3)	59 (5)	74(6)	—-
Aspirin	1627 (72)	1921 (85)	1921 (85)	67	24(2)	29 (2)	29 (2)	67
Thrombolysis	23 (1)	113 (5)	226 (10)	10	2 (0.2)	11(1)	23 (2)	4350

*Basis of estimate for a notional population of 1 million described in table 1.
†1240/2260 (55%) estimated to be dead or dependent at three months or at one year without any treatment.[20]
‡For stroke units and for thrombolysis this assumes that 56% of patients are admitted to hospital after a stroke[13] and, for stroke units, that the 68% spending >50% of their admission on a stroke unit[6] obtain the full benefit reported in the Cochrane stroke unit review; for aspirin this assumes that the proportion of patients with ischaemic stroke not admitted to hospital receiving aspirin within 48 hours is the same as the 85% of patients with ischaemic stroke without contraindications to aspirin who are admitted to hospital[6].
§ From table 1.
¶Drug costs to nearest pound (£1/patient for aspirin; £435/patient for intravenous alteplase).[21]

MIKE DEVLIN/SPL

The rush to give patients intravenous thrombolysis in a specialist unit should not be at the expense of other parts of the service

thrombolysis, and only the costs but not the savings of stroke unit care were provided.

However, Dudley and Blacktop's concerns about the calculations seem to be well founded.[8] The NAO estimated the potential cost savings from intravenous thrombolysis for acute ischaemic stroke based on delivering treatment to 9% of all stroke patients in England, on the grounds that this was achieved at Box Hill Metropolitan Hospital in Melbourne, Australia.[2] But the Box Hill figure was 9% of stroke patients admitted to the hospital (27/300 acute stroke admissions each year), which we calculate to be equivalent to just over 1% of all incident and recurrent stroke patients in the local population of 800 000 (estimated from a recent study of stroke incidence in another part of Melbourne to be about 2300 a year[17]). Closer to home, the Southern General Hospital in Glasgow has one of the UK's highest rates for thrombolysis; 11% of patients admitted to the stroke unit are treated, but we calculate this to be less than 4% of all strokes occurring annually in the local population of 370 000 (estimated from a recent study of stroke incidence in Oxfordshire to be about 840[13]).

Furthermore, it is difficult to assess the reliability of the NAO's estimates of potential benefits or cost savings from either stroke units or intravenous thrombolysis, since the description of the economic model it used is neither completely transparent nor consistent[16]—for example, it produced figures for numbers of deaths prevented by intravenous thrombolysis and for numbers of recurrent strokes prevented by stroke unit care when the estimates used in the model for the effects of these interventions did not show reductions in either of these outcomes.[16 18]

Our arithmetic

We have made our own transparent estimates of the net benefit (in terms of numbers avoiding death or dependency) of the three proved interventions for acute stroke at current UK levels of service provision (estimated from the 2008 national sentinel stroke audit figures) and at what we consider realistic and optimistic target levels (tables 1 and 2).

Subject to several explicit (and modifiable) assumptions (see table footnotes), these show that at present, in a notional UK population of one million people, intravenous thrombolysis is preventing two patients from having a poor outcome each year, while stroke unit care and aspirin are preventing 37 and 24 poor outcomes, respectively. If 5% of all 2260 stroke patients in our notional population of one million could be treated with intravenous thrombolysis within three hours (a greater than fivefold increase in what is currently being achieved UK-wide, and an improvement even on the highest rates in the UK), then 11 would avoid a poor outcome, while increased rates of stroke unit admission and early aspirin administration would lead to 59 and 29 patients avoiding a poor outcome, respectively. Even more optimistically, intravenous thrombolysis given to 10% of all acute stroke patients in the population could avoid 23 poor outcomes, and yet higher stroke unit admission rates (requiring an increase in the proportion of acute stroke patients currently managed as inpatients) could avoid 74 poor outcomes. Further increases in aspirin administration are unlikely to be achieved because patients with intracerebral haemorrhage and a proportion of those with ischaemic stroke are ineligible.

The absolute numbers of patients benefiting at current or realistic target levels are far larger for stroke units and aspirin than for intravenous thrombolysis (and they remain higher even at optimistic target levels), since the last is applicable to many fewer patients. Table 2 also shows that the drug costs per poor outcome avoided are much greater for intravenous thrombolysis than for aspirin, despite the much larger absolute benefit of thrombolysis (we have not attempted to estimate non-drug costs or the costs of stroke unit versus general medical ward care). If further evidence from ongoing randomised trials shows that a wider range of patients could benefit from intravenous thrombolysis—for example, those aged over 80 years or with symptom onset more than 3 hours before treatment[22]—a target of treating 30% or more of acute stroke patients in the population may become realistic, and reduction in poor outcomes could potentially increase further, but more evidence is required.

Beyond hyperacute care

To achieve a higher rate of thrombolysis we will need to make radical changes to local

systems, such as those being planned for London. These may bring other benefits too, such as improved recruitment into much needed trials of interventions for acute stroke, but we must be careful that the emphasis on developing hyperacute stroke care, mainly to allow delivery of thrombolysis to the small proportion who may benefit, does not distract attention and resources from the other proved interventions. We might assume that so long as more patients with stroke can be transferred quickly to dedicated hyperacute stroke units, the rest will all fall into place. But this will happen only if the expertise in the excellent centres in London that will no longer be providing hyperacute care is maximally tapped into; if the additional transfers needed from hyperacute to non-hyperacute stroke units occur without discontinuity of care or duplication (requiring better than the usual standard of record keeping); and if adequate resources are made available for stroke prevention initiatives and for much needed developments in rehabilitation services.[6]

Although it is important to give intravenous thrombolysis in an appropriate setting to as many eligible patients as possible, it is crucial that this should not be at the expense of any of the other parts of a comprehensive stroke service. All elements of effective stroke care must be properly joined up, and funded, from hyperacute care to long term community support.

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Provenance and peer review: CS is an epidemiologist and consultant neurologist at the University of Edinburgh and has research interests in epidemiology of and treatment and prevention of stroke. CW has contributed throughout his career to the evidence base for managing stroke, from acute treatment to prevention. Both authors drafted and revised the article together, using their knowledge of stroke, its management and service reorganisation, with extensive reference to all the relevant government documents and reports mentioned. CS did (and CW checked) the calculations in the table. CS is guarantor.
Competing interests: CW is on the steering committee of the third international stroke trial of thrombolysis for acute ischaemic stroke, and both authors are members of the Stroke Research Group in Edinburgh, where this trial has its coordinating centre.
Provenance and peer review: Commissioned; externally peer reviewed.

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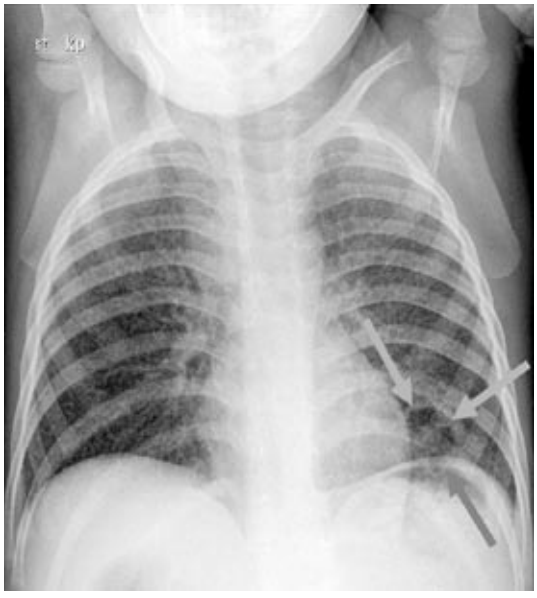
ANSWERS TO ENDGAMES, p 1451. For long answers use advanced search at bmj.com and enter question details

PICTURE QUIZ

A 2 year old girl with fever, cough, and tachypnoea

1 The two major abnormalities that can be seen on the patient's chest radiograph are a cavitating pulmonary lesion and widespread bilateral fine reticulogranular (miliary) shadowing.
2 On the basis of the history and the radiographic findings the most likely diagnosis is miliary tuberculosis.
3 A tuberculin skin test (Mantoux test), microscopy and culture of appropriate clinical specimens (such as sputum, gastric aspirates, bronchoalveolar lavage fluid, urine, cerebrospinal fluid, and blood), and an interferon-γ release assay are the most useful initial tests.



Chest radiograph showing bilateral miliary infiltrates and outlining the cavitating pulmonary lesion in the left lower lobe (arrows)

CASE REPORT

The management of accidental hypothermia

1 Basic life support should continue until core temperature is greater than 30°C. Cardioactive drugs and further defibrillation should be withheld until this temperature is reached.
2 Invasive rewarming methods should be used, such as airway warming; warm bladder, pleural, peritoneal, or nasogastric lavage; and, if available, partial cardiopulmonary bypass
3 Resuscitation should continue until core temperature is more than 30°C or be discontinued if the patient has obvious lethal injuries.

STATISTICAL QUESTION

Sampling distributions

c