What is the best imaging strategy for acute stroke?

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Executive summary

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Objectives

- To determine the cost-effectiveness of computed tomographic (CT) scanning after acute stroke.
- To assess the contribution of brain imaging to the diagnosis and management of stroke.
- To estimate the costs, benefits and risks of different imaging strategies.
- To provide data to inform national and local policy on the use of brain imaging in stroke.

Methods

A decision-analysis model was developed to represent the pathway of care in acute stroke using 'scan all patients within 48 hours' as the comparator against which to cost 12 alternative scan strategies. Data were obtained from: systematic reviews of brain imaging, antithrombotic, anticoagulant and thrombolytic treatment, and cost-effectiveness of CT in stroke; a large UK hospital stroke registry; the Information and Statistics Division of the Scottish Office; a survey of all Scottish CT scanning departments; the Scottish Office; and a direct comparison of CT and magnetic resonance imaging (MRI).

The primary data for the model were generated in the Department of Clinical Neurosciences in Edinburgh, drawing on: the teaching hospital stroke registry (1990–9); the Cochrane Stroke Review Group; two multicentre international trials [the International Stroke Trial (IST) and the Chinese Acute Stroke Trial (CAST) of 40,000 patients conducted in 36 countries worldwide] and substudies on quality of life; a primary comparison of CT with MRI; and expert clinical knowledge where data were lacking. Data on access to CT for stroke and costs came from three representative Scottish hospitals. The health economics modelling was conducted by the Health Economics Research Unit in Aberdeen. Systematic reviews were undertaken by both departments.

Subjects were patients admitted to hospital with a first stroke and those managed as outpatients.

Interventions comprised the effect: on functional outcome after ischaemic or haemorrhagic stroke, tumours or infections, of correctly administered antithrombotic or other treatment; of time to scan and stroke severity on diagnosis by CT or MRI; on management, including length of stay, functional outcome, and quality-adjusted life years (QALYs), of the diagnostic information provided by CT scanning; the cost-effectiveness (cost versus QALYs) of different strategies for use of CT after acute stroke.

The main outcome measures were death and functional outcome at long-term follow-up (6 months, 1 year and 2 years); accuracy of CT and MRI; cost of CT scanning by time of day and week; effect of CT diagnosis on change in health outcome, length of stay in hospital and QALYs; cost-effectiveness of various scanning strategies.

Results

Clinicians disagree on the clinical diagnosis of stroke (versus not stroke) in about 20% of patients. It is impossible to differentiate infarct from haemorrhage by clinical examination. CT is very sensitive and specific for haemorrhage within the first 8 days of stroke only. Suboptimal scanning used in epidemiology studies suggests that the frequency of primary intracerebral haemorrhage (PICH) has been underestimated.

Aspirin increases the risk of PICH. There was no evidence that a few doses of aspirin given inadvertently to patients with acute PICH significantly increased the odds of death [odds ratio (OR) 0.96, 95% confidence interval (CI) 0.62 to 1.5] or recurrent intracranial haemorrhage (OR 1.02, 95% CI 0.5 to 1.8), so long as only a few doses were given. There were no reliable data on functional outcome or on the effect of antithrombotic treatment given long term after PICH. In 60% of patients with recurrent stroke after PICH, the cause is another PICH and mortality is high among PICH patients.

Among 232 patients (mainly outpatients) with mild stroke, 3% had a PICH and 15% had haemorrhagic transformation of an infarct. CT did not reliably detect PICH after 8 days. A specific

MR sequence (gradient echo) is required to identify prior PICH reliably.

CT scanners were distributed unevenly in Scotland (0.8, range 0.05–0.36/10,000). A total of 65% provided CT scanning within 48 hours of stroke, and 100% within 7 days for hospital-admitted patients, but access out of hours was very variable, and for outpatients was poor. The average cost of a CT brain scan for stroke in the NHS in Scotland ranged from £30.23 to £89.56 during normal working hours and from £55.05 to £173.46 out of hours.

Average length of stay was greatest for severe strokes and those who survived in a dependent state (alive and independent, 14 days; dependent, 51 days; and dead, 33 days).

For a cohort of 1000 patients aged 70–74 years, the policy 'scan all strokes within 48 hours' cost £10,279,728 and achieved 1982.3 QALYs. The most cost-effective strategy (least overall cost and most QALYs) was 'scan all immediately' (£9,993,676 and 1982.4 QALYs). The least cost-effective was 'scan patients on anticoagulants, in a life-threatening condition immediately and the rest within 14 days' (£12,592,666 and 1931.8 QALYs). 'Scan no patients' (but treat on the basis of clinical diagnosis alone) reduced QALYs (1904.2) at increased cost (£10,544,000).

Conclusions

In general, strategies in which most patients were scanned immediately cost least and achieved the most QALYs, as the cost of providing CT (even out of hours) was less than the cost of inpatient care. Increasing independent survival by even a small proportion through early use of aspirin in the majority with ischaemic stroke, avoiding aspirin in those with haemorrhagic stroke, and appropriate early management of those who have not had a stroke, reduced costs and increased QALYs. Sensitivity analyses to vary the cost of scanning, different age ranges, proportions of infarcts, haemorrhages or tumours/infections, accuracy of CT, utility weights, and length of stay assumptions did not alter the ranking of strategies. However, although, the model was sensitive to reducing the cost of inpatient care, 'scan all immediately' remained the dominant strategy.

Recommendations for research

Future research should obtain better data on:

- the use of antithrombotic treatment in acute PICH in patients at risk of DVT or ischaemic vascular events
- whether secondary prevention of ischaemic events with antithrombotic treatment is safe and effective in patients with prior PICH
- best management of acute PICH
- the proportion of first and recurrent stroke due to infarct or haemorrhage by age and severity
- costs of stroke care in hospital and in the community
- the accuracy of, and better methodology for assessing imaging
- improving accuracy of clinical diagnosis of stroke.
- ways of streamlining CT scanning for stroke.

Publication

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NHS R&D HTA Programme

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Initially, six HTA panels (pharmaceuticals, acute sector, primary and community care, diagnostics and imaging, population screening, methodology) helped to set the research priorities for the HTA Programme. However, during the past few years there have been a number of changes in and around NHS R&D, such as the establishment of the National Institute for Clinical Excellence (NICE) and the creation of three new research programmes: Service Delivery and Organisation (SDO); New and Emerging Applications of Technology (NEAT); and the Methodology Programme.

This has meant that the HTA panels can now focus more explicitly on health technologies ('health technologies' are broadly defined to include all interventions used to promote health, prevent and treat disease, and improve rehabilitation and long-term care) rather than settings of care. Therefore the panel structure was replaced in 2000 by three new panels: Pharmaceuticals; Therapeutic Procedures (including devices and operations); and Diagnostic Technologies and Screening.

The HTA Programme will continue to commission both primary and secondary research. The HTA Commissioning Board, supported by the National Coordinating Centre for Health Technology Assessment (NCCHTA), will consider and advise the Programme Director on the best research projects to pursue in order to address the research priorities identified by the three HTA panels.

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