Will telemedicine facilitate access to hyper acute stroke care across the UK?

Delayed and inconsistent adoption of telemedicine among many acute stroke services is undermining recent advances in acute stroke care. Widespread use of telemedicine will be required for stroke care to achieve the standards demanded by the National Stroke Strategy.

The use of telemedicine in the management of acute stroke has attracted considerable academic interest in recent years. Reasons for this include a steadily expanding evidence base to support the safety and efficacy of the technique (Audebert et al, 2006; Wu and Langhorne, 2006; Meyer et al, 2008; Johansson and Wild, 2010). There is now a growing consensus that remote, real-time audiovisual systems can enable stroke specialists to examine patients, view their computed tomography brain scan images and assess their suitability for thrombolysis with similar accuracy to face-to-face contact.

The use of telemedicine also appears to be in line with health policy initiatives advocating a specialist hyper acute stroke service with the potential to deliver intravenous thrombolysis 24 hours a day, 7 days a week, coordinated through a network of hospitals (Department of Health, 2007; National Institute for Health and Clinical Excellence, 2008).

Some regions have responded to these demands by adopting a 'hub and spoke' model for acute stroke care, whereby local hospitals pass suspected stroke patients into a single hyper acute centre staffed 24 hours a day, 7 days a week by specialists. However, such a model poses a number of problems. It may require the patient to travel a considerable distance before reaching the specialist centre. In a condition where 'time is brain', this introduces an undesirable delay. There is also the problem of stroke mimic patients who, upon arrival at the hub, turn out not to have had a stroke and must then be 'repatriated' back to their local hospital. Patient preference is consistently in favour of high quality treatment being carried out closest to home.

Furthermore, a hub and spoke model may create a two-tier system in which specialist staff are relocated from spoke hospitals while the multidisciplinary teams who remain lose essential acute care skills. This may result in a different standard of care for those stroke patients who, for a variety of reasons, never reach a 'hub' hyper acute stroke unit. This group of patients is not insignificant if data for stroke admissions to London hyper acute stroke units, as documented in the Stroke Improvement National Audit Project (2011), are accurate.

In contrast, telemedicine may allow local hospitals to maintain their acute stroke services 24 hours a day – via bedside assessment during standard office hours or by accessing specialist expertise remotely if a suspected stroke patient presents at the weekend or during the night. Transportation delays are reduced and local hospitals continue to deal with complex and challenging patients, which help maintain the skill set of the stroke unit staff.

Telemedicine in the UK

More than 30 acute trusts in the UK are now using telemedicine to provide prompt treatment to acute stroke patients (Daloni Carlisle, 2011). These include Lancashire and Cumbria, which recently produced a Quality, Innovation, Productivity and Prevention business case for its system. The strategic health authority's investment of £285 000 for equipment and £115 000 for annual running costs was expected to yield annual savings of £2.3 million (Daloni Carlisle, 2011).

Other centres leading the way in the use of telemedicine include Royal Bournemouth and Christchurch Hospitals NHS Foundation Trust, the Avon, Gloucestershire, Wiltshire and Somerset Cardiac and Stroke Network, St Thomas' in London, Surrey Stroke Network and the author's own service in East Kent.

However, the expansion of telemedicine beyond these early adopter sites has been disappointing. Some regions have been slow to implement the technology despite the initial agreement of commissioners and clinicians. Other regions seem reluctant to embrace the model, choosing to settle for a service that is partially compliant with the stroke strategy. This reluctance to fully embrace telemedicine may place a significant limitation on the undoubted improvement in acute stroke services seen in the UK over the past few years.

The University of Central Lancashire is currently involved in a detailed analysis of current UK stroke telemedicine practice, looking to produce a standardized telemedicine toolkit for stroke (ASTUTE) for

Dr David Hargroves *is Consultant Physician and Clinical Lead for Stroke Medicine, South East Coast Strategic Health Authority and East Kent Hospitals University NHS Foundation Trust, William Harvey Hospital, Ashford, Kent TN24 0LZ (david.hargroves@ekht.nhs.uk)*

users and commissioners of stroke services. It is hoped that this resource may alleviate some of the concerns limiting adoption.

Treatment of acute stroke

Ischaemic strokes are caused by the blockage of an artery in the brain by a blood clot. Prompt treatment is essential to restore blood flow before major brain damage occurs. For every minute that an acute stroke goes untreated, 1.9 million neurons, 14 billion synapses and 7.5 miles of myelinated fibres are destroyed (Saver, 2006).

For patients without contraindications, the treatment of choice in acute stroke is intravenous thrombolytic therapy. The benefits of this treatment are clearly related to the speed at which it is given after symptom onset.

In a Cochrane review of 26 trials involving 7152 patients, thrombolytic therapy, mostly administered up to 6 hours after ischaemic stroke, significantly reduced the proportion of patients who were dead or dependent (modified Rankin 3 to 6) at 3–6 months after stroke (odds ratio=0.81, 95% confidence interval=0.73–0.90) (Wardlaw et al, 2009).

In a pooled analysis of intravenous thrombolysis from 3670 patients who were allocated to alteplase or placebo in the NINDS, ATLANTIS, ECASS (1, 2, and 3) and EPITHET trials, the adjusted odds of a favourable 3-month outcome compared with placebo was 2.55 (95% confidence interval=1.44–4.52) in patients treated within 90 minutes of symptom onset (Lees et al, 2010).

Improving standards of acute stroke care in the UK

National Institute for Health and Clinical Excellence guidance recommends all patients with suspected stroke be admitted to a specialist acute stroke unit, receive brain imaging promptly and be assessed for their suitability to receive thrombolysis with intravenous alteplase (National Institute for Health and Clinical Excellence, 2008). There is no doubt that the number of patients receiving this standard of care has increased considerably since the publication of the National Stroke Strategy in 2007 (Department of Health, 2007) (*Figure 1*).

All relevant hospitals in England now have a specialist stroke unit and provide access to brain imaging (National Audit Office, 2010). The proportion of applicable patients given a brain scan within 24 hours of arriving at hospital is increasing and some units report that this is over 90% (Stroke Improvement National Audit Programme, 2011). Between 2008 and 2010 the proportion of stroke admissions given thrombolysis increased from 1.8% to 5% (Intercollegiate Stroke Working Party, 2011). Nevertheless, there is ample room for improvement.

Despite the prevalence of specialist stroke units, only 17% of stroke patients reach these units within 4 hours of arriving at the hospital (National Audit Office, 2010). Around 30% of appropriate patients do not receive their brain scans within 24 hours of the onset of their symptoms (Intercollegiate Stroke Working Party, 2011) and, at 5%, the national thrombolysis rate is still considerably lower than the 10% target set in the National Stroke Strategy. It is even further from the 15% of patients that the Intercollegiate Stroke Working Party (2011) believes could benefit from the treatment. Indeed, the Intercollegiate Stroke Working Party has pointed out that a possible relaxation of the time and age limits on alteplase use (currently set at within 3 hours of symptom onset and in patients under 80 years of age) could result in the proportion of patients eligible for treatment with the drug rising as high as 26%.

Clearly, even those centres that have introduced far-reaching improvements in their acute stroke services need to consider all available options to improve these services still further. Those centres that do not currently have access to telemedicine – or that use a very basic form – may find that by adopting a sophisticated telemedicine model, treatment numbers may increase and symptom to needle times reduce.

Figure 1. Telemedicine delivers two of the 20 key quality markers of a stroke service as outlined in the National Stroke Strategy (Department of Health, 2007).

Quality marker 7

All patients with suspected acute stroke are immediately transferred by ambulance to a receiving hospital providing hyper acute stroke services (where a stroke triage system, expert clinical assessment, timely imaging and the ability to deliver intravenous thrombolysis are available throughout the 24-hour period).

Quality marker 9

- All stroke patients have prompt access to an acute stroke unit and spend the majority of their time at hospital in a stroke unit with high-quality stroke specialist care
- Hyper-acute stroke services provide, as a minimum, 24-hour access to brain imaging, expert interpretation and the opinion of a consultant stroke specialist, and thrombolysis is given to those who can benefit
- Specialist neuro-intensivist care including interventional neuroradiology and/or neurosurgery expertise is rapidly available
- Specialist nursing is available for monitoring of patients
- Appropriately qualified clinicians are available to address respiratory, swallowing, dietary and communication issues.

Telemedicine in acute stroke

There is no strict definition of telemedicine. At its most basic it can simply mean using a telephone to offer or receive guidance on the treatment of a patient. To this can be added access to imaging via a laptop computer. The addition of audiovisual support can offer real-time visual images and the opportunity to converse with the patient, relatives and attending hospital staff.

In the UK, the telemedicine systems used in acute stroke often consist of a digital network including a two-way video and audio conference link. There is also a facility for the high-speed transfer of brain scan images.

The system is wheeled to the patient's bedside where the video camera captures clinical signs that the remote consultant can view in real time (*Figure 2*). The consultant, who may be at another clinical setting or at home, can converse with the patient, any attending relatives and with the medical and nursing staff. The consultant can immediately assess brain scan images via picture archive and communication system (PACS) and broadband technology.

Barriers to implementation of telemedicine

Complacency

Ironically, one of the major barriers to wider adoption of telemedicine is the improved standard of care that most acute stroke services are now delivering.

In 2006, fewer than one in five trusts offered access to thrombolysis for at least part of the week; over two-thirds now do so. Where this improvement has been achieved through the reorganization of non-specialist medical services, redesign of a specialist on-call rota or by transferring suspected stroke patients to a specialized hyper acute centre, there may be a reluctance to interfere with a system that appears to be working for at least part of the week.

Figure 2. System used for remote assessment of suspected stroke patients.

However, there are limitations built into some of these systems. The time taken for an on-call specialist to arrive from home, or for a patient to be transferred to the hyper acute centre, is an avoidable delay. In practice, to reduce these delays it seems likely that specialists may not always attend in person. Important decisions on acute stroke care may therefore be made by junior doctors in consultation with a specialist via a mobile phone.

Equally, relying on non-stroke specialist consultants to provide out-of-hours hyper acute care is unproven. All those on a stroke thrombolysis rota should have some ongoing clinical responsibility for stroke inpatients. A sophisticated opinion, based on up-to-date knowledge and experience of the sequelae of acute stroke is required, over and above the decision on use of thrombolysis.

Equipment concerns

A variety of different types and brands of equipment are used to provide telemedicine for acute stroke services. Most systems are based around standard video-conferencing hardware and software. Standard Windows-based PCs are used, allowing access to the patient's clinical notes and any other relevant information systems. Existing networking technologies are used including WiFi and home broadband. The systems normally have a battery back-up in case of power cuts.

There are a number of concerns, both perceived and legitimate, about using the equipment. These include:

- Equipment failure – occasional technical failures do occur and are obviously a major concern in the emergency care of people with acute stroke. However, the risk can be mitigated by contingency plans that should always be in place both at single sites and, particularly, across multiple networked sites. A typical contingency plan would be for the consultant to come in to the hospital or to continue the consultation via telephone with a third party reviewing the cerebral images
- Picture quality – some clinicians are initially disappointed with the quality of picture offered by the system. However, in practice, this is rarely a problem in making the assessment
- Broadband connection – the standard of broadband connection varies considerably around the country. It is often at its worst in the remote areas where telemedicine is most useful. Nevertheless, even in situations where the audio line goes down it is usually possible to continue the consultation via telephone. Indeed, this has the advantage of allowing the consultant to talk privately to patients, relatives and staff
- Mobile phone coverage – again, this is intermittent in some areas of the country.

Cultural resistance

Clearly there is a significant cultural difference between a face-to-face consultation at the patient's bedside and a remote assessment via a video link. Many physicians are concerned that they will lose the intuitive element in their assessments. In practice, it does not take long to develop new audio telecommunication skills and to learn to trust the specialized nursing staff to be your hands on the ground. It is certainly a challenge to examine a patient from 100 miles away, but one that can be overcome.

Concerns over confidentiality and consent

While patient confidentiality and consent are clearly important, good local guidance and protocols usually ensure they rarely present any practical problems. In over 1000 telemedicine consultations carried out by the acute stroke service in East Kent, an objection has never been received from a patient or family member. On the contrary, most have been relieved and keen to receive a specialist opinion so promptly.

As with any consultation or examination it is important to consider where and how the teleconference takes place so that confidentiality can be ensured.

The patient and family should be informed that telemedicine is going to be used and their consent or assent sought. If the remote telemedicine consultant is not employed by the trust where the patient is located, this should also be made clear.

Commissioning challenges

The development of an acute stroke telemedicine protocol requires the involvement, agreement and coordination of numerous health-care commissioners and providers. This kind of consensus can only be achieved through managerial leadership to ensure that the clinical leaders from all the relevant health-care providers are signed up and committed to the policy.

At the time of writing, this leadership should be delivered via stroke networks and commissioned through primary care trusts. The advent of GP consortia covering much smaller populations than current primary care trusts presents a challenge to specialized services that require coordination between commissioning groups. Cooperation between these new commissioning agents will be essential to ensure that a coordinated and rational response continues.

Table 1. First year thrombolysis data (2008–9), East Kent Hospitals University Foundation Trust

	Bedside	Telemedicine
Number of stroke patients assessed	190	278
Number thrombolysed	40 (21%)	64 (23%)
National Institutes of Health Stroke Scale* pre-treatment	12	11
Deaths	6 (15%)	9 (14%)
of which intracerebral haemorrhage	2	1

*nihss-english.trainingcampus.net/uas/modules/trees/windex.aspx. From Pollock et al (2010)

Experience in East Kent

East Kent Hospitals University NHS Foundation Trust is one of the largest hospital trusts in England. It serves a population of 750 000 people, with three acute hospitals and several outpatient facilities providing over 1000 beds.

Covering around half the county of Kent, the acute stroke service faces significant geographical and demographic challenges in delivering a 24 hours a day, 7 days a week specialist stroke service with potential to administer thrombolysis. To address these challenges, the Trust decided in 2008 to implement a horizontal telemedicine service across the three acute hospital sites.

The new service required the employment of 18 extra band six nurses over the three sites and the purchase of video conferencing hardware and software. The equipment was piloted for 3 months and the nurses underwent approximately 3 days of training to gain the skills needed to conduct an abbreviated neurological examination (National Institutes of Health Stroke Scale) and appreciate the treatment challenges of acute stroke. Mandatory radiology training for all clinicians on the rota was required; a radiologist is available to report cranial images out of hours, although this is rarely required with the stroke physician reporting the scans. One-year data showed that the outcomes of patients examined via telemedicine were equivalent to those examined at the bedside (Pollock et al, 2010) (*Table 1*). Comparison of bedside decision making with patients assessed via telemedicine showed that an equivalent proportion of patients were offered treatment with similar outcomes.

Direct benefits of the East Kent Hospitals University NHS Foundation Trust horizontal telemedicine system include:

- Simplicity of use
- Rapid set up (within 3 months)
- Patients receive immediate access to a stroke consultant
- Patients remain at the local receiving hospital
- Patients remain on the local stroke unit for the entirety of their stay.

The system also offers the potential for virtual weekend ward rounds on all three sites. Neurologists with a knowledge and expertise in neurovascular medicine make up 40% of clinicians on the rota.

The future of telemedicine in acute stroke

The use of telemedicine in acute stroke is currently confined to a number of pilot sites that have embraced the system to overcome specific challenges related to geography and demographics. However, as experience with the technique grows, it seems clear that telemedicine offers the potential of significant improvements across the whole spectrum of acute stroke care.

Areas that have adopted the hub and spoke model of acute stroke care could use telemedicine to allow throm-

bolysis to be initiated in the outlying spoke hospital before transfer to the specialist hub. Specialists contributing to the hub rota may also use the system to assess patients remotely thus reducing travelling time, which is of both clinical and economic value with regards to job planning and time off in lieu of on-calls.

Telemedicine also offers the exciting possibility of diagnosing acute stroke patients during their transfer to hospital by ambulance. Early work from Baltimore, USA (LaMonte, 2004) suggested the potential to diagnose ischaemic stroke during a patient's transfer to hospital. On arrival at hospital appropriate patients would be delivered directly to the computed tomography scanner, potentially reducing door-to-needle times. They found that the mean time to treatment for those patients who were assessed in the ambulance was 17 minutes +/- 4 minutes compared to 33 minutes +/- 17 minutes (P=0.0033).

The availability of remote communications technology within the ambulance may also allow the consultant to talk to friends or relatives of the patient. This can offer extremely valuable information on the exact time of symptom onset, thereby guiding the type of imaging performed: either plain computed tomography or with inclusion of a perfusion protocol.

Conclusions

Greater use of telemedicine offers the potential to significantly increase the availability of high quality acute stroke care services that can be accessed promptly 24 hours a day, 7 days a week.

Despite the undoubted recent improvements in the management of acute stroke in the UK, the condition continues to exert a considerable toll in terms of death, disability and health-care costs. Stroke accounts for over 56 000 deaths in England and Wales each year (National Institute for Health and Clinical Excellence, 2008) and there are currently around 300 000 people living with moderate to severe disabilities as a result of the condition (National Audit Office, 2010). In 2008–9, the direct care cost of stroke was estimated at least £3 billion per year, within a wider economic cost of about £8 billion (National Audit Office, 2010).

Effective telemedicine strategies can hasten both the diagnosis of stroke and the implementation of treatment. These benefits extend to stroke mimic patients who will also receive a specialist assessment, differential diagnosis and appropriate treatment without unnecessary transfer to a specialist stroke centre.

The potential for telemedicine exists beyond those rural and remote centres traditionally considered prime candidates for its use. In particular, those centres that have opted for a hub and spoke model of acute stroke care should consider how telemedicine could be integrated into these systems and thereby capitalize on the improvements in care that these centres have already achieved. BJHM

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KEY POINTS

- Remote examination of suspected stroke patients via telemedicine offers the same accuracy as face-to-face contact.
- Treatment and patient outcomes of those assessed via telemedicine are equivalent to those assessed at the bedside.
- Use of telemedicine in acute stroke can reduce the time from symptom onset to initiation of treatment.
- The success of thrombolytic treatment is significantly related to its speed of initiation after symptom onset.
- Telemedicine can allow local hospitals to offer specialist stroke expertise and access to thrombolysis 24 hours a day, 7 days a week.
- Hyper acute stroke centres can use remote diagnosis to reduce the problem of admitting non-stroke patients who then have to be 'repatriated' to local hospitals.
- Telemedicine is cost-effective in acute stroke.